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NOVEMBER 2021

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ELECTRIC RACER**

BALANCE OF POWER –
CHINA V TAIWAN

ATR AT 40

A CHANGING MIDDLE EAST SKYLINE

HOW THE BIG THREE GULF AIRLINES ARE
FACING NEW CHALLENGERS SPRINGING UP



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The 2022 AIAA SciTech Forum, the world's largest event for aerospace research and development, will explore the science, technologies, and policies that are shaping our industry's future and enabling sustainability. The 2022 program features five days of inspiring sessions, high-profile industry leaders, and over 3,000 technical presentations.

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- › Aerodynamic Measurement Technology
- › Aeronautics
- › Aircraft Design
- › Applied Aerodynamics
- › Electric Aircraft Technology
- › Fluid Dynamics
- › Guidance, Navigation, and Control
- › Intelligent Systems
- › Propulsion
- › Transformational Flight
- › Unmanned Systems

Note: In-person sessions will not be broadcast online, however, a prerecorded video summary will be available for all technical presentations.

SPEAKER HIGHLIGHTS

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Chief Scientist, U.S. Air Force

The Honorable Steven J. Isakowitz

President and CEO, The Aerospace Corporation

Laura McGill

Deputy Laboratories Director and Chief Technology Officer for Nuclear Deterrence, Sandia National Laboratories

Pam Melroy

Deputy Administrator, NASA

Brendan Reed

Director, Airport Planning & Environmental Affairs, San Diego Airport Authority

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President, Bajío Aerospace Cluster

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The AIAA logo, featuring a stylized globe icon to the left of the text "AIAA" in a large, bold, sans-serif font. Below "AIAA" is the tagline "SHAPING THE FUTURE OF AEROSPACE" in a smaller, bold, sans-serif font.
AIAA
SHAPING THE FUTURE OF AEROSPACE

EDITORIAL

A ticking countdown to lift-off

Half a century ago last month, Britain bowed out of the (launcher) space part of the space race when its Black Arrow rocket, with the *Prospero* satellite, blasted off from Woomera, Australia, as a swansong to UK rocketry. Today, in 2021, the release of the long-awaited National Space Strategy (NSS) was a welcome update on how the UK's space sector has expanded since 50 years ago, with satellites, data and services, and of its potential future opportunities in orbit with an ambition to be the leader in small satellite launches. Despite the boasts of 'Galactic Britain', the NSS quietly dropped a previous goal to capture 10% of the world space market by 2030 – an ambition that was looking increasingly remote even before 2021. Yet, if the UK is determined to realise the high profile and public goal of an orbital space launch in 2022, it will need to get a move on as the countdown is rapidly ticking down. Unst in the Shetland Islands, the base for both ABL Systems and Skyrora launches with the Lockheed Martin UK-built SaxaVord Spaceport, is still, as *AEROSPACE* goes to press in mid-October, awaiting planning permission from Shetland Council, which is mulling opposition to the development lodged by Scottish nature protection agency NatureScot and Historic Environment Scotland on environmental and heritage grounds. If approved, the SaxaVord spaceport will eventually create 140 jobs at Unst and inject £4.9m a year into the tiny island's economy. Though the small rocket's vertical spaceport facility on Unst is more like Rocket Lab's minimal launch facility in New Zealand than the VAB, gantries, giant crawlers and blast pits that makes up NASA's Cape Canaveral in Florida, there will still need to be concrete laid, roads widened, masts installed and the like. It would be ironic (but perhaps not unsurprising for *Hitchhikers Guide to the Galaxy* fans), if the UK's much-heralded return to the space race next year was kept earthbound by that traditional obstacle of progress – council red tape.

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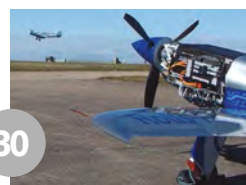
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NAL/RAeS

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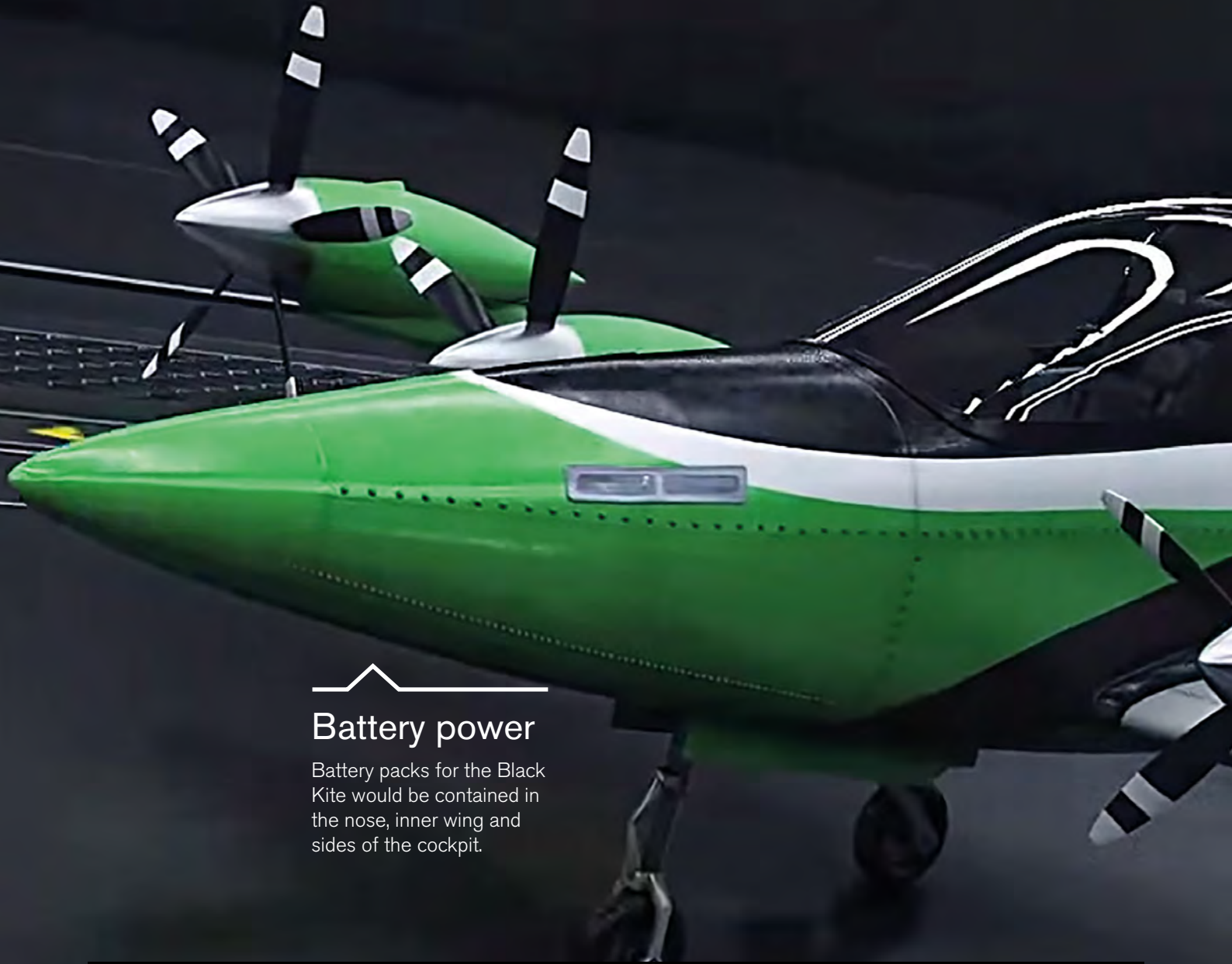
Why the RAeS published a Position Paper in 1921 on a future aircraft design to fly passengers from London to Paris.

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Could single pilot operations be supported by an additional pilot on the ground?

Blueprint

INTELLIGENCE / ANALYSIS / COMMENT



Battery power

Battery packs for the Black Kite would be contained in the nose, inner wing and sides of the cockpit.

DEFENCE

Zero-carbon trainer

On the eve of the South Korea's ADEX defence and aerospace exhibition in October, Korean Aerospace Industries (KAI) unveiled the 'Black Kite', a concept for a twin-seat electric-powered military basic trainer. Based on the turboprop-powered KAI KT-1 trainer, the Black Kite would use four distributed electric motors. The electric propulsion would reduce operating and maintenance costs, minimise noise, as well as producing a zero-carbon training aircraft.

Virtual wingmen

The Black Kite would also feature advanced avionics and embedded training systems including an augmented reality helmet allowing students to fly formation with 'virtual' aircraft. The cockpit would be compatible with that of the T-50/FA-50 advanced trainers and the KF-21 stealth fighter.

Leveraging design

The Black Kite will reduce risk by reusing the tail, cockpit and undercarriage of the previous turboprop-powered KT-1 trainer.

Distributed power

The Black Kite would feature four electric motors driving four propellers mounted on the wings. Power output would be 1,190kW.

Specifications

Wingspan	11.2m
Height	4.7m
Length	11.6m

Radome

COVID-19

AEROSPACE

US mandates vaccine jobs



United Airlines

US airlines, including American Airlines, Alaska Airlines, Southwest and United Airlines, have now mandated compulsory Covid-19 vaccination for all their employees. It follows a White House directive covering companies with more than 100 workers. However, the move has provoked controversy with some pilots and workers saying they will refuse the order. United Airlines has already fired 200 employees who refused the vaccine. Boeing has followed suit and will now require all employees to get vaccinated or risk losing their jobs. The company has given its 125,000 US-based workers a deadline of 8 December to comply.

AEROSPACE

US transatlantic travel opens up on 8 November

The US has announced that it will relax its Covid-19 restrictions for fully vaccinated air travellers from 33 countries, including China, India, Brazil, the UK and much of Europe on 8 November – relaxing the tough rules that were imposed at the start of the pandemic. The move, which will boost the most lucrative

transatlantic services, has been welcomed with enthusiasm by airlines, airports and the tourism sector and follows the lifting of UK restrictions on US visitors in August. Pent-up demand saw Virgin Atlantic report a 91% boost in bookings for US flights, while BA reported a 700% increase in searches for US holiday destinations.

AIR TRANSPORT

UK travel restrictions ease further

The UK government has relaxed Covid-19 travel restrictions further with 47 countries and territories now removed from the 'Red List' of high-risk areas. That leaves seven destinations on the UK 'Red List' for the pandemic (Colombia, Dominican Republic, Ecuador, Haiti, Panama, Peru and Venezuela) where arrivals will be

required to quarantine. The government also announced changes in minimum requirements for England, with vaccinated passengers only needing to send a picture of a negative lateral flow test, once the Day 2 PCR arrival lab test switches to the cheaper and simpler home lateral flow test from 24 October.

AIR TRANSPORT

Airlines put A380 back in service



Qatar Airways

In a sign of recovering international traffic, several airlines, including British Airways, Qantas, Qatar Airways and Singapore Airlines, will be reactivating their Airbus A380 fleets and returning the superjumbo to scheduled flights. British Airways will start with short-haul flights to Europe this month, while Singapore will also restart Singapore-London A380 services from 18 November. For its part, Qatar Airways will begin flying its A380s in December. Qantas, meanwhile, has brought forward the return of five of its A380s to service to July 2022.

NEWS IN BRIEF

Airbus Defence has announced that its solar-powered Zephyr high altitude platform system (HAPS) drone has completed its 2021 test flight campaign. The flights, conducted on behalf of UK Strategic Command, saw the uncrewed aircraft fly over Arizona on four low-level and two 18-day stratospheric test flights at heights up to 76,100ft – a new world altitude record for this class of UAV.

Danish charter operator Great Dane Airlines filed for bankruptcy on 11 October, leaving 118 passengers stranded at Billund Airport. Operating three Embraer E195 regional jets, the privately-owned operator commenced flying in June 2019 but suffered from Covid-19 travel restrictions.

The USAF has successfully tested a new

heavyweight bomb, the 5,000lb GBU-72, with a drop from a Boeing F-15E Strike Eagle. The test on 7 October saw the aircraft drop the Advanced 5K Penetrator over the Eglin AFB range – and marked the end of a series of tests of the GPS-guided weapon, which is designed to attack hardened underground targets.

Shares in Virgin Galactic fell by over 20% after the

announcement that the space tourism company has put back the start of full commercial service to Q4 of 2022. Virgin Galactic announced that it was postponing a test flight in October which would have been crewed by representatives of the Italian Air Force and the US National Research Council.

The UK Civil Aviation Authority (CAA) has announced the creation

of an international industry consortium that will focus on safety aspects of the fast-growing eVTOL sector. The group, the eVTOL Safety Leadership Group (eVSLG), includes manufacturers, operators and regulators, such as the AAIB, Virgin Atlantic, Joby, Vertical Aerospace, Flexjet and Bristow Helicopters, along with NATS.

Mojave-based Stratolaunch, the developers of the world's

GENERAL AVIATION

HondaJet reveals HondaJet 2600



At the 2021 NBAA business aviation exhibition in Las Vegas, HondaJet revealed a mock-up of a new larger bizjet, building on its original HondaJet light business aircraft. With distinctive overwing engines and natural laminar flow wings, the HondaJet 2600 concept would seat 11 occupants, have a ceiling of 47,000ft and a range of 2,625nm – making it the longest-range light business jet.

DEFENCE

USMC F-35Bs operate from Japanese carrier

For the first time since World War 2, fixed-wing aircraft have flown from a Japanese warship when USMC STOVL F-35Bs operated from the Japanese Navy's JS *Izumo* helicopter carrier during joint exercises. *Izumo*, Japan's largest warship, was built as a helicopter carrier but with the potential to be modified for STOVL

fixed-wing aircraft – the first phase of which has already been completed. The trials were part of multinational air and naval exercises in the region that have involved US, UK and Japanese carriers, as well as warships from the Canadian, Dutch and Royal New Zealand Navy. See 'Balance of Power' p18.

largest twin-fuselage, six-engine aircraft, the 'Roc', has completed a critical design review of its Talon-A hypersonic test vehicle. The company says that, with the design review completed, it is on track to conduct the first flight test of the Talon-A in 2022, with the Roc air-launching the test vehicle.

In an update on its services solutions, Airbus forecasts a 'strong demand' post-pandemic

for new airline pilots and technicians with 100,000 new pilots and 175,000 new technicians needed over the next five years.

The second Royal Navy supercarrier, HMS *Prince of Wales* has been declared operational and has also tested the first jet drone launches from a RN warship. The carrier had been trialling the use of QinetiQ's Banshee target drone, for use as

AIR TRANSPORT

Arrivederci Alitalia, ciao ITA



After 74 years in business, Italy has said goodbye to its bankrupt flag carrier Alitalia, which has finally closed down after multiple rescues and state aid. It has been replaced by ITA (Italia Trasporto Aereo) Airways, which inherits its brand but not its name and debts. ITA will operate a 50% smaller fleet and reduce its 10,000 employees to 2,800 with the aim of being profitable by the end of 2025.

an organic way to train the fleet in anti-missile defence but, in the future, other payloads could be used on the catapult-launched UAV.

With delays to Boeing's CST-100 Starliner capsule, NASA has made the decision to switch two of its astronauts assigned to the SpaceX Dragon Crew 5 mission, which will launch to the ISS in 2022. Nicole Mann and Josh

AEROSPACE

Boeing test pilot charged with fraud in 737 MAX trial

Former Boeing chief technical pilot for the 737 MAX, Mark Forkner, has been charged with fraud and giving false or incomplete information about the aircraft's safety to the FAA by a US federal grand jury. In the indictment, Forkner was charged with misleading aviation regulators about the airliner's MCAS (Manoeuvring Characteristics Augmentation System), a critical factor in the two crashes of 737 MAX

airliners in 2018 and 2019 that killed 346 passengers. Chad Meacham, acting US attorney for North Texas said: "In an attempt to save Boeing money, Forkner allegedly withheld critical information from regulators". However, a US lawyer who represented victims from the Ethiopian Airlines' 737 MAX crash called the trial a "corporate whitewash". If found guilty, Forkner could face up to 20 years in prison.

Cassada were slated to fly on the Starliner. However, its first human flown flight has been delayed after a second uncrewed flight earlier this year was scrubbed due to faulty valves and the flight delayed until an unspecified time in the future.

Diamond Aircraft has unveiled a four-seat all-electric version of its popular DA40 training aircraft. Called the eDA40,

the aircraft will incorporate batteries and a DC fast-charging system from battery technology company Electric Power Systems. The eDA40 is aimed at flight schools and will have an endurance of up to 90mins with a recharging time of 20mins with the batteries installed in an under-fuselage pod. Operating costs of the eDA40 are expected to be slashed by 40% compared to piston trainers.

Radome

GENERAL AVIATION

Airbus withdraws from next-gen UK SAR bid

Airbus Helicopters has pulled out from the UK Maritime & Coastguard Agency's Second Gen SAR contest for a ten-year UKSAR2G contract, saying it is: "very disappointed to conclude that it was not in the best interests of the company to submit an offer". Airbus was partnered with Draken Europe in March for UKSAR2G to offer short

and long-range rotary and fixed-wing SAR services. Airbus Helicopters says that it: "will continue to offer its helicopters and associated support services to any interested remaining bidder". Other shortlisted bidders for UKSAR2G include: Bristow Helicopters, EEA Helicopters and Serco. The winner/s is expected to be announced in 2022.

SPACEFLIGHT

Australia announces Lunar Rover mission



Australian Space Agency

The Australian Space Agency has announced that it has agreed a partnership with NASA to deliver an Australian-built Lunar Rover to the Moon on a future space mission. The 44lb rover, which will leverage Australian experience and technology from its mining sector, will search for oxides in the lunar soil which could potentially be extracted and converted into oxygen to help support human exploration. The mission could launch as early as 2026.

AEROSPACE

Xwing opens path to autonomous Cessna Caravans



Xwing

Autonomous flight systems specialist Xwing has signed an agreement with manufacturer Textron Aviation to help develop remotely piloted or autonomous versions of its aircraft. The company, which specialises in converting piloted aircraft to autonomous flight, has already flown a trial with a Cessna Grand Caravan earlier this year, with a view to introducing UAV cargo operations within the next two years.

AIR TRANSPORT

Full circle as Tata takes over Air India

India's giant industrial conglomerate Tata Sons has won a bidding war to acquire flag carrier Air India, put up for sale by the Indian government. Tata Sons, which bid \$2.4bn (180bn rupees) for the struggling national airline against a rival 151bn rupees bid from owner of low-cost carrier SpiceJet, was the original founder of Air

India as Tata Airlines in 1932, which was then nationalised in 1953. The Indian government had been attempting to sell the loss-making state airline since 2018 with limited interest. Tata Sons takes over an airline currently operating a fleet of 121 airliners, as well as 25 aircraft with its subsidiary Air India Express.

NEWS IN BRIEF

Russian engine manufacturer UEC-Aviadvigatel has announced that its new PD-35 turbofan has commenced ground testing on the core. The PD-35 is being pitched for Russia's future military transport aircraft fleet, as well as the Russian Il-96-400 and Russia-China CR929 commercial aircraft programmes.

At the 2021 IATA AGM, the global airline

association pledged that the air transport industry should achieve net zero carbon emissions by 2050 – bringing the aviation industry in line with the Paris Agreement on climate change goals. Meanwhile, manufacturers' group, the US Aerospace Industries Association also pledged to achieve net zero emissions by 2050.

Germany is to acquire five Boeing P-8A Poseidon maritime multimission

aircraft (MMA). The aircraft, which will be used to replace German Navy Lockheed Orion maritime patrol aircraft (MPA), are due to be delivered by February 2025. The contract is worth \$756.6m but could increase to \$1.8bn if training and sustainment support options are exercised.

China has reportedly tested an orbital nuclear weapon delivery system similar to the Cold War Soviet FOBS (Fractional

Orbital Bombardment System). Details are still sketchy but, according to the *FT*, the system uses a hypersonic glide vehicle for the terminal phase of attack.

Gulfstream has unveiled two new bizjet models – the G400 and G800. The jets, revealed in a virtual presentation at its Savannah, Georgia headquarters, fill gaps in Gulfstream's existing line-up. The 19-seat G800, powered by Rolls-

Royce Pearl 700 engines, features a range of 9,200nm – Gulfstream's longest ever range bizjet. Meanwhile, the 12-seat G400, powered by Pratt & Whitney PW812GA engines, features a range of 4,833nm. Both aircraft feature the Symmetry flight deck and active control side-sticks. G800 deliveries will begin in 2023, with G400 to enter into service in 2025.

Lufthansa Technik's Irish MRO division at

DEFENCE

Gripen E tests GPS-denied optical navigation



Saab has revealed that it has conducted Gripen E flight trials of a new precision navigation system for use in GPS-denied areas. The system, tested using a Gripen E prototype, uses high-resolution video sensors that compare imagery with a 3D surface model of the Earth in real time to provide accurate positioning where GPS or satellite navigation systems are jammed or degraded.

SPACEFLIGHT

UAE announces asteroid landing space mission

The United Arab Emirates Space Agency has announced plans for its next ambitious robotic space mission, which will see a probe visit Venus, before attempting a landing on an asteroid 560million km away. The five-year mission, which is intended to launch in 2028, will see the spacecraft perform a gravity assist manoeuvre

around Venus first before heading off to the asteroids, ahead of a landing in 2033. Like the Emirates Mars Mission, which is now returning its first scientific data, the space probe will be developed in partnership with the Laboratory for Atmospheric and Space Physics at the University of Colorado, Boulder, US.

Shannon has been acquired by Irish maintenance company Atlantic Aviation Group. Under the deal, brought on by the Covid-19 downturn in civil aviation, 300 out of 485 jobs will be saved.

Air New Zealand has repurposed one of its Boeing 787 Dreamliners into a vaccine clinic to encourage people to get the Covid-19 jab. The 'Jabaseat' airliner will act as a temporary drop-in

vaccine centre, with the jet being open to the public for one day at the airline's hangar in Auckland.

L3Harris has conducted the first flight of the new EC-73B Compass Call electronic warfare aircraft for the USAF. The EC-73B is based on a Gulfstream 550 business jet and will replace the legacy EC-130H currently used in this role.

At 90 years of age, veteran *Star Trek* actor

AEROSPACE

GE flies Catalyst engine



Engine-maker GE Aviation has conducted the first flight test of its new Catalyst turboprop engine. It was flown on a Beechcraft King Air from Berlin Airport in a 1 hour 40minute flight. The engine, launched in 2015, is aimed at the business and general aviation market and is designed to compete with the ubiquitous P&WC PT6 engine. The Catalyst will have 20% lower fuel burn and 10% higher cruise power than rival engines. Launch customer for the Catalyst, which incorporates additive manufacturing and digital design, is Textron which will use it on the new Beechcraft Denali.

AIR TRANSPORT

Southwest hit by flight disruptions

US airline Southwest Airlines experienced major disruption over the weekend of the 9-10 October, cancelling nearly 2,000 scheduled flights in its network and another 360 flights cancelled on 11 October with delays affecting other flights. The airline initially blamed ATC issues and bad weather for its operational difficulties. However,

the US Federal Aviation Administration then took the unusual step of pushing back against the claim of ATM issues, saying: "No FAA air traffic staffing shortages have been reported since Friday," adding: "Some airlines continue to experience scheduling challenges due to aircraft and crews being out of place."

ON THE MOVE

Air New Zealand's CEO Carrie Hurihanganui is to become the new head of Auckland Airport in 2022.

Former Airbus CTO Grazia Vittadini has been named as Rolls-Royce's CTO, Designate, taking over from current CTO Paul Stein in 2022.

Boeing has appointed Heidi Grant, currently Director of the US Defense

Security Cooperation Agency (DSCA), as its VP Business Development, Boeing Defense, Space & Security.

Harry Holt is the new COO at eVTOL developer Vertical Aerospace, having previously been Chief People Officer at Rolls-Royce.

CFO of airline group IAG, Steve Gunning is to step down in 2022.

Clarification

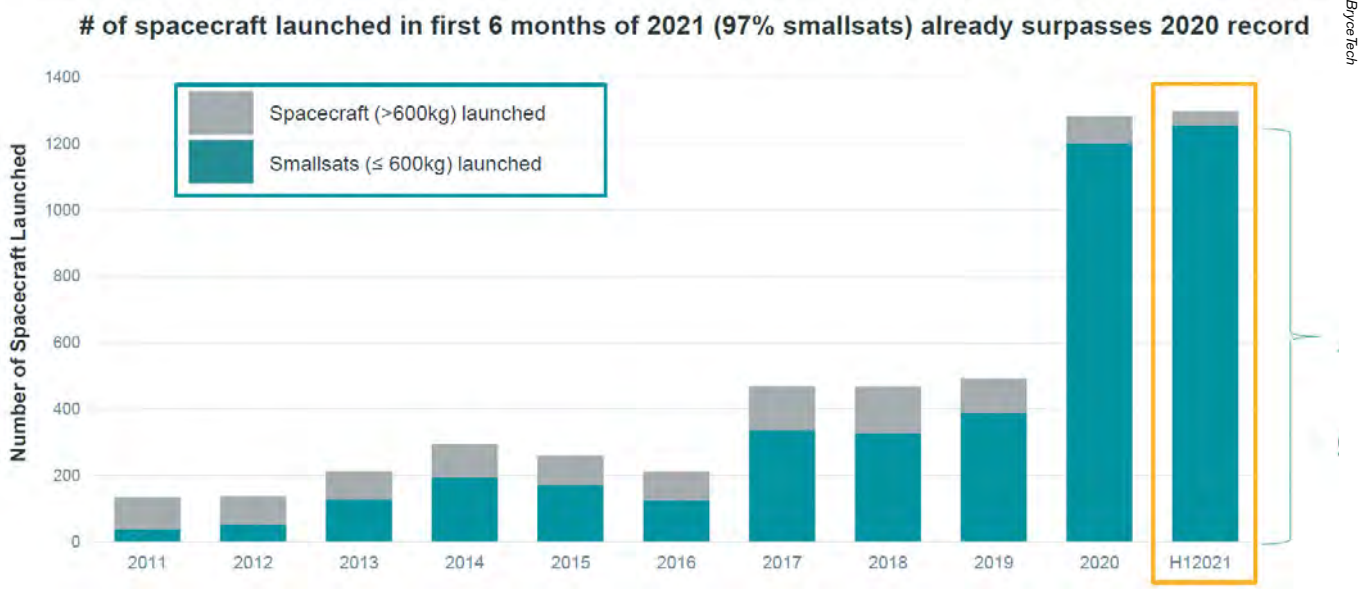
In the October 2021 edition of *AEROSPACE*, in the feature on South Korea's KF-21 fighter it was stated that it had undergone 3,000 hours of wind-tunnel testing at Calspan's facility in the US. However, the KF-21 was also tested in ARA's wind tunnel in the UK for over 2,500hrs.

By the Numbers

Understanding the world of Aerospace through data

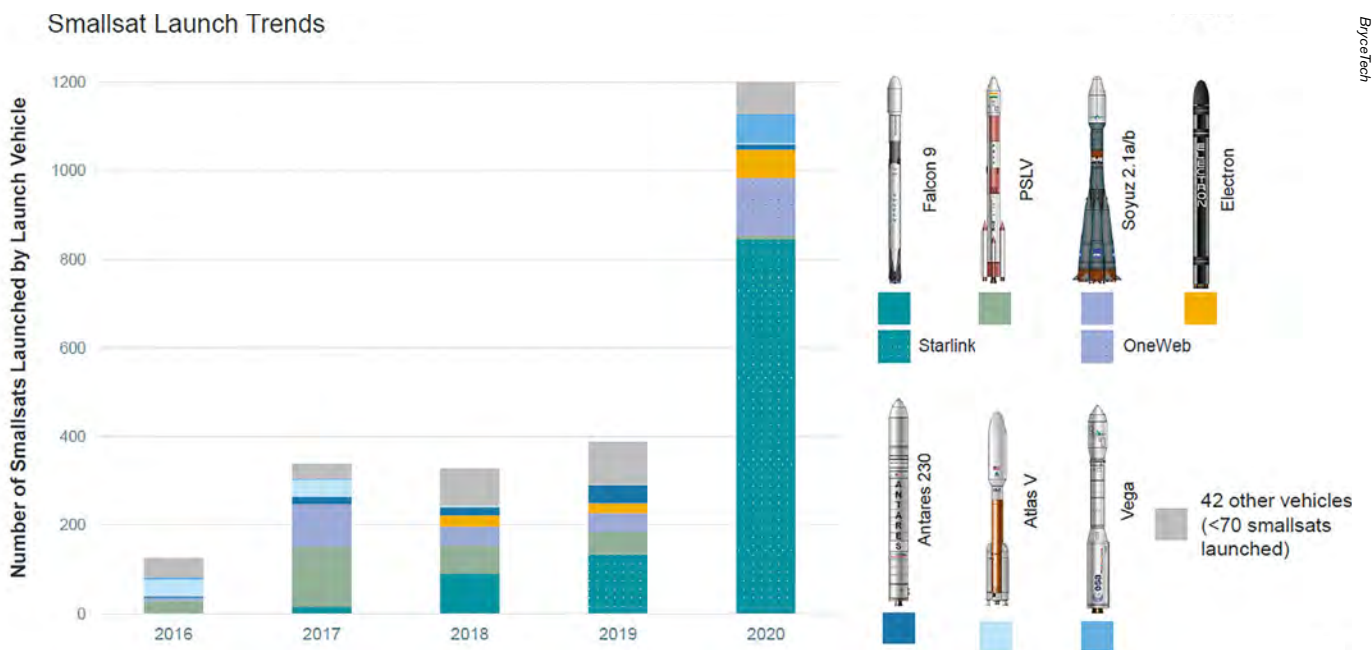
A decade of the smallsat revolution

Number of spacecraft launched 2011 – first half 2021



ByjceTech

Smallsats 2016-2020, by launch vehicle



ByjceTech

Pushing the Envelope

Exploring advances on the leading edge of aerospace



Robert Coppinger

Clearer vision on the flight deck

Eye tracking has been used for decades. More than 20 years ago devices strapped to pilots' heads would be used to allow the monitoring of the test subjects' gaze but it gave the wearers headaches. Those impractical headsets were laboratory curiosities and, while the technology has moved on in the years since, the question remains, does eye tracking have a place on the flight deck commercially?

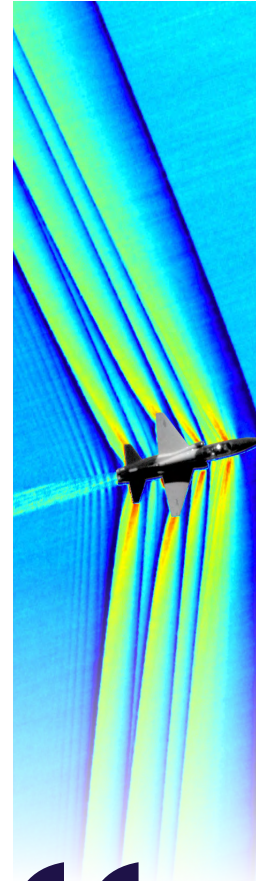
Tracking eyes, knowing where the pilots are looking and what information they are acting on would appear to have many uses from training to on-the-job performance measurement and accident investigation. Studies measuring pilots' drowsiness were expected to lead to a flight deck use case where performance could be measured, but still there is no operational airline or military use of the technology. To track eyes on a flight deck, additional technology needs to be built into the cockpit. Tracking eyes begins with infrared lighting to obtain reflections from the eyes and then cameras located around the flight deck detect and capture the reflection from that illumination. The reflection data is then processed to allow the gaze to be followed. The more cameras there are, the more precise the gaze tracking is but it all adds further cost and complexity to the flight deck. Where eye tracking has found a commercial outlet and an aviation application is in the use of the box-like goggles for virtual reality (VR). The VR goggles use infrared light-emitting diodes to illuminate the eyes and internal cameras spot what users' eyes are focusing on in the headset's three-dimensional (3D) computer-generated images (CGI).

A Finnish view

Varjo is a Helsinki-based professional VR and mixed reality headset developer and has worked with aviation companies on simulation. Mixed reality, which also uses eye tracking, has cameras built into the headset to take 3D video of the outside world and CGI is overlaid on top of that. The Finnish company has worked with Boeing and Airbus on their training methods and Varjo has been involved with civilian pilot training at the preparatory phase using its VR headsets. Varjo co-founder and chief technology officer, Urho Konttori, expects the

headset technology to be more like eyewear in the not-too-distant future. The company has also been involved with research, studying surgeons, and tracking their eyes found differences between novices and veterans. The veteran will rapidly scan a scene to obtain the information they need while the novice needs to slowly take in all the information the scene can provide. However, studies with airline crew found that after the thousands of hours of training pilots have, the differences fade between them when measuring their gaze dwell time on specific instruments.

For pilot performance, automation of the flight deck and how pilots work with that increased level of automatic decision-making is an ongoing issue. There has been a long-standing issue of pilots' awareness of the auto flight mode, for example. As far back as 2007, NASA studied what pilots understood about the status of the autopilot system. Similar studies were carried out in Europe. Many airlines, on both sides of the Atlantic, have policies where pilots must be aware if the mode changes and call out the change. Research in the US found that pilots were not looking at the mode change a third of the time. The experiments also involved changing the flight modes to an incorrect mode and seeing how pilots react. Pilots were detected seeing that incorrect mode and not calling the change out or acting on that information. Perhaps one real-world application might be an alarm to bring to the pilots' attention a flight mode change when neither crew member has glanced at the display? While eye tracking would seem to present an opportunity for improvement for many elements of piloting, gaze monitoring without eyewear has drawbacks. The technology is not always reliable because different lighting conditions can hinder tracking. Randy Mumaw is a San Jose State cognitive psychologist working in the Aerospace Cognitive Engineering Lab at NASA Ames Research Center. He previously worked at Boeing and was involved in those tests that saw the subjects get headaches. For Mumaw, eye tracking is still a laboratory aid and not ready for airlines' fleets or military squadrons. Some technologies seek an application and some problems need a technical solution. Eye tracking is a solution for many challenges but it has problems that require further technical advances.



PILOT PERFORMANCE, AUTOMATION OF THE FLIGHT DECK AND HOW PILOTS WORK WITH THAT INCREASED LEVEL OF AUTOMATIC DECISION-MAKING IS AN ONGOING ISSUE

Transmission

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f Making money from space

Iain T S Meek [On UK Government publishes National Space Strategy⁽¹⁾ Excellent ££££££££. The government-owned British Business Bank (BBB) helps finance markets to work more effectively for innovative firms seeking equity capital. This includes boosting the capacity of angel syndicates, particularly outside London, and investing in selected venture capital funds, including those specialising in space technologies. One of these funds has seeded the Seraphim Space Investment



Artist's impression of a future UK space launch.

Trust which was recently listed on the London Stock Exchange. This will be the world's first quoted vehicle investing primarily in Space Tech businesses. From summer 2021, the BBB will also be investing directly in companies, alongside the private sector, through a new £375 million programme, Future Fund: Breakthrough and the UK will invest around £5 billion over the next ten years in our military satellite communications programme, delivering through the Skynet 6 programme.

Farewell to Sir Brian



On 30 September, RAeS staff members, past and present, gathered in No.4 Hamilton Place to say goodbye and thank you to outgoing CEO Sir Brian Burridge (left) for all his work in leading the Society, as he handed over to new CEO David Edwards (right).



@MarkBateUK Super segment on green hydrogen this morning on @BBCr4today. It's coming sooner than we think and IMHO is the mass market solution, not this nonsense of electrifying everything for Carrie's agenda.

New GA designs

@TeglerWrites [On With new electric aircraft, is the end in sight for clean-sheet piston engined designs for light and GA aircraft?⁽²⁾] Nope.

@ChrisMilrine With the current momentum – most likely.

More pilots needed

@ShropsAeroPig [On Airbus forecasts 55 new airline pilots needed every day over next five years] Yet pilot terms and conditions trend ever downward.

@Captain_Deltic And do they have to pay to get their ATPLs?



The eDA40 – an electric version of Diamond Aircraft's DA40.

✈ Maintaining attention to passenger safety videos

@NZAirplaneFan [On Are viral safety videos undermining a critical safety message⁽³⁾] So many passengers still don't listen or watch the safety videos. I always remember being on a Southwest flight when one of the cabin crew said after the safety briefing: "Thanks to those who paid attention, good luck to those who didn't"

@PauloSergioMDC Maybe. Airlines should tell people to carry on their person at all times on board an aircraft, those artefacts of important sentimental value. The rest in the bag. The FAA should probably fine people for breaching safety rules.

@AviationLed Simple answer, 'Value Proposition', you've paid less for your ticket than the cost of your carry-on and its contents – in your own mind – and you believe the risk to your life and to that of others is not increased significantly by you egressing with your bag. You'd be wrong.



A Lego-themed passenger safety video from Turkish Airlines.

@free_body_diagr Long, seemingly boring, complex information presented matter-of-factly can result in passengers tuning out. Every manual briefing I've seen had pretty much every passenger looking at their phone or sleeping or something else. I loved the Qantas, BA, ANZ videos to be honest – it grabs attention. To address your concern, any potential videos could first be tested on sample audience for information retention?

@bonedoc123 Having recently flown both long and short-haul, it is clear that passengers by and large didn't seem to give a monkeys about safety. Barely any regard given to instructions. Most shoes and jacket off the moment they sat down. Totally unprepared for or willing to consider a rapid egress.

High Flyer Award



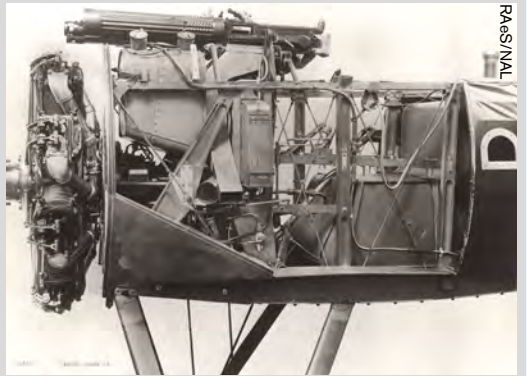
Lalita Dhavala has won the 2021 High Flyer Award in IATA's 2021 Diversity & Inclusion Awards, sponsored by Qatar Airways. A member of the RAeS Advisory Council and Membership Services Board, Lalita is an Aviation Engineering Consultant with McLarens Aviation Middle East and Asia region.

Cool Aeronautics in Derby



On 13 October, RAeS Careers hosted a Cool Aeronautics event at the Museum of Making in Derby. The event welcomed over 30 students from Ashover School to experience a fun and educational STEM based day with the support of Rolls-Royce. Among the topics covered, wind tunnels proved to be a topic of huge excitement.

From the RAeS photo archives



A very detailed photograph of a Sopwith Snipe Mk1a 'long distance' version of 1918. Without the front fuselage cowling, to show the larger main fuel tank below and behind the pilot's seat. Handling was poor and this derivative never saw operational service.

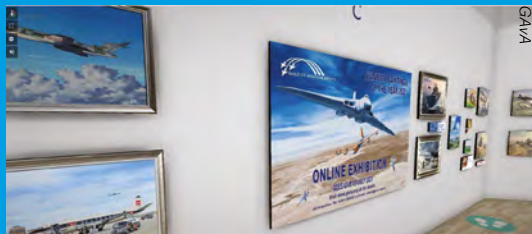
GAvA virtual aviation art gallery



An aerial view of the virtual art gallery.



Visitors can walk around the exhibition and stand wherever they like to view the paintings.



Each painting can be viewed at different angles and sizes.



There is also a virtual catalogue which provides details of all the paintings and artists.

One of the highlights of every July is the annual exhibition held by the Guild of Aviation Artists in the Mall Galleries in London. However, due to Covid-19, it was impossible to stage the exhibition in 2020 or 2021. This year the Guild decided to stage a virtual art exhibition instead which, unlike the physical event that only lasts a week, is still open and available to view via GAvA's website <https://www.gava.org.uk/>.

- <https://www.aerosociety.com/news/first-thoughts-on-uk-national-space-strategy/>
- <https://www.aerosociety.com/news/a-crunch-point-for-hydrocarbon-powered-light-aviation/>
- <https://www.aerosociety.com/news/passenger-safety-briefings-are-some-operators-missing-the-point-by-undermining-the-safety-message/>

● AIR TRANSPORT

Middle Eastern airlines



Shifting sands

As international air travel slowly returns after the Covid-19 pandemic the Gulf mega-carriers face new challenges to regional dominance – Saudi Arabia and an influx of low-cost carriers. **ALAN DRON** reports.

For the past two decades, the Middle East – together with China – has been one of the growing centres of gravity of the airline industry. The so-called 'ME3' – Emirates, Etihad Airways and Qatar Airways – set new standards in passenger service and became some of Boeing and Airbus' most important customers.

However, the balance of power among the region's airlines is shifting. Etihad announced earlier this year that, as part of its efforts to reduce its huge financial losses, it was officially recasting itself as a mid-size carrier. Standards would remain the same but, effectively, it would no longer be a full-scale competitor to the two other members of the troika.

Until the summer, Etihad's place in the ME3 looked like being taken by Saudia. For a long time as a large, but low-profile, player in the region, senior Saudia officials made clear a couple of years ago that it planned to come out of its shell and start promoting itself much more forcefully than before. That plan was backed up by an order for up to 100

Airbus aircraft placed at the 2019 Paris Air Show, to be split between the mainline carrier and its low-cost offshoot, flyadeal.

In July, however, those plans were apparently up-ended by a speech by Saudi Arabia's Crown Prince, Mohammed bin Salman Al Saud, who announced the formation of a new national carrier.

The new player

Details, both of the new flag carrier and how this will affect Saudia, have yet to be made clear, although it appeared that Saudia's new role will consist of a combination of domestic flights (already a significant part of its services) and carrying religious tourists from throughout the Islamic world to Saudi Arabia for the Hajj and Umrah pilgrimages. The Saudi government has said that it intends to increase religious tourism significantly over the coming years.

According to the Al Jazeera news agency, Riyadh plans to increase the number of pilgrims from 17m pre-Covid to 30m by 2025.

Etihad Airways Boeing 787-9 departing from Abu Dhabi.

Nabeel Hashmi



CLEARLY, SAUDI ARABIA HAS SEEN THE ECONOMIC BENEFITS THAT THE AVIATION SECTOR HAS BROUGHT TO ITS NEIGHBOURS, NOTABLY DUBAI, WHERE AN ASTONISHING 30% OR SO OF GDP IS NOW GENERATED BY THE EMIRATES' AEROSPACE ECOSYSTEM

More significantly, however, Saudi Arabia is making a major play to put the country on the secular tourism map. Just a few years ago, this would have seemed a risible concept, given the kingdom's reputation as a strict Islamic nation where alcohol is banned and strict social mores still apply.

However, the Saudi government is going for the international tourist market in a major way. A series of gigantic resorts are being built on the country's Red Sea coast and its country's tourism authorities are increasingly promoting its historic, archaeological and landscape attractions.

The aim: to help diversify the economy away from the oil and gas industries. The target: 100m tourists a year by 2030.

Given the scale of the new resorts and the pace at which they are being constructed, this figure does not seem far-fetched. There is already a significant upswing in the amount of domestic tourism, with Saudis flying around their country for leisure breaks.

Bold hopes

Clearly, Saudi Arabia has seen the economic benefits that the aviation sector has brought to its neighbours, notably Dubai, where an astonishing 30% or so of GDP is now generated by the Emirates' aerospace ecosystem. Saudi Arabia is already stepping up its activities in the military support sector, with increasing amounts of MRO work for the Royal Saudi Air Force being handled in-country. However, exactly how the new national carrier will slot into this vision of an expanding aerospace sector remains to be seen.

One analyst, Robert Mogielnicki, senior residential scholar at the Arab Gulf States Institute in Washington DC, believes that the reason behind the

decision to create a competitor to Saudia may be due to the fact that it can be easier to create a new entity rather than trying to improve an existing one.

Added to that, a new airline is one way of establishing the new image of Saudi Arabia that the Crown Prince wants to create in the international arena. A completely new flag carrier, presumably to be launched with a major PR campaign, will (theoretically) create an immediate and visible impact on audiences worldwide.

Providing new aircraft will not be a problem. Given that the new airline will almost certainly be state-owned, aircraft could easily be reassigned from the Airbus order.

While Mogielnicki does not believe that Riyadh will cease supporting Saudia, competition for relatively scarce resources may see it playing second fiddle to this new rival – assuming it gets off the ground and is not merely a mirage.

Emirates and Qatar Airways, meanwhile, seem likely to emerge from the pandemic in reasonable shape. Both have received funding from their respective governments. Emirates has made it clear that it intends to continue to fly its huge fleet of Airbus A380s – much loved by passengers but not by airline accountants – into the 2030s. Delivery of Emirates' last A380 has been brought forward from mid-2022 to this November and it would not be surprising if it made its debut at the Dubai Airshow.

Qatar Airways has continued to expand its route network and laid claim to the title of biggest network carrier during the pandemic as rivals slashed their route maps and, like Emirates, is increasingly looking to Africa for new revenue streams. At the time of writing it was in the final stages of negotiating a 49% stake in RwandAir, while the state of Qatar is taking

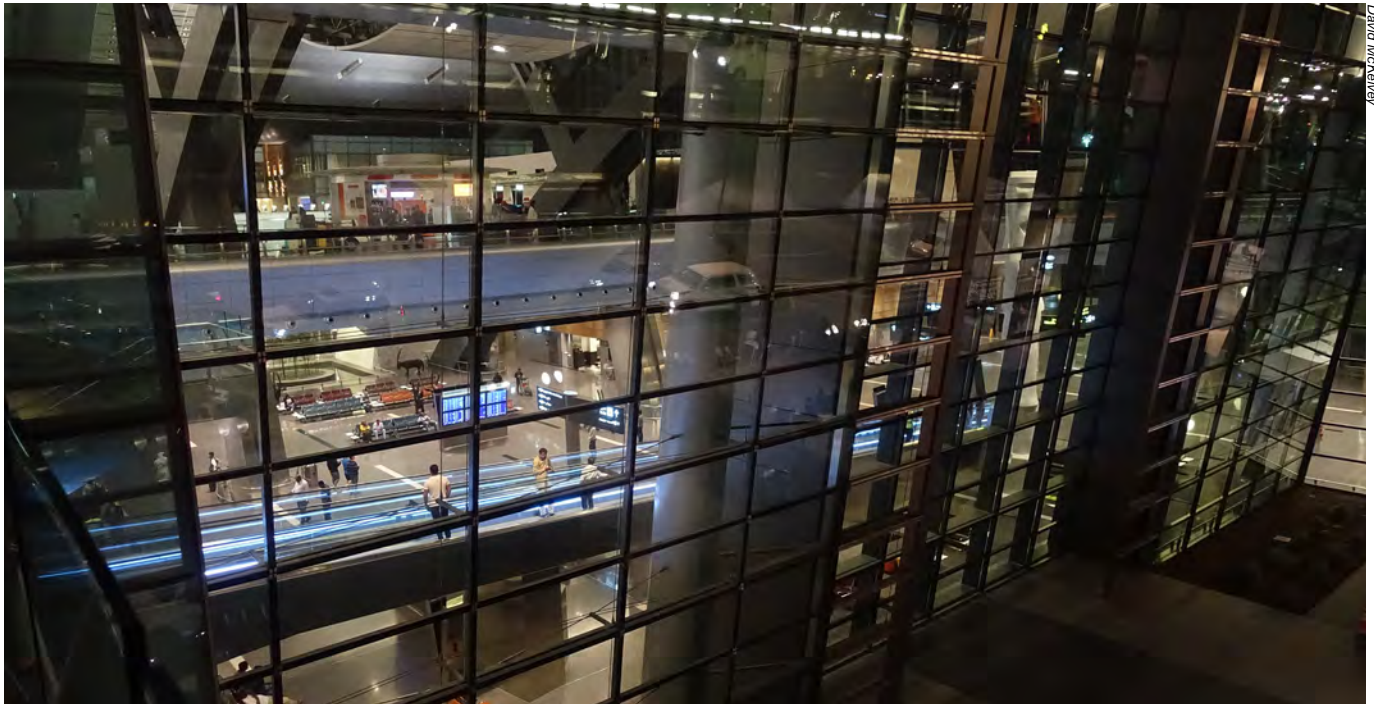


A Flyadeal Airbus A320neo.

Airbus/P. Piquere - Master Films

● AIR TRANSPORT

Middle Eastern airlines



David McKeivrey

a 60% stake in Rwanda's new airport serving the capital, Kigali, seeing it as a central African hub.

Both Qatar Airways and Emirates – as well as EgyptAir and Turkish Airlines – are increasingly creating interline deals with African carriers to help siphon off Africa-originating traffic to their respective hubs. EgyptAir is increasingly looking south, having signed a deal to help establish a new national airline for Ghana and another to help revive the fortunes of Sudan Airways, whose prospects have, for years, been stifled by US sanctions against Khartoum.

Pandemic aftermath

Generally, airlines in the Middle East have felt the effects of the pandemic just as badly as their counterparts elsewhere in the world and some carriers – especially those with lower profiles than the 'Big 3' are facing problems. "Some are struggling," admits Abdul Wahab Teffaha, Secretary-General of the Arab Air Carriers Organisation, which represents around 30 airlines in the Middle East and North Africa.

Many have received little or no financial assistance from their respective governments. Teffaha notes that levels of government support have been around one-third of that granted by the US government to its country's carriers. An interesting trend in the Gulf, meanwhile, is the rapid growth of low-cost carriers (LCCs).

The biggest battlefield for LCCs seems likely to be Abu Dhabi, where Etihad and LCC Air Arabia have created a new joint venture, Air Arabia Abu Dhabi (AAAD) while central Europe's fast-expanding LCC

Wizz Air has linked up with Abu Dhabi state holding company ADQ as Wizz Air Abu Dhabi (WAAD). WAAD has major plans for the region, with CEO József Váradi predicting that the joint venture will base 100 aircraft there by 2035.

In Saudi Arabia, Saudia's LCC subsidiary flyadeal is planning to launch its first international route imminently, having previously delayed doing so firstly because of the scale of demand in its domestic market and secondly, by the disruption caused by Covid.

To help handle the anticipated increase in traffic, it will be receiving 30 Airbus A320neos, part of Saudia's previously mentioned order for up to 100 aircraft. The deal includes flexibility for flyadeal to convert some of the options to the larger A321neo, which would be viable on Saudi Arabia's more heavily trafficked domestic routes.

Fellow Saudi LCC flynas has also embarked on a major expansion programme. It has 80 A320neos on firm order (10 of which have been up-gauged to A321neos) and also became an early customer for the long-range A321XLR at the 2019 Le Bourget show, when it ordered 10.

In Dubai, LCC flydubai's services are increasingly closely integrated with those of Emirates, with a growing cross-flow of traffic between the two. Moreover, further established LCCs can be found in Kuwait (Jazeera Airways) and Oman (SalamAir).

A flooded sky

All this has led to concerns among some of the region's airline CEOs of massive over-capacity and

The passenger terminal at Hamad International Airport in Doha, Qatar.

subsequent financial losses as airlines fight for passengers. Observers particularly doubt whether there is sufficient traffic in Abu Dhabi to merit the presence of two major LCCs, AAAD and WAAD.

Wizz Air's CEO, Váradi, believes that the most efficient carriers will survive, while AAAD's Ali has said that "every airport needs an LCC in addition to whatever conventional airline assets exist. LCCs have proved themselves everywhere they've started. They stimulate the market and grow the tourist trade." AACO's Teffaha also believes that the market will balance itself out.

It is true that arrival of an LCC in a market has traditionally 'grown the pie', both by encouraging new passengers to take to the air and with existing passengers flying more often, but competition for traffic is likely to become intense.

However, Etihad's Group CEO Tony Douglas is sanguine about the presence of a large rival LCC on his home turf; indeed, he says he would be content if more budget carriers pitched up there. "I'd be happy if there were further additions to Abu Dhabi International Airport when it comes to alternative carriers; the more feed into Abu Dhabi, the more the home-based carrier will take benefits from it."

Perhaps sensing another revenue stream, meanwhile, Air Arabia has embarked on a succession of projects involving the creation of joint ventures to set up new airlines.

Qatar and Emirates are major users of Dubai's International Airport.



As well as the AAAD project with Etihad, in August it announced a joint venture to set up a new LCC in Armenia, to be dubbed Fly Arna, and another in Pakistan, where it proposes to link up with major Pakistani conglomerate Lakson Group to create Fly Jinnah, named after Pakistan's first leader.

Aside from airlines, aviation infrastructure in the region continues to be upgraded. Since the last Dubai show in 2019, the vast new Terminal 1 at Jeddah's King Abdulaziz International Airport has fully opened (it had a 'soft opening' earlier that year), greatly improving what was one of the region's least pleasant airports to traverse. Bahrain International Airport has also opened a new terminal four times the size of its 1970s predecessor, providing greatly improved facilities for national carrier Gulf Air.

Still awaiting an official opening date at the time of writing, however, was Abu Dhabi International Airport's Midfield Terminal. Designed and built when home carrier Etihad Airways was in expansionist mode, its scale now seems out of kilter with the airline's more modest future ambitions.

Both LCCs and some carriers, such as Gulf Air are increasingly opting for more profitable point-to-point flights rather than pushing large quantities of low-yield transfer passengers through their hubs. However, just as direct services seemed to be coming back into vogue, some airline analysts are suggesting that 'green' considerations mean that hub and spoke operations may yet be the most efficient option, with large-capacity aircraft carrying more people on fewer flights via a home base.

With aviation providing skilled, well-paid jobs, several Gulf states are keen to increase their involvement in the sector. Next door to Dubai, Abu Dhabi is steadily expanding an aerospace cluster of companies beside Al Ain International Airport.

The Nibras Al Ain Aerospace Park acts as a catalyst for economic development and diversification and is an important provider of local employment.

The 25km² industrial area, jointly developed by Mubadala Aerospace and Abu Dhabi Airports, brings together advanced aerospace manufacturers and suppliers, research and knowledge institutions, and educational and scientific bodies. Already operating there are advanced composites manufacturer Strata, unmanned air vehicle (UAV) manufacturer Abu Dhabi Autonomous Systems Investments, and maintenance, repair and overhaul (MRO) specialists SR Technics.

Under the UAE's industrial plans, the focus over the next decade will be on attracting global original equipment manufacturers (OEMs), industry suppliers and small to medium-sized enterprises (SMEs) to the site.

Despite current travails, few people would bet against the Middle East again becoming a growth point in the world aerospace industry.

● DEFENCE

Chinese air power and Taiwan

Balance of power

As escalating tensions between China and Taiwan threaten to spark a wider conflict, **TIM ROBINSON FRAeS** considers the changing air power and geostrategic balance between China and the West.

In 1914 a single shot in Sarajevo plunged the world into a terrible conflict, sparking a global war that left millions dead and that set the conditions for another devastating conflict in 1939. A highly globalised and interdependent economic system was rent asunder – with what some described as a slow motion catastrophe in which train timetables, mobilisation schedules and alliances contributed to an inevitable drift to war.

Fast-forward to 2021 and there are growing concerns that once again the world is slowly sleepwalking into another large-scale international conflict – this time over the island of Taiwan and Beijing's ambitions to reunify it into mainland China – which would threaten to draw in the US and allies.

In recent years, relations between China and the West have deteriorated sharply through issues, such as Huawei, 'Wolf Warrior' diplomacy, a crackdown in Hong Kong and the treatment of the Uyghur minority. The final straw in some critics' eyes, was the coronavirus pandemic, its origin in Wuhan – with the delay in communicating the severity of Covid-19 to the outside world, costing lives.

Beijing argues that others are seeking to restrict and hobble its rise as a 21st Century superpower, with the centre of gravity in the world inexorably shifting to Asia-Pacific in technology, economic and military power. For example, Huawei, it might be argued, simply copied previous Western success in information technology by investing heavily in R&D and retaining its IP, only to have the US and Europe suddenly pull up the drawbridge. China also points out that it has accomplished its rise through peaceful means and economic soft power, rather than in foreign interventions that have characterised Western foreign policy in Afghanistan, Iraq and Syria. The news that China had been the first to cement ties with the new Taliban regime in Afghanistan,

after US and NATO nations withdrew, was thus seen as confirming this seismic shift of power eastwards.

Today, the risk of invasion of Taiwan is now seen as higher than ever, as China's new-found military strength has closed the gap between it and the US.

Aerial probing

For Taiwan, this year has seen a record number of aerial probes into its ADIZ (Air Defence Identification Zone) by Chinese PLAAF aircraft, including a surge of sorties in early October that, on one occasion, saw 52 aircraft penetrate this zone and a 28% increase over September's total. This followed earlier incursions by half as many aircraft over the summer. The formations have consisted of fighters, such as J-16 and J-11, H-6 bombers and KJ-500 AEW platforms, making for a combined potent strike force.

While a country's ADIZ is not considered sovereign airspace and spyplanes probing other nation's reaction times and defences have been a feature since the start of the Cold War, mass incursions like this have raised fears that, as well as being provocative acts by themselves, the increasing numbers are conditioning Taiwanese defenders to accept larger strike forces that may one day turn hostile. For Beijing's part, it has said that the incursions were due to the US provocations, such



US Navy



Main: US Navy Super Hornets and USMC and UK F-35Bs overfly the CSG21 carrier strike group in the Philippine Sea in early October with HMS Queen Elizabeth joined by the Japanese Maritime Self-Defense Force helicopter carrier JS Ise and the USS Ronald Reagan and USS Carl Vinson.

Below: PLAAF KJ-500 AEW aircraft intercepted in the Taiwan ADIZ in early October.

as arms sales to Taipei and its warships transiting the Taiwan Strait under FONOP (Freedom of Naval Operations) rules.

Taiwan's air force itself consists of over 500 front-line aircraft, arrayed against China's 3,330 combat aircraft – although not all of these will be committed to any invasion. The RoCAF's most potent assets are over 100 F-CK 1Cs, 46 Mirage 2000-5s and over 141 F-16s – with the air force set to upgrade these to the highly capable F-16V standard by 2023. As might be expected with the Chinese mainland so close, Taiwan also boasts extensive surface-to-air and surface-to-surface missile capabilities, including Patriot PAC-3 and Sky Bow III SAMs, Yui Feng supersonic cruise missiles and Hsiung Feng III anti-ship missiles.

The West flexes its naval muscles

Meanwhile, the growing rift between China and the West has seen one of the largest displays of air and sea military power, with the UK's HMS Queen Elizabeth and its CSG21 carrier group becoming a focus around a number of exercises this year during its Indo-Pacific tour, including at one point seeing an unprecedented four carriers (two US, one UK and a Japanese helicopter carrier) sail together in a massive show of strength. Though USMC F-35Bs have deployed aboard the US Navy's assault ships before, the joint US/UK F-35B air wing aboard HMS Queen Elizabeth was the biggest deployment of fifth-generation air power at sea yet. The exercises also saw the first operations by fixed-wing aircraft on Japanese warships in over 70 years when USMC F-35Bs landed on the Japanese Maritime Self-Defense Force (JMSDF) helicopter carrier Izumo. All told, the exercises involved 15,000 sailors and aircrew from six nations and a combined air wing of over 200 aircraft and helicopters.

Though the UK MoD has said that the watchword of CSG21's Indo-Pacific tour is 'confident not confrontational' and the US Navy says this demonstrates its 'ability to work closely with its unmatched network of alliances and partnerships in support of a free and open Indo-Pacific', this display of multinational air and sea power, by the US and allied partners has sent a strong message to Beijing that its actions are now bringing together allies to defend the international rules-based order and push

back against any aggression. Even the most pacifist of nations, Germany, deployed a frigate to the Pacific this year to demonstrate its commitment to the global order, although it was routed anti-clockwise so that Berlin could publically claim it was not part of any-US led force.

Likewise, the recent AUKUS trilateral agreement with Australia, the UK and US to acquire nuclear submarines, as well as long-range strike missiles, such as TLAMs, and air-launched JASSM-ERs and LRASMs can also be seen in the context of nations, perhaps belatedly, waking up to China's ambitions over Taiwan.

China's air power modernisation

Beijing then certainly has the motive for an invasion of Taiwan to reunify it into one China. But does it have the means – particularly from an air power point of view? In the past decade or so, the sheer scale of China's air power modernisation has been incredible, developing everything from stealth fighters, active electronically scanned array (AESA) radars, long-range missiles and air transports. Its aerospace industry has progressed from licensed production of Soviet-era warplanes to cutting-edge aircraft programmes that allow its industrial base and designers to learn and reiterate at a staggering pace. For example, the J-20, a heavy, long-range fighter with canards and conventional exhausts, optimised for frontal stealth clearly has a different concept of operations than the thrust-vectoring VLO F-22. Its latest BVR air-to-air missile, the PL-15, outranges the standard US AIM-120 AMRAAM, a key advantage in air battles, while it is soon set to unveil the Xian H-20, a flying-wing stealth bomber.

In other areas, China has pioneered diamond-wing high-altitude ISR UAVs, hypersonic glide vehicles and weapons, such as the DF-21F – a ballistic 'carrier-killer' missile that has no equivalent in the West. A CGI video released by AVIC at this year's Zhuhai Air Show also hinted that China is also developing 'swarming' drone decoys launched themselves by flying-wing UCAVs. This sort of capability, with the aim of blinding and confusing enemy air defences is similar to concepts from US and Western defence contractors.



Taiwan MND



● DEFENCE

Chinese air power and Taiwan

The final and most crucial part of the jigsaw needed has been indigenous-designed powerplants and here China watchers have noted that its WS-10 turbofan now equips the J-10, J-16 and J-20 fighters.

At the Zhuhai Air Show in October, there was further evidence of China's military muscle, including a Loyal Wingman-style UCAV, loitering drones and an electronic warfare version of the J-16 fighter, similar to the EA-18G Growler. The J-16, based on the Russian Flanker, features increased composites in its structure and an AESA radar – making it arguably the most capable Flanker variant in the world.

A naval stealth fighter, based on the the J-31/FC-31, is also reported to be close to a first flight and would be a further boost to the PLN's already impressive naval air power. Though it has only just begun operating aircraft carriers relatively recently, it has already built up experience and its second-generation of aircraft carriers will switch from the Russian CATOBAR (catapult assisted take-off but arrested recovery) involving a ski-jump to the US EMALS (electromagnetic launch system), mirroring the shift by the US Navy in the latest USS *Gerald R Ford* supercarrier.

As well as impressive developments in hardware and engines, China has worked hard to develop military capability in doctrine, tactics and training that the US has mastered since the Vietnam War. It now runs regular 'Red Flag' style exercises to train its pilots, breaking away from Soviet-era rigid tactics that relied on GCI ground control. In 2011 it also instituted a 'Golden Helmet' Top Gun-style aerial competition for PLAAF fighter squadrons to boost *esprit de corps* and find its most elite pilots.

Paper tiger?

However, some analysts still have doubts over whether this rapid military modernisation translates into success on the battlefield. Air-to-air refuelling, a routine enabler of US and coalition air operations is still somewhat of a novelty in Chinese service, with under 30 aerial tankers, compared to 450 of

the USAF tanker force. Second, is that China and the PLAAF lacks combat experience, with its last state-on-state conflict being in 1979 with Vietnam, (ignoring recent high-altitude clashes between Chinese and Indian troops using sticks.).

This lack of recent combat experience with the PLA, PLAAF and PLN compares with the US forces and its allies which have been engaged in conflicts across the Middle East and elsewhere from 1990 in places, such as the Balkans, Iraq, Afghanistan and Libya – honing dynamic joint and now multi-domain operations to a fine art. The anti-ISIS campaign also saw the US and its coalition partners contend with a non-kinetic, yet contested environment – exposing them to advanced EW, GPS-jamming and the latest Russian military equipment over Syria. In comparison, despite attempts to move away from Soviet-era doctrine, there still is rigidity and a lack of 'jointness' in Chinese air power. The fact that the PLAAF still comes under the PLA (army) and the influence of the CCP means that there is still an element of inflexibility in command and control.

There is also some evidence from its international sales of Chinese UAVs that its aerial systems may still have some way to go to match Western technology – despite their low acquisition costs compared to US-built armed UAVs. Jordan, for example, put its six CH-4 (equivalent to Predators) up for sale in 2019. Meanwhile, Iraq's CH-4 fleet has been rendered almost combat ineffective due to maintenance issues. This suggests that, in some key areas, China may still lag the West in air power.

Finally, there are also reports that China's economic success, while on the one hand allowing it to rapidly expand and modernise its military forces, is also sowing the seeds of weakness. With a large and growing affluent middle class, public utterances by the CCP have shown that it is now worried that its young people are now too 'soft' and interested in social media, reality TV shows and video games, rather than tough military service. There was a crackdown on online video gaming earlier this year, along with efforts to reduce the influence of Western popular culture.

Shenyang J-15 lands aboard a PLN aircraft carrier. Challenging 24/7 carrier operations are the pinnacle of air power at sea.



Chinese MoD



Has China won the AI war?

Yet for its part, China has closely studied the US way of war over the past three decades and the way in which air power gives it the decisive advantage. For example, its A2/D2 'bubble' has the effect of pushing US assets and the critical non-stealth enablers, such as tankers, AEW and ISR aircraft, further away – reducing the range and time on station of tactical combat aircraft. Meanwhile, scores of missiles would target key US bases, such as Guam, where concentrations of American airpower – particularly where these force multipliers above – would make for tempting and vulnerable targets.

Cyber attacks would also likely precede any such surprise attack, causing disruption and chaos and slowing any response from Washington. There is evidence that Beijing has conducted a major cyber-espionage campaign against the US, with hacking hoovering up astonishing amounts of data – with one estimate that China now has personal identifiable information on 80% of US citizens.

China is also racing ahead in AI – with one US defence official recently resigning in protest over the slow pace of AI and software development by the US military – saying that, at the moment, China has already won. This is despite US efforts to field a next-generation 'combat cloud' network architecture which would use AI to speed up the sensor-to-shooter kill chain.

Summary

There are thus worrying signs. Language is becoming increasingly bellicose and it is known that premier Xi Jinping hopes to reunify Taiwan with mainland China within his presidency. Second, is that there is now a ticking clock in that the US, distracted by Afghanistan and Iraq over the past 20 years, has now woken up and is reorienting to face this challenge, with investments in more ships,

Revealed at this year's Zhuhai Air Show was this 'Loyal Wingman' UCAV – Feihong FH-97. Note loitering sub-drones with fold out wings.

hypersonics and high-speed distributed warfare. For Beijing, the window of a successful attempt to keep the US at bay over a Taiwan invasion or blockade may be closing – it may be that it is approaching the peak of its military capability, versus the might of American air and sea power now looking in its direction. There are also internal factors at play here, with China currently undergoing its own Lehman-Brothers-style financial meltdown in the property market. That could make it attractive for the CCP to distract its populace by engineering an external crisis with foreign enemies.

Despite the rhetoric, there are reasons for optimism. The first is still the interconnectedness of the modern global economy which has demonstrated through the Covid-19 pandemic how reliant countries are on each other – despite attempts to decouple economies and supply chains. Shortages of port workers in China, for example, has led to production slowdowns in the US car industry, due to a lack of computer chips. China, too will have to keep these in mind; – it will be aware that even a successful invasion would cast it as a pariah and do untold economic damage.

Meanwhile, its 'Wolf Warrior' diplomacy has somewhat backfired and succeeded in hardening attitudes and pushing nations together, for example with AUKUS – suggesting that a return to a more nuanced approach may be more successful.

An invasion of Taiwan too, with it being the world centre for semiconductor computer chips, would also expand any reunification attempt from purely wrapping up loose ends from the 1949 Chinese civil war into a China vs the US, allies and even the rest of the world.

Like Saddam Hussein's ill-advised invasion of Kuwait in 1990 that threatened the global oil supply over the border in Saudi Arabia, would the rest of the world be able to stand aside when this strategic resource that underpins our modern digital age comes under threat?

● SPACEFLIGHT

China and Russia lunar partnership



РОСКОСМОС

The new moonwalkers

A new lunar base is being planned to be jointly built by China and Russia as part of ambitious plans to explore the Moon. **EUGENE GERDEN** finds out more.

In March, China and Russia signed a memorandum to jointly build a lunar space station. According to Sergei Savelyev, Deputy General Director of the department of International Co-operation of Roscosmos, a roadmap of the project was officially presented by the partners during the GLEX global space exploration conference in St. Petersburg in June.

Building of the new lunar station (dubbed the International Science Lunar Station (IAS)) was also part of a wider agreement of joint space exploration which was signed between the partners in November 2017 and designed for the period of 2018-2022. The programme consists of six sections, one of which is dedicated to research on the Moon.

Currently, the partners are continuing consultations regarding the project and assessing potential difficulties during its implementation, associated with the need for design of some conceptually new technologies and apparatuses, including space modules and systems for soft

landing – all of which will be built almost from scratch.

According to analysts, successful implementation of the project will pave the way for regular crewed flights to the Moon within the next decade. The majority of observers believe the project has a significant chance of being successful.

Chinese exploration

In recent years China has achieved great progress in the field of space exploration, and is planning the implementation of some major projects, such as Mars missions, in the years to come.

One example of Chinese achievements is the publishing of the first complete topographic map of the Moon's surface (with a resolution of seven metres based on images of the second Chinese lunar mission 'Chang'e-2' ('Moon Princess-2') by the Chinese Department of Defense Science,

Technology and Industry in February 2012.

In addition, the third mission, 'Chang'e-3', which in December 2013 made a soft landing on the Moon (37 years after the landing of the Soviet Luna-24 AMS), delivered the Yutu spacecraft, *Jade Rabbit*, to the Moon.

In 2019, China was the first country to land the 'Chang'e-4' robotic probe on the far side of the Moon. The Yutu-2 rover, which arrived with it, remains currently in operation.

At the end of 2020, the 'Chang'e-5' spacecraft took samples of lunar soil and delivered them to the Earth. Previously, only the USSR and the US managed to do this. In addition, as part of that mission, the first-ever automatic docking in lunar orbit was conducted. The current lunar programme, which is implemented by China involves the landing of Chinese astronauts on the Moon by 2028.

At the end for three years in a row, China has been the world's leading country in terms of its number of rocket launches, with China's space budget being the second largest after the US.

While Chinese investments in its space and lunar programme significantly exceed those of Russia, the lack of technologies for its implementation creates conditions for co-operation between both countries. That means that China could be interested in using space technologies developed by Russia (and earlier, the USSR) over many years of space exploration, as Russian and Soviet space enterprises have rich experience in the production of unique spaceflight technology and equipment that has worked successfully in many projects.

Russia – renewing its efforts

In addition, Russia has extensive experience in the construction and operation of inhabited orbital stations. This is very useful for a lunar orbital station – a bridgehead for the delivery of cargo and crews to the Moon and back. For this purpose, Russian elements of the ISS could be used.

As for Russia, it has long-standing scientific and technical ties with Beijing in the field of astronautics. For example, Chinese designers used Russian developments to create rocket engines, while the Chinese Yutu-2 lunar rover has Russian-made radioisotope generators in its structure. Russia has its own lunar exploration programme which will begin to be implemented this year with the launch of the 'Luna-25'

mission from the Vostochny Cosmodrome. That will become the first lunar lander in the history of modern Russia, after the launch of a similar space probe in the USSR in 1976. The launch of the first 'Luna-25' is scheduled for July 2022, to conduct research of the Moon's surface and to drill in the area of the South Pole. According to scientists, this is an important task as it will allow it to estimate water ice deposits which are concentrated in this area of the Moon that could be useful for the building of a future lunar base.

In 2024, Russia plans to conduct the launch of its second spacecraft of the Luna series – 'Luna-26' – which is expected to be conducted in conjunction with the Chinese 'Chang'e-7' mission, and a year later – 'Luna-27' jointly with China's 'Chang'e-8'.

Finally, the 'Luna-28' mission – to send a sample of lunar ice to Earth is likely to be completed in 2026 or 2027, while the launch of a heavy lunar rover as part of the 'Luna-29' mission will probably be completed closer to 2030.

All these probes will be equipped with high-resolution cameras, georadars, neutron sensors, spectrometers, seismometers, magnetometers, water and hydrogen isotope analysers and other devices that are currently being developed by scientists at dozens of scientific institutes in Russia and China.

It is also planned that the 'Luna-27' station could become the basis for Russia's future probes, as an uncrewed station on the Moon can prepare the ground for astronauts to land and create a lunar settlement.

The power couple

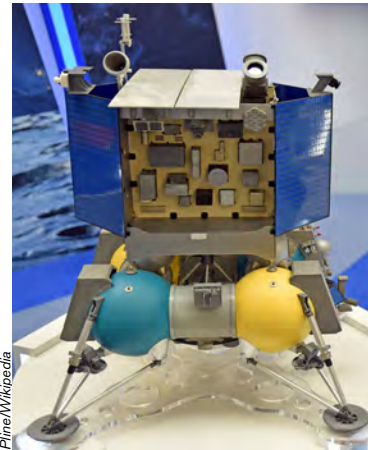
According to analysts, when the partners are technically ready to make a crewed launch, this automated station will be well suited as the first target of the lunar lander and may become the basis for a crewed lunar base.

However, neither China and Russia have experience in building permanent lunar bases (as has no other country in the world). It will require the partners to develop technologies for completely new tasks, such as arranging the living environment on the Moon, producing electricity and obtaining oxygen, as well as hydrogen for rocket fuel. The prospects for such a grand project largely depend on how successfully Russia and China complete the joint first stage of the project.

Interestingly the launches will not need super-



CHINA HAS BEEN THE WORLD'S LEADING COUNTRY IN TERMS OF ITS NUMBER OF ROCKET LAUNCHES, WITH CHINA'S SPACE BUDGET BEING THE SECOND LARGEST ONLY AFTER THE US



Prime/Wikipedia



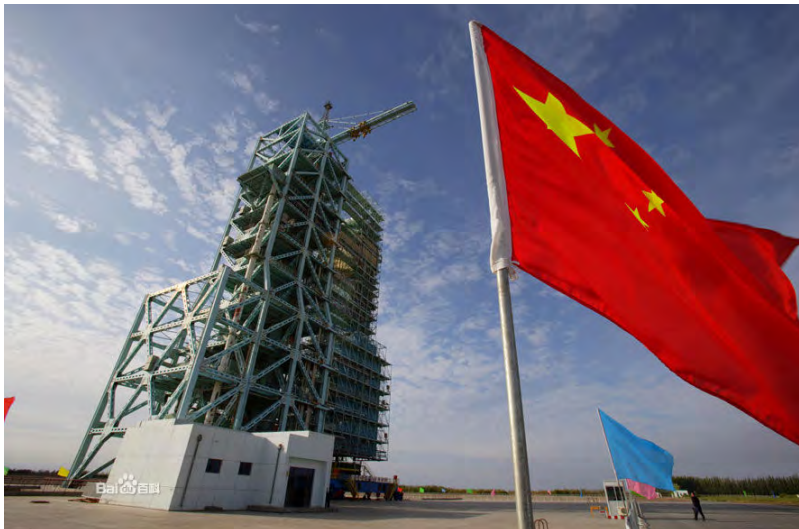
CSMA/Siyu Zhang/Kevin M. Gill

Top: A model of Russia's 'Luna-27' probe.

Above: The 'Chang'e-4' lander.

● SPACEFLIGHT

China and Russia lunar partnership



CNSA

China's Jiuquan Satellite Launch Center.

heavy rockets, with the Soyuz-2.1b launcher expected to be the booster for the majority of planned launches.

The project is considered very important by the partners as, in addition to the considerable national prestige it will bring and the beginning of regular flights to the Moon, it could be associated with other more important benefits for them.

As Vladimir Surdin, an astronomer and associate professor at Moscow State University, stated in an interview with the Russian-language *Eurasianet*, the country that will lead in Moon research and development will demonstrate its technological superiority in a variety of spheres including electronics and weapons etc.

According to Surdin, for scientists, the Moon has always been an intriguing object of study, due to the existence of various hypotheses of its origin. As Surdin added, even as of now, the surface of

the Moon has been studied to a depth of only two metres but no deeper. An important task that could be implemented by the partners, according to him, is the beginning of geological exploration of the Moon at greater depths.

In the meantime, according to Vitaly Egorov, a well-known Russian scientific blogger and an expert in the field of aerospace during the first stage of the project, the partners would have considered building an automated research base (that could be established as a result of landing several spacecraft, which have interaction with each other) at the South Pole of the Moon. As Egorov added, the plans for its construction have already been unveiled by the Chinese side some time ago, with the scheduled completion by 2030.

Adding to the family

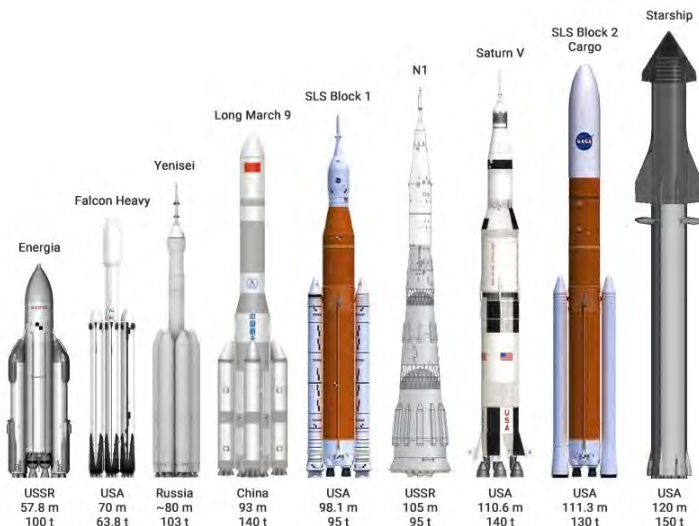
There is also a possibility that the Russian-Chinese IAS project may involve participation of other countries, particularly those from the Middle East (many of which have increased investments in their space programmes in recent years), such as India (despite its traditional tensions with China) and even Iran and Turkey.

According to analysts, if the 'eastern bloc' is created, it will become a rival to a number of countries participating in NASA's 'Artemis' programme, although it will still be unlikely to overtake competitors on that programme.

So far, Russia and China have experienced similar problems in ambitions to send humans to the Moon. Implementation of the Russian crewed lunar programme, which was initially announced in 2014, is seriously delayed, which is also due to the current problems with the design of a super-heavy Yenisei rocket, which is initially planned for launches. The main reason is the high cost of the project, which in 2016 was estimated at about RUB 1.5tn, is higher than the cost of the entire Russian federal space programme. In addition, according to the General Director of the rocket and space centre 'Progress', Dmitry Baranov, one of Russia's leading companies in the field of space science and aerospace research, it is important to adjust the design and performance of the rocket.

At the same time the development of the Chinese super-heavy lunar rocket Long March 9 is also at its initial stage, while its test flight will take place no earlier than 2030.

How China's Long March and rockets compare to the rest of the world's



Wikipedia/Thoren

Realignment of objectives

Until recently, many products of the Russian space industry had the status of being irreplaceable. However, the loss of the country's monopoly on the flights to the International Space Station and the end of purchases of rocket engines by the US had a negative effect on Russia's prestige.





The Soyuz TMA-16M spacecraft is seen here after having been rolled out by train to the launch pad at the Baikonur Cosmodrome, Kazakhstan.

Below: NASA's Deep Space Gateway orbital lunar station.



NASA

Moreover, ten years ago, China's attempt to send the Inho-1 satellite to Mars with the help of Russia's Phobos-Grunt interplanetary probe failed: the spacecraft failed to cross the Earth's orbit and burned up in the upper atmosphere. Since then, China has made a breakthrough in its own independent research of the Red Planet.

Most of Russian space achievements dated from the Soviet era, while China has its own Martian spacecraft, preparing to land the rover. In this regard, it will be difficult for Russia to offer anything conceptually crucial and important to the Chinese side in this joint ISA programme.

Indeed, a while ago Russia had plans to participate in NASA's Deep Space Gateway orbital lunar station project. However, it later decided to leave the project.

Commenting on that decision, Dmitry Rogozin, head of Roscosmos, said that: "Deep Space Gateway is positioned as the entirely American project with limited involvement of external partners, while Russia is not interested in such an option".

In addition, according to Rogozin, in contrast to the US, which is mainly interested in the research of lunar orbit, the sphere of interest to Russia is primarily related with the Moon's surface.

According to industry experts, the biggest

obstacles to Roscosmos were related to its minor role in the Deep Space Gateway project being limited to the design of a gateway module and life support systems for the station, although the Russian state corporation insisted on an equal partnership.

Still, as analysts of the Russian *Izvestia* business paper believe, even if an agreement was reached, its actual implementation would probably be blocked in the US Congress.

Insiders believe both China and Russia will be able to challenge the current leadership of the US in the 'second lunar race', although that could be complicated by the existing significant technological gap with the US, as well as deep disagreements between the partners. More deeper co-operation between the sides is prevented by the unwillingness of the Chinese to allocate significant financial resources to the project, while Russia is set to transfer much of its technologies to China.

In addition, according to analysts, the US has also achieved serious progress in the field of lunar exploration in recent years. This is reflected by the almost complete design of the SLS launch vehicle for the flight to the Moon. In addition, a test launch of a potentially crewed spacecraft for Artemis is expected soon.

The safety factor

RHIAN WILLIAMS-SKINGLEY, Dr ANNE ISAAC and CHRISTINE DEAMER from NATS and the Royal Aeronautical Society's Human Factors ATM subgroup look at Day-2-Day safety surveys.

Aviation is considered an 'ultra-safe' system with very small numbers of serious incidents and accidents. However, even in ultra-safe industries, accidents happen that surprise us, where nobody saw the accidents coming. Often in these cases, performance of the individuals, teams and organisation itself 'drift into failure'. Small changes occur over time that are hard to notice because they gradually become normal. Alternatively, performance can simply become more variable, with no specific trend.

Most safety critical organisations have systems for event reporting, incident investigation and lesson learning. However, even mature systems related to these functions have three problems. Firstly, the data is reactive rather than proactive; the event has already happened. Secondly, accidents and incidents are often unique events with different patterns of contributing factors. Therefore, preventing future

incidents is rarely possible. Lastly, since there are few accidents and serious incidents, we should not rely exclusively on such data for safety monitoring and improvement.

Safety experts also agree that traditional approaches to improving safety are coming up against the laws of diminishing returns and are looking towards other leading safety indicators to help them understand safety and human performance. Figure 1 (on the opposite page) shows the different pressures which all operations are continuously under.

Increased safety efficiency

Organisations place pressure on the operation to 'make it more efficient'. For example, we cannot fund every initiative, provide every variant of equipment or have unlimited funds for operational staff. All organisations must make the best use of their



resources and there will always be a drive towards greater efficiencies. The green line in Fig. 1 indicates this. Individually, there is only so much work which can be done and therefore workload pressures also play a part. If workload is too high, then overloads can result, and the work stream may break down, resulting in stopping some activities. Similarly, if there is too little work, individuals and teams may be 'underloaded' and there may also be safety incidents, often more critical. The failure of the organisation due to workload imbalance is shown by the blue line and the arrow shows the pressure to reduce workload.

Lastly, there are safety culture programmes, safety initiatives, assurance methods and other activities all pushing away from the safety line where an accident could occur. These activities ensure that we keep the operational environment safe.

These three pressures change constantly and the point where we operate will be in a different place from day to day and from minute to minute. Gaining an understanding of the dynamics of these stressors tactically is going to be key to supporting a safe operation especially when we know the frequency of serious adverse events is low and the complexity of large safety critical teams continues to grow.

It is for this reason the relatively new concept of Safety II may deliver improvements to safety. The following principles of Safety II need to be considered when developing this alternative perspective:

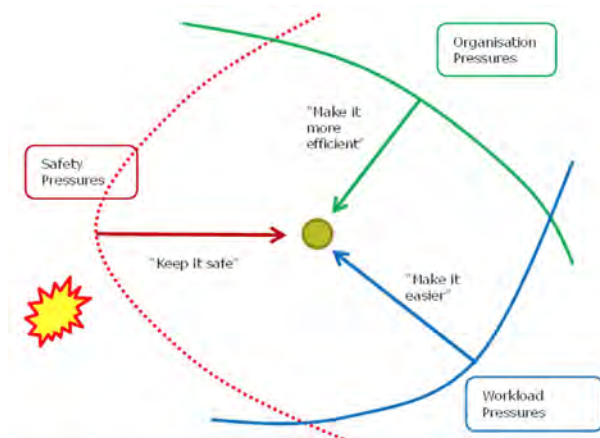


Figure 1. A Safety II framework (adapted from Rasmussen, 1997).

- Understand current performance, and how performance varies, to understand safety.
- Understand the pressures which cause the operating point to vary its position and drift towards danger.
- Develop the safety actions which will counter this increased pressure.
- Understand the trade-offs which are made in the operation to support efficiency, workload, and safety.



● AEROSPACE

Human factors in air traffic management

- Understand the gap between work as imagined and work as done.
- Understand what actions we take to anticipate risk and whether we are approaching our safety margins.

Alternative safety observation methodologies have therefore been developed to examine these issues, known as the Day-2-Day Safety Survey approach. These safety survey methods of the operational environment have several things in common:

- They focus on safety improvement.
- They are 'over the shoulder' observations by trained observers.
- The observations are confidential and non-punitive.
- The observations focus on the whole system not individuals per se.
- They are periodically recurring rather than continuous programmes.

Day-to-day safety survey measures can be captured from everyday operations and include positive indicators of safety. These indicators will enable safety performance to be better understood over a short period of time and provide a means of obtaining rapid feedback on the impact of safety improvement actions. They will also complement the analysis of incident data and provide a better understanding of safety performance, enabling proactive safety management.

In NATS, and other related high-risk, high-performance industries, this approach associated with the philosophy of Safety II, which emphasises how operational staff 'do things well', was developed and has successfully evolved over the last ten years.

The following paragraphs explain this methodology and its application in aviation and medicine.

Experience from air traffic management and beyond

Amongst the myriad of non-technical behaviours utilised by air traffic controllers (ATCs), visual scanning has long been of interest to human performance and safety specialists. In the ATC environment, poor visual scanning is thought to be an aggravating factor in a variety of errors. Visually, it can lead to controllers not seeing or miss-seeing an element of the visual scene, eg a conflict or misidentifying an aircraft. There are several reasons as to why this may occur, including tunnelling of the visual field, expectation, and distraction. This situation can also be exacerbated by the controller being over or underloaded. Poor scanning is also thought to affect judgement, planning and decision-making as these actions are dependent on the quality of information that is assimilated in the perception stage of information capture. In the dynamic world of air traffic control, missing a critical piece of visual information can have serious consequences, leading to operational errors.

The NATS Day-to-Day (D2D) Safety Observation programme recognises 'effective' visual scanning techniques as a strong mitigation against certain perception errors. In instances where data from D2D observations reveals that positive behaviours are less frequently seen, human factors specialists work closely with safety managers and operational staff to prioritise and define safety improvement activities. Utilising this early, indicative data, activities were designed and developed, which formed the basis of new training packages for controllers and trainees and also assisted in the design and implementation of new systems. As a result of these types of activities, an increase in the presence of positive scanning behaviours was noted. Furthermore, it was also realised that, where D2D and incident data were correlated, improvements in the day-to-day operational performance reduced incident rates.



NATS

Having now been utilised for over ten years in NATS, several safety improvement activities at aerodrome, approach and en route centres/units have been carried out as a result of the findings from the Day-to-Day Safety Observation programme. Early identification of 'weak signals' allows operational units and teams to put in place proactive and preventative safety measures. Examples within NATS include: the development of handover checklists, updates to procedures, telephone discipline, defensive controlling simulations and hearback/readback exercises for use in training. The findings are also being used to inform the development of future changes to both technology and airspace. Using a more proactive approach to 'designing in' safety performance enabled a 70% reduction in NATS' Safety Risk Index between 2007 and 2010, which was a weighted average of all significant incidents.

Programme developments have also allowed the extension of day-to-day safety observations into the flight deck of two of the United Kingdom's major airline carriers, adjacent ATC units, and ground handling staff. Numerous recommendations have resulted from these observations relating to training, procedure changes and equipment enhancements.

Further developments

In terms of human performance issues, ATM does not differ from other industries in which individuals work in highly coupled teams within high-risk, high-reliability environments. Highly-coupled complex organisations demand that individuals follow well founded rules and procedures and have clear, concise and often standardised communication protocols. The individuals in these situations also rely on others to work in close collaboration with little room for errors which are unrecoverable. Although in many cases individuals work on their own individual tasks, they continuously interact and co-ordinate their activities which are jointly monitored and supported where appropriate. These characteristics can be found in all aviation situations, as well as construction, transport, emergency response, nuclear and medicine. It is for this reason that the approach and method described is so successful. Typically, therefore, in the last few years many further developments have evolved, both in aviation and in medicine. Observation criteria have now been developed for the following situations:



USING A MORE PROACTIVE APPROACH TO 'DESIGNING IN' SAFETY PERFORMANCE ENABLED A 70% REDUCTION IN NATS' SAFETY RISK INDEX BETWEEN 2007 AND 2010

- standard human performance behaviours
- team-working
- students within college training
- on-the-job training instruction
- supervisory activities within live operations
- intra-team co-ordination
- inter-unit/centre co-ordination, including across international interface sectors
- new technology simulations in live operations
- flight deck operations, across all flight phases
- flight deck interface operations, including with cabin and ground crews
- communication and co-ordination between aerodrome ground handling teams
- clinical processes in specialist blood and organ transplant teams

This approach can be used in two ways – firstly by organisations, such as NATS, who want to monitor their safety status on a continuous basis and compare the results from one time period to another. This has

the advantage of also monitoring the efficacy of improvement activities. Secondly, this activity has also been used when an organisation believes there has been an increase in safety data in a specific operational area, such as an increase of events associated with airport or runway occurrences or a particular flight phase in an airline.

Focusing on observing the presence of 'good behaviours' allows us to build a picture of where our latent risks in the system may be, as well as including positive indicators of safety.

However, it should also be realised that the latent risks in a system are complex and fluid, and every opportunity should be explored to view and identify these risks from differing perspectives to assist our understanding and subsequent safety management. The competency of individuals, as part of the system, can be valuable information and allows us to understand the manifestation of latent risk. This is only meaningful, however, if there are complementary methods of performance standards which include measurements of capability and confidence.

These indicators, among others, enable safety performance to be better understood in a proactive manner, allowing for a better appreciation of safety performance, particularly for front-line operational staff.

● GENERAL AVIATION

Electric world speed record attempt

Leading the electric charge



Rolls-Royce is currently conducting test flights of a battery-powered electric racing aircraft with the aim of setting a new world speed record and also gaining insights into how electric technology could be used to power a new generation of commercial aircraft. **BILL READ** FRAeS reports from Boscombe Down.

Before the end of this year, Rolls-Royce plans to break the world speed record for an electric aircraft with the *Spirit of Innovation* battery-powered racing plane. The record-breaking attempt is part of Project ACCEL (accelerating electrification of flight) which aims not just to fly fast but also to gather data and research into the applications of battery technology for future electric aircraft projects.

The ACCEL flight test team is made up of around 20 people from Rolls-Royce (responsible for safety, engineering and flight operations), UK electric motor and controller manufacturer YASA (motors) and aviation start-up Electroflight (powertrain design, battery design, control and simulation). Rolls-Royce has invested £3m into the project, with a further £3m funded by the Aerospace Technology Institute, in partnership with the Department for Business, Energy & Industrial Strategy and Innovate UK.

Record

The objective of Project ACCEL is to set a new world speed record for electric-powered aircraft. According to the rules set out by the FIA (Federation Aeronautique Internationale – World Air Sports

Federation), aircraft have to set the record over four passes of 3km legs with a 1km approach at an altitude of under 500m. Currently, this record stands at 213mph (337 km/h) which was set in 2017 by a customised Extra 330LE racing aircraft powered by an engine from Siemens eAircraft – a division of Siemens – a company which was independent at the time of the record but is now owned by Rolls-Royce.

Aircraft

The airframe selected for the record attempt is a Sharp Nemesis NXT, a US-designed carbon fibre sports class single-propeller kitplane. Powered by a highly tuned Lycoming TIO-540-NXT Thunderbolt six-cylinder engine, the prototype of the NXT (an acronym for Neoteric eXperimental Technology) currently holds the internal combustion air record speed holder with a FAI 3km speed of 415mph (667.8km).

The kit for the airframe of the NXT was delivered to Electroflight at Gloucester Airport in May 2018. Two airframes were acquired, one for test flights and another for ground testing. The 400hp Lycoming engine has been replaced by three electric motors and the fuel tank by three battery packs.



THE SPIRIT OF INNOVATION HAS OVER 6,000 CELLS – THE MOST ENERGY-DENSE BATTERY PACK EVER ASSEMBLED FOR AN AIRCRAFT

Power of three

The 24ft (7.3m) wingspan aircraft is powered by three YASA 750v high power electric motors driving a single three-blade propeller via a single shaft running through all three motors. Rolls-Royce explained that the configuration of three motors powered by three battery packs was selected so that the aircraft can still fly safely if there is a problem with a motor.

Batteries packed

However, the main design challenge was that of the batteries which take up a large proportion of the aircraft. At an RAeS Flight Test Group online lecture in September, Rolls-Royce Flight Test Engineer, Andy Roberts described the technical challenges and lessons learnt from the integration of the *Spirit of Innovation* propulsion system, including weight, heat and power usage. "The main challenge of electrification is weight," he explained, adding how the problem was how to pack sufficient power into a small space. The *Spirit of Innovation* has over 6,000 cells – the most energy-dense battery pack ever assembled for an aircraft. The batteries produce direct current (DC) which is converted through an inverter into alternating current (AC) for the motor.

To save weight, Rolls-Royce had designed a special containment system for the batteries which also acts as a structural part of the aircraft. While electric cars typically have an equal weight proportion of cells and packaging, the battery box in the ACCEL aircraft weighs 450kg, of which the cells account for 300kg.

Keeping cool

Another issue with using batteries to power aircraft is that of safety. "Batteries can get hot," explained Roberts. "With the potential battery failure modes, you have to allow for the risk of batteries catching fire and a domino effect leading to thermal runaway and so the aircraft design has to include a tolerance to thermal events." The case cells are separated by cooling plates and are in fireproof containers lined with Portuguese cork which provides a thermal barrier because it's full of air pockets. There is also venting to take noxious fumes away, a purge system to maintain an inert

atmosphere and an active thermal management system consisting of a coolant radiator and numerous coolant pumps.

The batteries and engines aboard the *Spirit of Innovation* are monitored by sensors which can record over 20,000 data points per second, measuring voltage, charge state and temperature for over 6,000 batteries, as well as the overall health of the powertrain. This data is used both to provide the pilot with in-flight information on energy usage and temperature warnings but also to gain insights into battery usage for future projects.

Avionics

In addition to the engines and the batteries, the aircraft design also incorporates a power distribution system connecting the battery to the engine, the aircraft control mechanisms and the avionics bay which includes the control hardware, engine control unit (ECU), power distribution unit (PDU) and flight sensors. Multiple low voltage power supplies provide redundancy for the control systems.



Speed vs distance

Because the aim of the ACCEL project is to fly at high speeds, the batteries will provide high power for a short period of time – the aircraft will only be flying for 7-8min with enough power remaining to land with reserves. However, if the batteries were discharged more slowly, the *Spirit of Innovation* should fly for significantly longer.

Ground tests – Ion bird

Before the *Spirit of Innovation* aircraft began flight testing, Rolls-Royce conducted an extensive series of ground tests conducted on a wingless static version of the aircraft, known as the 'Ion Bird' – taking its name both from 'Iron Bird' ground test aircraft and the li-ion batteries it operates on. Much of the ground testing was conducted under

Above left: The Spirit of Innovation is powered by over 6,000 battery cells.
Above right: The batteries of the Spirit of Innovation (left) power the three electric motors.

● GENERAL AVIATION

Electric world speed record attempt

the restrictions of Covid-19 and was completed in September 2020. The 122 hours of ground tests, which included running the propeller at 2,400rpm and the University of Warwick testing the batteries to their point of failure, enabled Rolls-Royce to learn how to use the system and ensured that the battery was able to reach its maximum possible performance before being integrated onto the flight test aircraft.

Flight tests

This autumn Rolls-Royce began testing the flight test version of the ACCEL aircraft at the Ministry of Defence's Boscombe Down airfield, currently managed by QinetiQ – a site with a long heritage of experimental flights. In his September lecture, Andy Roberts explained how Rolls-Royce, while usually just supporting customers conducting their own flight tests, does have its own flight test pilots. It also has a number of flight test aircraft, including a Boeing 747 engine testbed based in the US, as well as a 1944 Mk XIX photo reconnaissance Spitfire with 2,000hp Griffin engine which can go at over 400mph. Unlike some flight test programmes, Rolls-Royce has relied on using real aircraft rather than creating a simulator. As part of the preparation for Project ACCEL, Rolls-Royce test pilot Phill O'Dell flew a piston version of the NXT racer at 350mph in the US. The test pilots have also flown over the electric speed record course in the Rolls-Royce Spitfire which has very similar dynamics to the NXT.

Flown by Phill O'Dell, the *Spirit of Innovation* aircraft took to the air for the first time on 15 September with a 15 minute flight. The first flight achieved a speed of 210mph – very close to the current record of 212mph. A number of further test flights, the details of which have not been disclosed, followed shortly afterwards. Over the next month, subject to test results and flying conditions, Rolls-Royce plans to conduct between 20-30 flights of 15min duration, each one gradually

increasing flying speeds while ensuring that the battery cooling and other systems are all working as they should do. The aim of the tests is not just to break the current speed record but to see how far it can be exceeded with speeds of over 300mph (483km/hr). As speeds increase, Rolls-Royce has said that it may have to use the Spitfire as the chase plane to keep up with the electric aircraft.

During the tests, performance data will also be gathered on the aircraft's electrical power and propulsion system. One interesting preliminary result from the first test flights is that the temperature levels have been very good, due to the addition of the ram air effect in flight, which could not be simulated in the ground tests.

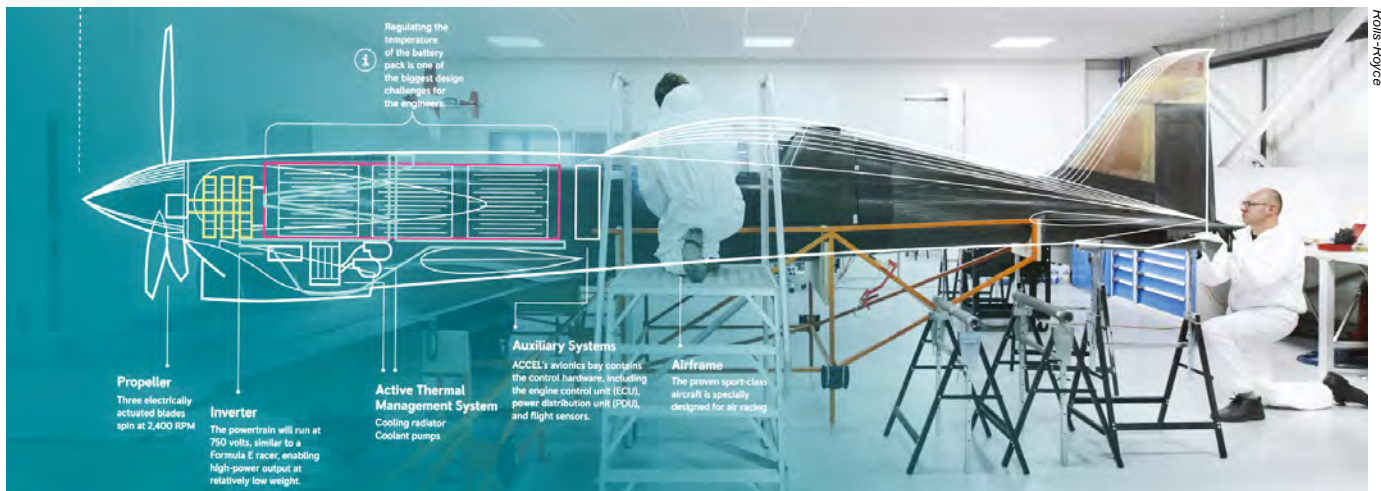
The electric experience

Rolls-Royce Chief Test Pilot Phill O'Dell explained that the *Spirit of Innovation* is not very different to fly than the existing aircraft he is familiar with. One issue is that controllers can become concerned if they see the propeller stop on the taxiway. Phill, who has had to lose 2kg of weight like a jockey to help reduce the overall weight of the aircraft, also described how it was quite difficult to see where he was going while lying back in the low-slung pilot's seat and had to wear special shoes to help control the aircraft. However, once the aircraft was flying, he said that the throttle was one of the best he had being 'very responsive and very linear'.

Future projects

Once the tests are completed – and hopefully the speed record won – the *Spirit of Innovation* will not be used for any further flights. The project has enabled Rolls-Royce to learn more about the characteristics of batteries over the longer term which are relevant to future electric aircraft projects which will focus on endurance rather than speed with the aim of maximising range.

Many different systems have gone into the ACCEL electric racer



Rolls-Royce

Rolls-Royce is already involved with a number of electric propulsion projects, including parallel-hybrid electric systems for the Tecnam P2010 H3PS (high power high scalability hybrid powertrain) technology demonstrator due to fly in November. Airbus' CityAirbus UAM demonstrator and Vertical Aerospace's eVTOL. It is also working with Tecnam and Scandinavian regional airline Widerøe, to develop an all-electric passenger aircraft, the Tecnam P-Volt based on the airframe of the 11-seat twin propeller P-2012 Traveller, to enter revenue service in 2026.

Rolls-Royce plans to use the experience gained from the ACCEL project in the development of a complete electric propulsion system for electric vertical take-off and landing (eVTOL) 'air-taxis' and larger electric-powered commuter aircraft. The company is also working on green solutions to power larger aircraft, including hybrid-electric systems, further efficiencies in gas turbine engines and sustainable aviation fuels (SAFs).

Power, size and altitude

Batteries used to power an aircraft have to endure unique conditions not found on the ground. One problem already highlighted is the risk of the arcing due to the corona effect. The higher the voltage used, the greater the risk. Arcing is also more likely to occur at greater altitudes. The risk of arcing can be reduced by separation of the cables but this becomes more difficult, the smaller the airframe. Designers of future commercial electric-powered passenger aircraft will need to make decisions on what voltage to run their engines on. Larger airframes will make it easier to separate cables but will also need more power to operate. The higher the aircraft will fly, the increase in the risk of arcing. Designers may need to adopt a number of different voltages depending on aircraft size, power and altitude.

There is also the problem that electric aircraft also have to have more frequent full discharges which can affect battery life, as cells will degrade with use at a rate dependant on how they are used. Unlike cars, aircraft cannot slow down or stop if batteries are running low. According to a member of the ACCEL team, batteries can only be recharged from 500 to 1,500 cycles before they degrade too much to be of use to power aircraft. This could be a problem for eVTOL operators which

will need to use full power for vertical take-offs and landings and require frequent recharges which could wear out their batteries quite quickly.

Rolls-Royce has also gained useful insights from the ACCEL project into battery recharging and the new infrastructure which will be needed at airports operating electric aircraft.

Second battery life

The company is also looking at the issue of what to do with degraded batteries. Batteries which have reached the end of their useful life powering aircraft can be used in marine applications which do not need the same discharge capability and then again in land use. There is also the issue of end-of-life battery disposal and recycling, a challenge which the aerospace industry has not yet had to tackle but which is monitoring the lead being set by the automotive industry which is currently tackling this issue.



New business models

In addition to new technology, the ACCEL project is also changing the way that Rolls-Royce plans to do business in the future. Up until now, the company has specialised in the manufacture and aftermarket care of gas turbine engines for other operators but has not been involved in other areas of the aerospace business. However, this business model is beginning to change as the company moves from being purely a powerplant business to a technology business. In addition to manufacturing electric engines, Rolls-Royce is investing £80m into developing its own energy storage capability and will be launching its own battery on the market in 2025. It is also getting more involved in fuels and is currently working with Shell on the development of SAFs.

We conclude with a quote from Matheu Parr, the project lead for ACCEL: "Rolls-Royce has been a pioneer over the past 100 years and now we want to be pioneers in the next 100 years."

From left to right: Rolls-Royce Chief Test Pilot Phill O'Dell, Propeller close-up, Ground tests were conducted using the 'lon Bird' duplicate aircraft.

● AIR TRANSPORT

ATR at 40

Top of the Props at 40

This November, regional aircraft consortium ATR celebrates its 40th anniversary. **TIM ROBINSON** FRAeS looks at how the turboprop manufacturer is staying ahead of the game four decades on.

There is no doubt that regional aviation is a tough business – with razor-thin margins for operators flying routes that can connect remote communities. The same might be said for manufacturers. Since ATR was formed as a joint venture between Airbus and Leonardo (then Aérospatiale and Aeritalia) in 1981, it has seen a number of rivals exit the regional airliner business – such as Fokker, BAE Systems, Saab and Dornier – although the latter is aiming to make a comeback. Its biggest rival in turboprops, Canada's Bombardier, is a shell of its former self after overextending with the C-Series and selling off its Dash 8 Q400 family to Longview Aviation. While there is competition on the horizon from Embraer's future turboprop, at present ATR is arguably 'the last man standing'.

As well as its 40th anniversary this month, this year will also see ATR celebrate its 1,600th delivery of a regional turboprop. Its products, the ATR 42 and ATR 72, are the best sellers in the 50-90 regional airliner market with ATR claiming 76% market dominance in firm orders over the Dash 8-400 since 2011. Against regional jets in the same

size category, such as the CRJ700/900 and E170/E175, ATR has a respectable 38% of the market.

Part of ATR's success then, is that it has stuck to its core business of regional and not expanded into risky ventures, such as regional jets or adjacent markets. However, the flip side of this is there is also the sense that its ambitions have been carefully held in check by its partners. Previous concepts to launch a brand new larger 90-100 seat stretched model of the ATR came to naught, most likely as this would have begun nudging up against the 107-seat 'baby' Airbus A318.

A factory with history

Based in Toulouse, ATR's factory with its natural light roof is one steeped in aviation history, from producing Dewoitine fighters just before WW2, to the Franco-German Transall, and most famously of all, Concorde. Both the metal wing ATR 42 and the composite wing ATR 72, as well as the new ATR 72-600F cargo variant are produced on the same line.

Today, the effect of the coronavirus pandemic has meant that production has slowed to just two a



ATR Aircraft



WE ARE A TINY COMPANY BUT ACTIVE ALL AROUND THE WORLD

Stefano Bortoli
CEO,
ATR



Tim Robinson/Paas

month, with the airframer aiming to increase to five a month by 2025. At the time of *AEROSPACE's* visit in September, the factory also had around 25 airframes in a backlog for completion and delivery to customers, with the intention to double the deliveries in 2021 from the 10 it handed over in 2020.

Worldwide customers

One impressive aspect of ATR is that, with a tiny workforce (1,200) compared to parent groups Airbus and Leonardo, it still has to support a varied set of over 200 operators from all around the globe – from the Arctic to the Pacific and from cargo to military users, such as maritime patrol aircraft and special missions. Many of these airlines could be operating 'microfleets' of just two or three aircraft – yet will still expect the 24/7 AOG support and responsiveness afforded larger carriers. Says ATR CEO Stefano Bortoli: "We are a tiny company, but active all around the world".

Meanwhile, the Covid-19 crisis has significantly impacted ATR's customer base, with the company working hard to reinforce relationships and support its airlines. For example, with passenger flying grounded in many parts of the world, it quickly made available a solution to convert a passenger configuration to a cargo one overnight to keep its customers flying.

New models, new innovation

While ATR has stuck closely to its strategy of two basic models over the past four decades – the ATR 42 and ATR 72 it has recently launched two derivatives to expand its family with two new models – the 42-600S STOL variant announced in 2019 and a new-build 72-600F cargo variant launched in 2017 with an order for 30 firm and 20 options from FedEx.

Despite focusing on these two base models in the past 40 years, ATR has not rested on its laurels

in improving and bringing the latest technology and advances to its products. The cockpit of the -600, for example, with five large screens is a far cry from the steam gauges of the original. The flight deck also features the latest in performance-based navigation standards, including VNAV, (vertical navigation) LPV (localiser performance with vertical guidance) and RNP AR 0.3/0.3 (required navigation performance) which allows for complex precision landings. As well as the obvious safety benefit of these in mountainous terrain, this saves fuel by more direct routes, fewer holds and missed approaches.



Stefano Bortoli (ATR Aircraft)

ATR is also breaking new ground in becoming the first commercial airliner manufacturer to introduce a head-mounted display (HMD) into the cockpit with its Clearvision HMD. The system, similar to the kind of advanced HMDs worn by fighter pilots, uses the latest technology to shrink this to a pair of lightweight goggles. This allows flight symbology and IR video from the EVS (enhanced vision system) or SVS (synthetic vision system) to be presented in front of the pilots' eyes, wherever they look – providing enhanced situational awareness in bad weather or at night.

A cabin that feels like a larger jet

Meanwhile, in the rear, ATR has also been busy in upgrading the passenger cabin, which now matches the experience of A320s and larger jets – with a number of details found in mainline airliners. Since 2016, ATR has been offering the ultra-lightweight (< 4kg) Titanium Seat from ExliSeat, which can save operators up to 300kg on ATR -600 cabin configuration. Additionally, the large overhead baggage bins feature a roller opening mechanism, meaning that doors are kept clear of hitting taller passengers. A Smart Galley allows for reconfiguration. The latest cabin also features wi-fi to allow passengers to connect their own devices for IFE.

● AIR TRANSPORT

ATR at 40



Upgauging at regional operators

While airlines in some markets are 'downgauging' to smaller narrowbodies, ATR sees a growing market for potential operators in the 30-50-seat range trading up to newer aircraft from older types. There are now over 900+ ageing turboprops in the 70-seat and below bracket that will need replacing in the coming years – double the number since ten years ago. These include Dash 100/200/300, Saab 340s and Embraer Brasilias – with the biggest airline fleet renewal opportunities being in the US, Australia and Canada.

Indeed, the launch of the STOL (short take-off and landing) variant of the ATR 42, with its ability to operate from 800m strips, with 40 passengers has also been attracting attention in the sub 40-seat category, from operators of aircraft, such as the Twin Otter and Islander as a way of upgauging or using it as a combi-passenger/freighter for remote regions. Air Tahiti, for example, will replace its 19-seat Twin Otters with the ATR 42-600S STOL, while PNG Air is set to replace its 37-seat Dash 8-100s too. All told, ATR says that the ATR 42-600S will open up an additional 500+ airports able to operate the STOL variant of the turboprop airliner.

One under-exploited market for ATR is still China, where certification of its latest 42-600 is still held up for unknown reasons, with expected approval slipping from autumn of 2020 to mid-2022. While industry insiders speculate that this could be down to the pandemic, increased workload at Civil Aviation Authority of China (CAAC) of certifying the Comac C919 or potentially the fact that China has its own regional turboprop, the MA700 waiting

Evolution of the ATR flight deck. From bottom left, clockwise, ATR 42-500 simulator in the company's training centre in Toulouse, the latest ATR 72-600 flight simulator and the Clearvision head-mounted display (HMD) now offered as an option.

in the wings, ATR, is careful not to be drawn on the reasons for this delay.

For the freighter good

Another opportunity, says ATR will be in the regional cargo segment, with the Covid-19 pandemic highlighting the value and importance of air freight as the world went into lockdown. Cargo activity has already surpassed 2019 pre-Covid levels in the first months of 2021 and the company says that in the past two years the number of cargo flights has increased by 72%.

Even as travel restrictions lift, the acceleration of e-commerce, remote working and the vaccine rollout to remote areas means that this momentum in the airfreight sector is likely to continue. While there are 130 ATR freighters flying today, ATR expects that there is a market potential of 460 turboprop cargo aircraft (both new and used) over the next 20 years. Its new ATR 72-600F, which first flew in September 2020, is thus aimed at this market.

Hydrogen power?

With its parent group Airbus now aiming to fast-track hydrogen as a fuel for zero-carbon aviation, ATR is also in the unique position of potentially being able to take advantage and 'piggyback' on this – with Airbus saying that it expects hydrogen-powered regional aircraft to be the first applications.

However, ATR itself is more cautious on the matter. It says that it intends to explore Universal Hydrogen's technology – a start-up from ex-Airbus CTO Paul Eremenko, that coincidentally is opening an

R&D engineering centre in Toulouse, with the intent to convert an ATR turboprop to this zero-carbon fuel. Says ATR CEO Bortoli: "We have a lot to bring to them, we have to understand what they bring to us".

Despite these potential paths to zero-carbon regional airliners, ATR also points out there are financial and operational challenges to be solved in bringing hydrogen to regional aviation. For one, will its small regional airline customers, with limited funds for fleet renewal compared to the major airlines, be in the position to buy a zero-carbon airliner that potentially could be more expensive than a conventional turboprop?

Secondly, there are operational challenges – with ATR operators regularly flying into austere and remote airstrips, as well as regional airports. This not only means that aircraft need to be durable and rugged to operate from gravel and dirt strips but also these remote airports make it far harder to develop the kind of hydrogen infrastructure that would support zero-carbon aviation.

ATR is also making strides in converting its aircraft to run on SAF (sustainable aviation fuel) and achieve 100% SAF compatibility by 2025. In 2019, with its Swedish customer Braathens Regional Airlines –and biofuel suppliers Air BP and Finnish Neste, ATR conducted a 'perfect flight' between Halmstad and Stockholm Bromma – achieving a 46% reduction in emissions with a 50% blend, direct routing and optimised flight altitude.

In 2022, ATR will repeat this 'perfect flight' with Braathens with 100% biofuel on one engine with the aim of reducing emissions by 64% compared to a normal flight in regular conditions. These tests then, a step along the way to 100% SAF compatibility in 2025, show what can be done with existing technology and operational improvements.

Summary

There is no doubt that ATR has benefited from the support and deep pockets of its two large OEM



Tim Robinson/RAS

Leading the way in responsible regional flying

This does not mean, however, that ATR is a lone hold-out against the growing momentum of sustainable regional aviation. Indeed, in some areas, it is already leading the way in many respects. Ultra lightweight cabin seats and precision navigation all save fuel and its fuel-sipping turboprops already save -40% CO₂ emissions compared to a similar sized regional jet and half the NO_x produced on take-off and landing. ATR's products, meanwhile, are more considerate to communities around airports, with a noise footprint three times smaller than jets.

Interior of a TAROM ATR 72-600 with NeoPrestige interior ready for delivery at Toulouse.

parent groups in the form of Airbus and Leonardo – giving it a strong foundation to lean on, when others have exited this small, yet challenging, sector. With arch turboprop rival Bombardier gone, the next challenger is set to be Embraer with a clean-sheet turboprop with rear-mounted engines.

Yet the rapidly expanding cargo market and the large replacement market for 30-seat and up older turboprops will keep ATR busy for years.

However, it is notable that, as electric, hybrid-electric and hydrogen aircraft develop, it may be from the smaller end of the market first but CEO Bortoli notes that, while ATR will consider any new green technology, it will need to be "available and affordable" before it is adopted.

● AIR TRANSPORT

1921 Channel air transport RAeS position paper

100 years of civil aviation



One hundred years ago, in 1921, the RAeS published a position paper on the design of a future British civil aircraft to fly passengers between London and Paris. **BILL READ** FRAeS and **TONY PILMER** from the National Aerospace Library consider the historical reasons why such an aircraft was needed and the insights, both past and present, which the paper provides into the safe and reliable development of a new form of passenger transport.



RAeS 1921 Position Paper.

One hundred years ago, the Safety and Economy Committee of the Council of the Royal Aeronautical Society published a position paper on the 'type of engine and mechanical arrangements required for the safe and economical working of an aeroplane carrying mails and passengers between London and Paris'. The report provides interesting insights, not only on the contemporary state of aeronautical engineering but also in the safe development of new technology in the early days of the development of commercial airlines.

It had also been intended to report on an aircraft design for a 500 mile route but this plan was

dropped as 'such benefit as might result would be greater if the report were produced at an early date.'

From this remark it can be deduced that there was some urgency in wanting to get the report published so that work could be started on an actual design. The reason for this urgency becomes apparent when we look at the early history of British commercial aviation.

The dream of a British civil aviation industry

In the depths of WW1, George Holt Thomas, the former publisher and then driving force behind Airco,

safety thought-leadership



one of Britain's largest aircraft companies, saw that delivering mail and passengers by air would not only become a commercial proposition but would be of key importance to the future of the British Empire. As early as November 1916, he had established his own airline, Aircraft Transport & Travel (AT&T). Only four days after the Armistice, AT&T announced that it was making arrangements to establish a route between the Ritz Hotel in London and the Ritz in Paris.

Unsurprisingly, Holt Thomas looked towards Airco and its designer, Geoffrey de Havilland, for aircraft. Airco had experience of converting the rear cockpit of the D.H.4 bomber into a cabin to create the D.H.4A civil aircraft for the RAF and these were also adopted by AT&T. Airco similarly converted D.H.9s into civil aircraft for AT&T and de Havilland also used spare parts for his D.H.16 bomber to create a four-passenger variant.



George Holt Thomas (1885-1961)

Britain's first airlines. AT&T was first in the air on 1 May 1919, though its first cross-country run started in disaster with its DH.9 crashing near Portsmouth. AT&T was then followed out of London's aerodrome at Hounslow by Avro Hire Co on 24 May, British Daimler Air Hire Co on 7 June and Handley Page Transport Co on 14 June.

AT&T's two main British competitors on the London to Paris route were Handley Page, which converted some of its wartime aircraft for civil use and S. J. Instone, a shipping company which started to use aircraft to transport staff and documents but decided to open up its service to the paying public in February 1920. It used a selection of aircraft the wartime designs of Vickers Vimy and de Havilland D.H.4A, as well as Westland's and de Havilland's first purpose-built civil aircraft, the Limousine and D.H.18, respectively.

Airlines take to the air

Though the first scheduled cross-channel trips would have to wait until the final peace treaty was signed and air international regulations agreed in 1919, four main companies lined up to become

The opening and closing of the London-Paris route

The official opening of the cross-channel route was scheduled for 25 August 1919. Once again AT&T was in the air first with the world's first international

● AIR TRANSPORT

1921 Channel air transport RAeS position paper



RAeS/IAL

Above: The de Havilland DH16.

regular scheduled flight, taking off at 12.30pm (a date which British Airways choose to celebrate as the beginning of its centenary in 2019).

The creation of British civil aviation was not all plain sailing. Two AT&T D.H.4As encountered problems in the winter of 1919. The aircraft came down in the English Channel without loss of life, after which both the pilot and his passenger were killed in an accident over Coulsdon Common in Surrey. Handley Page also experienced a crash just after take-off the following winter in which the pilot, mechanic and two of the six passengers also lost their lives.

Initially, it appeared that one or two of the new routes would turn the corner financially, which was fortunate, as the British government did not

The Royal Aeronautical Society to the rescue

It was at this point that the Council of the Aeronautical Society of Great Britain, by then renamed the Royal Aeronautical Society, decided to bring together a number of their leading experts to 'discuss what is required to ensure the safe and economical working of an aeroplane carrying mails and passengers between London and Paris'.

The references to 'safe and economical working' now become clearer, as a response to the air crashes of 1919 and the financial disasters of 1920 and 1921. What was needed was an aircraft design which could carry passengers safely, was reliable in service and economical to operate.

The fact that there was a need for new aircraft designs is borne out by an article written by Sir Alan Cobham at the time of the RAeS' centenary in 1966. "In the early 20s, as far as I can remember, there was little worthwhile development in new types of aircraft. Conversions of wartime aircraft to meet the demands of civil aviation, seemed to be the vogue of the day."

Cobham also commented on aircraft safety and reliability: "In the early days of flying, one lived as a pilot by virtue of one's ability to accomplish a forced landing, because one never knew 'from one moment to another' when the engine would fail to operate. Anything could happen – a faulty propeller, a bad fuel system, pumps that packed up, broken inlet valves, broken valve springs, conrods broken and even a split crank case."

The Safety and Economy Committee was formed in February 1921 and worked quickly. Within three months the report was put before the Council, adopted and it was decided that it should be published.

The majority of the report concentrates on the technical details of suitable aero engines, followed

RAeS/IAL

August 1919 London Paris.

Aug. 25th Aero 9 (Lt McNeill) left Hounslow at 1.15 with spares for Paris/Bruxelles. Landed at Bourget 3.40
 Aug. 25th Aero 14 (Lt Lawford) left Hounslow at 9.5 with 1 passenger and goods. Landed at Bourget 11.40
 Aug. 25th Aero 16 (Capt. Pittman) left Hounslow at 12.00 with 4 passengers. Landed at Bourget 3.5
 Aug. 26th Aero 14 (Lt Shaw) left Hounslow at 1.5 with 2 passengers and parcels. Landed at Bourget
 Aug. 27th Aero 9 (Lt McNeill) left Hounslow at 1.43 with 1 passenger and parcels. Landed at Bourget
 Aug. 29th Aero 14 (Capt. Selby) left Hounslow at 2.09 with 2 passengers and parcels. Landed at Bourget
 Aero 9 (Capt. Baylis) left Hounslow at 12.36 with 2 passengers and parcels. Landed at Bourget
 Aero 16 (Lt Lawford) left Hounslow at 12.26 with 4 passengers. Landed at Bourget
 Aug. 30th Aero 14 (Capt. Kirkwood) left Hounslow at 12.20 with 2 passengers. Landed at Bourget

Figure 1. The first daily international passenger services. An extract from the A T & T Flight Log Book. Courtesy of P. T. Griffiths, Assoc. Fellow

Above: IT&T London-Paris August 1919 flight log book.

look kindly towards the fledgling industry. On 11 March 1920 the Secretary of State for Air, Winston Churchill, underlined the government's stance when he told the House of Commons that: "Civil Aviation must fly by itself; the government cannot possibly hold it up to the air".

However, the new airlines' luck did not hold, as their continental rivals began to receive state aid. The losses mounted and the British companies stopped flying. However, the suspension of the British service across the channel did not last long. The government did a U-turn and made £60,000 available to subsidise the route.

Right: The first AT&T London-Paris flight.



RAeS/IAL

by some brief remarks on the design of the aircraft and concluding with a few comments on the requirements of the flight itself.

While it was the opinion of the committee that contemporary aero engines were largely reliable, they were still at risk of failure due to other factors, such as poor installation, lack of cleanliness, oil leaks, or faulty fuel feeds and filters. The report recommends that civil aircraft should adopt pressurised fuel systems rather than gravity feed, which would increase fire safety by having fuel tanks in the wings rather than inside the fuselage.

One cause of engine failure was due to faulty valves and springs which were not always a uniform size. Present day quality control managers would no doubt be horrified to learn that the procedure for inspecting new springs in 1921 relied on visual inspections from skilled manual workers. The RAEs recommended that research was conducted on the scientifically precise treatment of the spring material to bring mechanical differences within small and reliable limits of variation.

Fuel and compression ratios

It is also perhaps surprising to learn that fuel gauges were not yet standard equipment. The report states that: 'The pilot must have knowledge at any given moment of the amount of fuel in his tanks... Urgent efforts should be made to produce a satisfactory distance-reading petrol gauge.'

Safety

The committee also recommended that future aircraft should be fitted with a mechanical engine starter, observing that the 'present unsatisfactory method of starting the engine by swinging the airscrew' is an 'inefficient and dangerous proceeding'.

Ease of maintenance

Ease of maintenance is also considered, with the recommendation that 'engine cowlings should be completely dismantlable or replaceable in three or four minutes without the use of tools, and in such a way as to leave the engine and accessories completely clear.' Magnetos should also be readily removable and easily replaced.

Sharing information

It was also recommended that the aeroplane designer should give as much information as possible to the engine designer on their proposed designs, since 'the engine takes much longer to evolve than the aircraft'. In more recent times, an engine design is often ready before the aircraft but the suggestion for more communication and

collaboration between designers and manufacturers is an interesting foretaste of the present 'digital design' and 'virtual twin' interactive aircraft testing and design methods of the 21st Century.

One engine or two?

There was some debate within the committee over whether future commercial aircraft should have one or two propellers. It was felt that, for safety reasons, there should be two engines so that one could continue working in the event of the failure of another. However, there was no clear preference over whether the two engines should each power separate propellers or have them coupled together to one propeller (a design feature used to power rotors in many modern helicopters).

Navigation and air traffic control

The paper also issued an early call for the creation of what eventually evolved into air traffic control, saying that there was a need to establish 'some means to warn pilots of each other's presence'.

Again highlighting the need for a future ATC system was a recommendation that pilots should have the means to communicate with the ground by wireless so that warnings could be issued regarding local fog or cloud: 'The committee strongly recommend that a complete organisation of meteorological warnings by wireless should be developed.'



The Croydon air traffic control tower.

Brendan and Ruth McCartney/Wikimedia

● AEROSPACE

1921 Channel air transport RAeS position paper

The emergency exits are here – or you can just go out through the wall

The committee briefly commented on the emergency evacuation of aircraft, a recommendation that is again worth quoting in full: 'It is not always possible for passengers to make their exit from aeroplanes in certain positions, in the event of a crash and even where it may be possible to escape by making a hole in the fabric covering the fuselage, experience shows that passengers are not aware of this fact. It is recommended that the provision of emergency exits for rapidly discharging passengers in the event of a crash, in whatever position the aeroplane may be and the notification of such means of egress, should be made compulsory.'

Fire precautions on aircraft were also highlighted as an important factor but not included as a subject for discussion.

Finally, because the aircraft was going to operate across the Channel, the committee included a recommendation that the design include 'provision for safe alighting on water and for the flotation of the aeroplane for at least half an hour, coupled with some means of signalling for assistance.'

What happened next

The RAeS position paper was mostly well received. The RAeS 1922 Annual Report heralded it as a 'valuable report... (which) was most favourably received'. However, the test of the report was whether the findings were adopted by those designing the next generation of aircraft.

The new generation of aircraft

Instone and Daimler, which was born from the ashes of AT&T, relied on de Havilland's new civil aircraft, the D.H. 34. Though its Napier Lion engine did come out as a unit, there was only room for nine passengers and the pilot's view ahead was partially obscured by the engine's radiator header-tank.

Handley Page relied on the Handley Page W.8 and its variants. These were first flown in 1919 but only entered service in October 1921. Though the location of the fuel tanks was moved from the engine nacelles after the publication of the committee's report, they did



RAeS/NAI

not follow their recommendations to put them in the wings but chose to put them on top of the wings.

Instone also purchased three Vickers 61 Vulcans, which was quickly nicknamed 'The Flying Pig'. However, perhaps the airlines heeded the RAeS report more than the designers, as Instone ordered extra equipment, such as air flotation bags and pneumatic safety belts.

Above: The de Havilland DH16.

Bottom left: Vickers Vulcan Type 61 G-EBET.

An effect on ATC?

Perhaps the quickest recommendation to come into force concerned the committee's suggestion that radio should be used to bring aircraft into land. On 3 November 1921, *Flight's* Croydon Aerodrome reporter told readers that: 'Tests on a new wireless apparatus which has been erected in the control-tower were carried out on Saturday with extremely satisfactory results. This apparatus is for guiding aeroplanes once they have approached the air-station on days when visibility is bad and it is difficult to pick out landmarks.'

Losses mount up

Airline finances continued to decline in 1921. The government's predictions on cross-channel traffic were overly optimistic and Instone and Handley Page lost £5,398 between them. A longer-term solution was required and, from 1 April 1922, a £200,000 annual government subsidy was given to support the London to Paris route, though this was measly compared to the £1.3m of subsidy given by the French government.

However, even with the new scheme, losses continued to mount up. The longer-term solution was to combine the airlines into one large company backed with a ten-year subsidy from the government and, on 1 April 1924, Imperial Airways was born.

100 years ago, the RAeS was at the vanguard of thought leadership in improving aviation safety. Today, it and its Specialist Groups continue this learned role to advance the art, science and engineering of aeronautics.



RAeS/NAI

A longer version of this article is available online at the **AEROSPACE** Insight blog

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Remote pilots and 'shared fates'



Remote control

Dr **ROBERT E JOSLIN** FRAeS, Associate Professor, College of Aeronautics, Embry-Riddle Aeronautical University looks at the concept of 'shared fate' in emergency situations for remotely piloted airliners and eVTOL operations.

One of the concepts being considered for the introduction of single pilot operations (SPO) by transport category aircraft is to have an additional pilot remotely located at a ground control station. The remote pilot would act as a safety/back-up pilot for one or more aircraft being flown with a single pilot on board. This safety/back-up pilot would be expected to intervene primarily during an emergency condition if the on-board pilot became incapacitated or otherwise was not performing the required piloting tasks. In this scenario the pilot now making the aeronautical decisions and assessing the risks for the safety of the aircraft and the passengers on board would be someone remote to the aircraft, hence would not be sharing its fate.

In a similar manner, the integration of urban air mobility/advanced air mobility (UAM/AAM) aircraft operating fully autonomously through artificial intelligence/machine learning can be expected to require an intermediate step in which highly automated but not fully autonomous aircraft with passengers on board will be flown by a remote pilot. It has been recognised that the 'crash' of an uncrewed aircraft (without passengers) can still possibly result in the injury or death of people on the ground. Consequently, civil aviation authorities

have prohibited or otherwise required extensive mitigations when operating over people, thereby shifting the hazard of concern to damage of the aircraft and/or property. However, for UAM/AAM, the hazard will extend to persons on board an aircraft that is being flown by a remote pilot. Likewise, as in SPO, the UAM/AAM remote pilot will not have a shared fate with the aircraft passengers. Thus, in both cases the amount of risk a remote pilot is willing to accept during a normal, abnormal, or emergency condition can have severe consequences for those on board.

Shared fate

Although the concept of shared fate may not be recognised or completely understood by the public, numerous surveys and studies have reported air travel consumers' reluctance to fly in an aircraft of any type without a pilot on board. The one exception is a scenario that involves malicious, terrorist, or criminal intent, such as the Germanwings suicide crash that conceivably could have been prevented by disabling the on-board controls and then remotely flying the aircraft.

The extant research on shared fate related to remotely piloted aircraft operations has suggested that there may be negative consequences from

an off-board pilot not sharing the outcome of the aircraft. This new human factors issue, that is unique to uncrewed systems, has not been directly accommodated in the existing human-centric models for aircraft safety analysis, such as the Human Factor Analysis and Classification System (HFACS). However, accident reports for uncrewed aircraft reveal that remote pilots have exhibited a somewhat *laissez-faire* and disconnected attitude about the safety of the aircraft, which has resulted in unnecessary high-risk manoeuvres. Transcripts from publicly released US military uncrewed aircraft accidents illustrate this mindset.

"We're in the soup here. . . . Dude, uh, we're not sure what the aircraft is doing. . . . Yeah, we crashed."

"What's going on? Hang on! Hang on! . . . Uh-oh! It's spinning! . . . Okay, I think it just fell out of the sky."

"This thing's kind of climbing like a pig. Climb, you pig. . . . Boy, this is going to be tight. . . . Okay, interesting. We are falling out of the sky."

Consequently, numerous studies have examined mitigations, such as how adding motion cueing to a ground control station could affect a remote pilot's decision-making process and risk-taking behaviour. The findings have been that remote pilots perform less aggressive manoeuvring when experiencing the shared fate sensation provided through motion cueing. The extreme case is that the remote pilot of an uncrewed aircraft, who is free from the sensation constraints of shared fate, may choose to take risks with the survival of the aircraft.

Feeling it

Thus, the concept of shared fate should be considered during screening for selection, developing training syllabi and training devices, and determining certification/licensing requirements for remote pilots of passenger-carrying aircraft. Furthermore, the requirements for the design of the ground control station should be explored for the feasibility and effectiveness of providing the remote pilot with some degree of 'virtual shared fate'. Current ground control stations provide remote pilots with their situation awareness primarily through visual information with a limited field of view and field of regard, and a few aural/visual cues. However, a feeling of shared fate could be achieved by incorporating enhanced sensory cues beyond the alerts/messages associated with the displays and controls. For example, haptic/tactile (aircraft vibration), aural (engine sound/cabin noise/precipitation impact), visual (glare/



Autoflight's V1500M eVTOL was revealed at the 2021 Zhuhai Air Show.

flash), and olfactory (smoke/fumes) cues could mimic the actual aircraft state.

Incorporating virtual reality (VR) through a head-worn device or a mixed reality (ie VR and augmented reality) workstation could further enhance the remote pilot's perception and sensation of being in the aircraft. This 3-dimensional experience, strengthened by what some refer to as a 4th dimension component (eg sudden ambient temperature change, winds blowing), would provide a fully immersive sensation of presence in the aircraft environment. Moreover, enhanced sensory cues would improve the remote pilot's overall situation awareness (SA) of the aircraft state, as well as the level of SA in correctly perceiving information, comprehending the situation, and projecting the situation into possible future errors, thereby positively influencing aeronautical decision-making. The enhanced sensory cues would also address one of the Air Line Pilots Association's (ALPA) primary concerns expressed in a SPO white paper, which was that a remote pilot lacks the full situational awareness of an on-board pilot for flying and landing the aircraft safely.

The public's apprehension with flying in a passenger-carrying aircraft designed to be flown either full-time or part-time with no on-board pilot must be allayed for SPO, UAM, AAM or any other remotely piloted aircraft (e.g. eVTOL) to be a viable and marketable form of air transportation. Perhaps some of those concerns can be eased by more thoroughly investigating the situational awareness, psychological, cognitive and behavioural aspects and considerations of shared fate in the design of ground control stations for passenger-carrying aircraft and the certification/licensing of the remote pilots who will fly them.



THE AMOUNT OF RISK A REMOTE PILOT IS WILLING TO ACCEPT DURING A NORMAL, ABNORMAL, OR EMERGENCY CONDITION CAN HAVE SEVERE CONSEQUENCES FOR THOSE ON BOARD



Become a Chartered Manager

The Royal Aeronautical Society has partnered with the Chartered Management Institute (CMI) to offer RAeS Incorporated Engineer and Chartered Engineer members, a route to becoming a Chartered Manager (CMgr), along with discounted CMI membership.

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- CMgr is recognised globally throughout all sectors and management disciplines
- Bolster your management and leadership credentials
- Professional development
- Increase your earning potential

As a Professional Engineer, achieving CMgr status can provide clear evidence that you possess the management and leadership skills required to support your technical engineering competency.



Eligibility:

- You will need to be an active RAeS Incorporated Engineer or Chartered Engineer member, with five or more years' management experience.
- Depending on your experience, you can apply to be either a Chartered Member (MCMi CMgr) or Chartered Fellow (FCMI CMgr).

Applications for Chartered Fellow are open to those with a minimum of ten years' management experience, with at least three years at a strategic level.

For more information about the application process
please email the Membership Team at:

registration@aerosociety.com

Afterburner

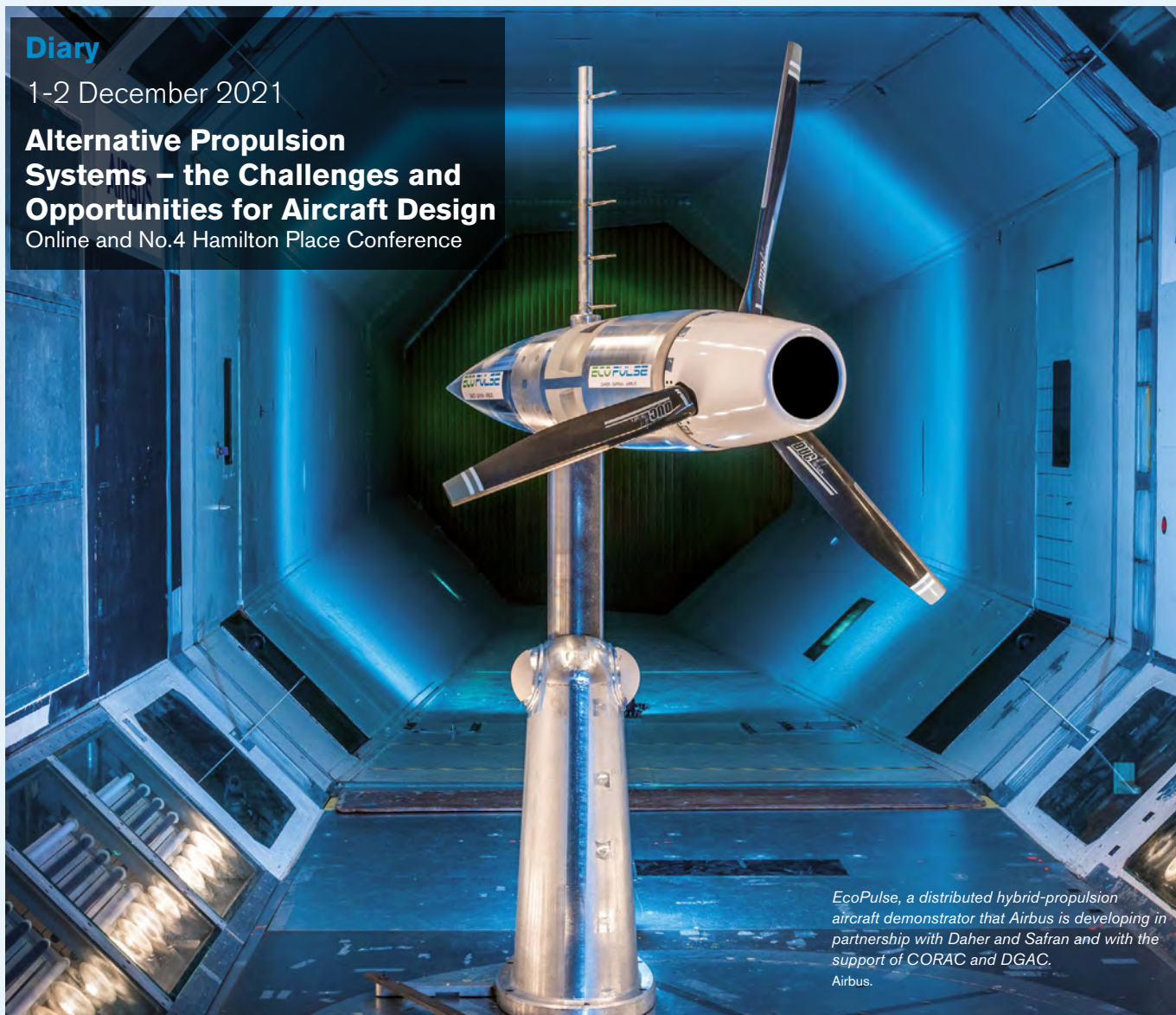
www.aerosociety.com

Diary

1-2 December 2021

Alternative Propulsion Systems – the Challenges and Opportunities for Aircraft Design

Online and No.4 Hamilton Place Conference



EcoPulse, a distributed hybrid-propulsion aircraft demonstrator that Airbus is developing in partnership with Daher and Safran and with the support of CORAC and DGAC.
Airbus.

48 Message from RAeS

– President

"I was interested to learn of the apprehension towards space tourism expressed by the UN Secretary-General António Guterres at the UN General Assembly on 27 September, concerning the ethical aspects, as the number of space tourism missions scheduled increases over the next five years."

– Chief Executive

"I'm making it a priority to get out as much as I can to meet with members and Corporate Partners in my first few months, the first opportunity being the 110th Branches Conference, hosted by the Coventry Branch on 8-9 October."

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John Samuel Fay MBE MRAeS.

Message from RAeS

OUR PRESIDENT

Howard Nye



Marking an historical moment for the UK, 27 September 2021 saw publication of the long-awaited *UK National Space Strategy*¹. No longer seeking to increase the UK share of the global space market to 10% by 2030, the strategic objective is now to 'put the UK firmly in the front rank of the global space industry', and to establish the right conditions to achieve the UK's civil and defence ambitions in space by unlocking growth in the space sector, collaborating internationally, growing the UK as a science and technology superpower and developing resilient space capabilities and services.

Publication not only coincided with the start of the three-day online 2021 UK Space Conference, which I personally attended, giving little time for conference delegates to deeply analyse the strategy and its implications but was only four days ahead of the deadline for submissions to the *Comprehensive Spending Review (CSR)*.

Interestingly, and without advance knowledge of the date of publication of the strategy, a Westminster Forum Seminar entitled 'Priorities for the UK space sector' was scheduled for 14 October. I was asked to speak specifically on the 'alignment of funding and investment with the strategic goals for the sector', very pertinent given the circumstances. In line with the Society submission to the CSR on 30 September², my message was that a significant increase in government funding will be required, given the fact that the UK lies around tenth in the global list of space nations (based on 2018 data) with 2.7% of NASA spending and 20% of French spending and given the fact that UK's academic and industrial reputation and experience has essentially been built up over more than 40 years through the UK's engagement as the fourth largest contributor³ to (and with guaranteed return from) the European Space Agency and that private investment is supportive but cannot take the place of government funding. However, given the schedule constraints, it is likely that government funding will be defined by the end of 2021 before any in-depth analysis of the options for implementation of the strategy has been conducted.

On a lighter note, regarding our engagement with young people, on 17 September I was pleased to contribute online to the RAeS Young Persons Conference 2021 'Next-Generation Opportunities in Space', encouraging people to enter the space domain, at all levels, and across all areas of expertise. On 5 October, the Society Space Group Early Careers Sub-Committee with Lockheed Martin UK ran a National Spaceport Competition, a student

competition to promote spaceflight and inspire the next generation, involving over 1,500 students from more than 30 schools across the country. The students developed designs for a future national spaceport making critical design decisions and trade off important factors, such as environmental impact, performance, safety, security and cost. Over the next month, the entries will be judged for awards and prizes for their school and next year the Society hopes to rerun the event on an even larger scale, reaching tens of thousands of young minds.

The 2021 Branches Conference took place on 8/9 October, and I gave a brief (online) introduction. I highlighted the excellent work of the Branches in fulfilling the Society mission, through their numerous high quality online events, and stressed the importance of our collective attention to diversity and inclusion, women in aerospace, aviation and space and, of course, engaging with young people in their regions. In addition, my thanks went to the Coventry Branch for hosting the conference, to Meggitt who had permitted a visit to their establishment, and to the Branches Committee for their continuous support to all the Branches. Simon Hall, Chair of the Branches Committee was unfortunately not available but the Vice-Chair, Hania Mohiuddin did an excellent job in chairing the event.

I was interested to learn of the apprehension towards space tourism expressed by the UN Secretary-General António Guterres at the UN General Assembly on 27 September, concerning the ethical aspects, as the number of space tourism missions scheduled increases over the next five years. Regarding the protection of our near-space environment, Space Forge, a UK start-up established in 2018 developing eco-friendly reusable satellites, has been awarded a contract under the ESA Boost! Initiative, to support technology development for its ForgeStar Orbital Vehicle (FSOV-1), scheduled for launch in 2022 and serving as an active field test for return-to-Earth reusable satellites and tracking software.

Finally, I look forward to meeting the winners at the Society Medals and Awards Night on 22 November in Hamilton Place.

“

MARKING AN HISTORICAL MOMENT FOR THE UK, 27 SEPTEMBER 2021 SAW PUBLICATION OF THE LONG-AWAITED *UK NATIONAL SPACE STRATEGY*

¹<https://www.gov.uk/government/publications/national-space-strategy>

²<https://www.aerosociety.com/media/16983/2021-raes-csr-submission-final.pdf>

³<https://www.statista.com/statistics/1169442/esa-budget-contributors-europe>

OUR CHIEF EXECUTIVE

David Edwards



As I write, COP26 in Glasgow is about to begin, and the world's focus once again returns to sustainability and, undoubtedly, how aviation and aerospace are working to reduce our impact on the environment around us. Our Climate Change conference, which took place on 19-20 October and addressed a number of challenges, was very well attended and saw us take our first steps into the next stage of our pandemic recovery as a hybrid event, with a blend of online and physical attendance.

We continue to provide fully virtual events, with over 500 people registered to attend this month's Careers in Aerospace & Aviation LIVE 2021 – a high point in our STEM outreach work. In addition, the Careers team are now travelling again, working with Boeing on our reimagined Ballantyne event 'Project Altitude', aimed at secondary school students. The next event is taking place at the WMG Academy Trust, based in the Midlands. The lack of STEM outreach events during the pandemic has meant that a significant number of children have missed out on the inspiration to join our sector, so we're very grateful to Boeing for their support in helping us raise the pace once again in this vital work.

During October, we submitted evidence to UK government in advance of the *Comprehensive Spending Review* and October Budget. Our partner, the National Engineering Policy Centre, submitted evidence on behalf of the community of Professional Engineering Institutions and we also submitted some evidence directly regarding funding for space, Jet Zero, R&D, defence and skills development and careers. Both submissions are available on the Society's website and we continue more work for our sectors this month.

I'm making it a priority to get out as much as I can to meet with members and Corporate Partners in my first few months, the first opportunity being the 110th Branches Conference, hosted by the Coventry Branch on 8-9 October. We're very grateful to Meggitt for its huge support of the event, particularly welcoming us as the first group visit to their impressive brand new facility at Ansty Park.

I want to thank all of the Branch representatives, speakers and attendees, particularly Ellie McBrien MRAeS from the YPC and also Hania Mohiuddin AMRAeS, the Vice Chair of the Branches Committee. The Coventry Branch were excellent hosts, in particular Branch President Steve Pilling FRAeS and Chair Ron Carr MRAeS. On 20 October I attended the Sir Geoffrey de Havilland Lecture at Hatfield by Dr Bill Brooks FRAeS, as well as having

the chance to tour the University of Hertfordshire which offers a range of courses accredited by the Society.

The Society is always interested in working with our members and Corporate Partners and in October we welcomed Marie de Saint-Cheron, SVP, Europe and Multilateral Affairs at Safran and Nigel Woodford FRAeS, UK Managing Director, to officially open the Safran Green Room at No.4 Hamilton Place (see p 56). It marks the continuation of our strong relationship across all areas of the Society's activities from engagement with our member Boards and Committees, support for our local Branch in Cheltenham & Gloucester, and participation in our skills and STEM outreach programmes. We are excited that Safran will take advantage of its Corporate Partnership by hosting its clients and guests in the Safran Green Room while in London.

Nominations for the 2022 RAeS Council elections are now open. The Council serves as the voice of our members and focuses on the outward facing aspects of the Society. To deliver our work globally we need Council members from all sectors of the aviation, aerospace, and space communities so that we have the breadth of background, experience and diversity that truly represents the membership. We would welcome nominations from across the sphere of our membership but particularly from groups under-represented at present, specifically women, members of the BAME and LGBTQ+ communities, and people with disabilities. If you can serve your Society in this way then we, and our interim Head of Governance and Compliance nigel.dingley@aerosociety.com would love to hear from you.

The Society's historic image collection is being digitised and is available to create ideal Christmas gifts from your favourite iconic and inspiring images. Visit www.aerosociety.com/gifts to browse what we have available.

Meanwhile, No.4 Hamilton Place is available to hire again and host your Christmas parties or celebratory occasions this festive season. If our team can help with our unique space in the heart of London, please visit www.4hp.co.uk/Christmas-parties or contact hello@4hp.co.uk to access discounted rates for members and Corporate Partners.

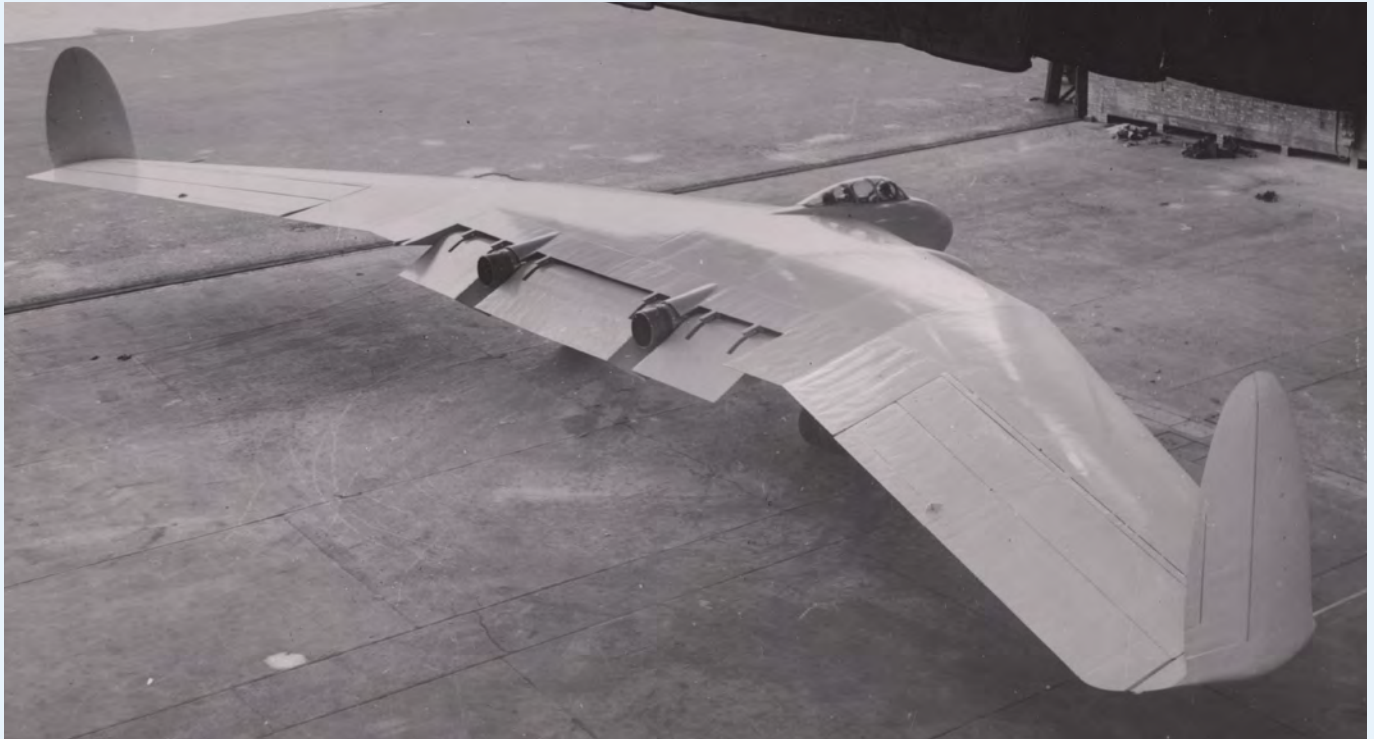
If you would like to attend any of our events, or to support our work through sponsorship, please do reach out to us – we'd love to hear from you.

“

DURING OCTOBER, WE SUBMITTED EVIDENCE TO UK GOVERNMENT IN ADVANCE OF THE COMPREHENSIVE SPENDING REVIEW AND OCTOBER BUDGET

Book Reviews

BRITISH SPECIAL PROJECTS



Flying Wings, Deltas and Tailless Designs

By Bill Rose

Fonthill, 2020, 288pp.

Ever since *Project Cancelled* was first published in 1975 there has been a steady stream of books on the subject of unflown design proposals. *British Special Projects* is the latest in this line.

Whereas others in the series usually deal with a particular type of aircraft – airliners, bombers, fighters, whatever – this book focuses on aeroplanes sharing a tailless configuration and it also includes aircraft which actually flew or even made it into volume production. How far such aircraft have anything in common, other than their unusual shape, might be open to question but it certainly makes for an interesting compendium. It is also unusual in that it covers this configuration of aircraft from the earliest days of piloted flight to the present time, embracing winged spacecraft along the way.

The book is well-written and clearly well-researched. Some of the designs have been fully covered in several earlier publications, particularly aircraft such as the Gloster Javelin but many of the design propositions will be a revelation to the vast majority of readers. Certainly, few will be aware of British proposals for spaceplanes

Armstrong Whitworth AW52. Two AW52s were built to investigate the high-speed characteristics of a tail-less aircraft with laminar flow. On 30 May 1949, while diving at 320mph, the first prototype encountered a pitch oscillation which rapidly increased to incapacitating levels. With structural failure seemingly imminent, test pilot John Lancaster opted to eject using its Martin-Baker Mk1 ejection seat and thus became the first British pilot to eject in a 'live' emergency. RAeS (NAL).

Books like this make an important contribution to understanding the history of aircraft design

which included a piloted version of the Blue Steel stand-off bomb.

The three-view drawings, of which there are around 140, are commendably clear and produced to a constant standard, though some readers will have preferred the dimensions to be included within these drawings rather than given in end-of-chapter tables. One criticism that might be levelled is that the majority of photographs have already been extensively used in other books, though this possibly won't detract from the book for readers unfamiliar with the subject matter.

Although clearly having a strong fascination for tailless aircraft, the author does well to avoid using the book as a vehicle for his own views. It is all too easy to stray into expressing 'if only' judgements on cancelled projects, when in fact it is impossible to assess their likelihood of success. History has shown that the latter is dependent on many factors, of which technical merit and attainment of projected performance usually come second to changes in requirements, politics and lack of resources.

Books like this make an important contribution to understanding the history of aircraft design. They provide an insight into the minds of design engineers at a time when the state of the art was advancing fast and the future was far from clear. One can only admire their ambition and ingenuity.

Sir George Cox
CRAeS



Renew your membership for 2022

Looking ahead to 2022 at the Royal Aeronautical Society, we aim to remain at the very heart of the aviation and aerospace industry, expanding our global reach and ensuring we provide the optimum tools and resources for every member. We are looking forward to continuing to engage with you in 2022.

Through renewing your membership with the Royal Aeronautical Society you will continue to have access to a range of exclusive membership benefits which recognise your professionalism and your expertise. This includes access to digital resources, opportunities to network with your peers, support with your professional development and access to industry conferences and events.

Ensure to get involved with Specialist Groups and your local Branch by updating your preferences. Log in to your online profile on the Society's website to update your details and preferences:

www.aerosociety.com/login

You will shortly receive an email which provides further information on how to renew your membership with details on how to make payment.

If you require any further assistance regarding your membership renewal or would like to make payment over the phone please contact the Subscriptions Department on:

+44 (0)20 7670 4304

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Your membership benefits include:

- Use of your RAeS post nominals, as applicable
- Subscription to the monthly *AEROSPACE* magazine through the post and the app
- Access to the National Aerospace Library resources which includes e-Library, podcasts and films
- Discounted rates for a variety of online and hybrid conferences and webinars
- Access to industry news and insight blogs online
- Engage with a Specialist Group or your local Branch through events and networking opportunities
- Support gaining Professional Registration
- Recognition of achievement through the Society's Medals and Awards
- Exclusive 20% discount on 30+ Cambridge University Press books on the topic of Aerospace Engineering
- Aeroiversity, the Society's Learning Management Platform with access to online courses, resources and CPD recording tool

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Thank you in advance for renewing your membership!

With your support, the Royal Aeronautical Society remains the world's foremost professional institution dedicated to the entire aerospace and aviation industry.

Book Reviews

ENGLISH ELECTRIC LIGHTNING



Genesis & Projects

By Tony Wilson

Tempest Books, 2021, 150pp, Illustrated, £12.99.

The English Electric Lightning remains the only supersonic fighter designed, developed and put into service entirely by the UK. The story of how the manufacturer first proposed its P.1 research aircraft in the late 1940s and then turned it into the Lightning during the 1950s has been covered in many publications but not in the very detailed way presented here.

To start there is a splendid computer graphic on the cover showing how the P.1, as first envisaged in 1948, might have looked in flight. Moving inside the first four chapters describe 'Origin and Initial Concepts', 'The Procurement Process and Environment', 'Configuration Development' and 'Weapon System Development'. Self-explanatory but a long series of three-view drawings show how the original P.1 was turned into the aircraft that flew in 1954 (backed up with brochure materials and data) while the author fills in with information describing the complex process of dealing with the Ministry, ie the customer. This might sound dry but the author's easy writing style means this text is never heavy going.

There are reviews of other concurrent UK fighter programmes and the various threats presented by the Soviet Union which the new fighter would have to counter. The chapter on weaponry explains not only the difficulties of fitting new air-to-air missiles on to a new aircraft but how new and more capable versions of a missile could

then disrupt the decision-making process.

The second half of the book moves on to 'Lightning Projects' with proposed developments of the Lightning itself, right through to a swing-wing version offered to the Navy in 1963. The projects include ground attack types, export offerings and pure fighter developments and, once again, further research and development in missile weaponry is revealed. There is nothing on the service history of the Lightning in here, just the complex process of turning proposals into real aeroplanes.

The author is an advisor at BAe Systems Heritage Department at Warton and clearly has had a free hand searching through original English Electric documents and brochures but extensive use of the National Archives at Kew as well has ensured a balanced approach. Primary source material is listed in detail at the end of the book and it appears that no secondary (published) sources have been consulted. This reviewer must record that his name appears in the Acknowledgements but only for the contribution of some specific reference materials. Until receiving a copy of the book he had no experience of Mr Wilson's written work whatsoever. Having read it now, he hopes there will be plenty more.

This volume is a modest-size but very complete work and, in general, the illustrations and, especially the drawings, are well reproduced on high quality paper. For anyone interested in the Lightning specifically, or the design and development of fighter aircraft in general, this is a little gem! Modellers will love the book as well.

Tony Buttler

The second English Electric P1B Lightning, XA853.
RAeS (NAL).

For anyone interested in the Lightning specifically, or the design and development of fighter aircraft in general, this is a little gem!

Library Additions

BOOKS

AIRCRAFT

Hurricane R4118: the extraordinary story of the discovery and restoration of a great Battle of Britain survivor by Peter Vacher, 2005, 160pp.

SERVICE AVIATION: WORLD WAR 2



Air battle for Moscow: 1941-1942 by Dmitry Degtev and Dmitry Zubov, Air World, 2021, 238pp.

An in-depth look into the aerial battle for Moscow with Operation Typhoon and Operation Clara Zetkin, where the Luftwaffe was opposed by Stalin's Falcons, the elite 6th Air Defence Corps.

Dowding's despatch: the 1941 Battle of Britain narrative examined and explained by Andy Saunders, Grub Street, 2021, 224pp.

In September 1946, the *London Gazette* published a despatch from ACM Sir Hugh C T Dowding that was titled simply: 'The Battle of Britain' and became the very framework for the accepted Battle of Britain narrative. Andy Saunders takes a critical look at Dowding's despatch and analyses the facts and details contained in that important document.

Operation Allied Force: air war over Serbia 1999, volume one by Bojan Dimitrijevic and Jovica Draganic, Helion, 2021, 96pp.

An overview of the air war over Serbia and the run up to the campaign. The book also includes material on the Serbian Air Force and Air Defence in the run-up to the campaign and colour profiles of aircraft used by the Serbians and NATO allies.

AERODYNAMICS

Aircraft aerodynamic design with computational software by Arthur Rizzi and Jesper Ooppelstrup, Cambridge University Press, 2021, 431pp.

Presenting aerodynamic design of aircraft with realistic applications, using CFD software and guidance on its use. Tutorials, exercises, and mini-projects provided involve design of real aircraft, ranging from straight to swept to slender wings, from low-speed to supersonic and covers topics, such as shape optimisation to minimise drag and collaborative designing.

AIRCRAFT IDENTIFICATION

Civil aircraft registers of the British Isles 2021 edited by Sue Bushell, Air-Britain, 2021, 642pp.

Air-Britain's annual publication listing the civil aircraft of the UK, Ireland, the Isle of Man and the Channel Islands, and giving details, such as their manufacturer, types and ownership.

AFQR 2021: airline fleets quick reference by Terry Smith, Air-Britain, 2021, 303pp.

Air-Britain's annual listing of aircraft operated by airlines operating across the world.

Under B-conditions: British experimental and production aircraft test flown under B-conditions of the Air Navigation Order since 1929 by D S Revell and P H Butler, Air Britain, 2020, 208pp.

A useful reference guide that de-codes the aircraft identification numbers placed on the side of experimental aircraft.

SERVICE AVIATION

Flying light helicopters with the Royal Marines: collective tales from Marine Air 489 by Robert Wilsey, Air World, 2021.

Written by a pilot who served through much of the existence of the Royal Marines Air Squadron, the book examines the evolution and technological advances of Royal Marines aviation, flying the Westland Sioux, Scout,

Gazelle and, ultimately, Lynx helicopters. He describes the rigorous training undertaken and operating globally from Malta, Northern Ireland, the jungles of Brunei, the Pyrenees, Arctic Norway and, in 1991, Northern Iraq.

The men who flew the Hawker Hunter by M W Bowman, Air World, 2021, 286pp.

Retells stories of those who flew the aircraft at aerobatic displays and on operations in Europe with Fighter Command and 2nd TAF, and in Cyprus, the Middle East and the Far East, where Hunters in the ground-attack role operated against rebels in Aden and Malaysia respectively.



Fleet Air Arm Boys: Volume two, strike, anti-submarine, early warning and support aircraft since 1945, true tales from Royal Navy men and women air and ground crew by Steve Bond, Grub Street, 2021, 285pp.

A compilation of first-hand recollections from air and ground crew, operating from aircraft carriers and land bases. Includes reminiscences of working with Scimitars, Sea Hawks, Buccaneers and Skyraiders and on operations, including Suez, the Beira Patrol, the Falklands, Belize and Bosnia.

Buccaneer Boys 2: More True Tales by Those Who Flew 'The Last All-British Bomber' by Graham Pitchfork, Grub Street, 2021.

A compilation of 30 informal reminiscences of flying the Blackburn military jet aircraft as recounted by former Fleet Air Arm, Royal Air Force and South African Air Force (SAAF) pilots and including

operations in the first Gulf War and the Border War.



Tornado: In the Eye of the Storm by John Nichol, Simon & Schuster, 2021, 458pp.

The story of the RAF crews and their families that flew the Tornado over Iraq during Operation Desert Storm.

Desert Warriors: Iranian Army Aviation at War by Babak Taghvaei, Helion, 2016, 132pp.

A history that concentrates on the use of helicopters by Iran during the 1980s.

Hungarian eagles: a Magyar Kiralyi Honved Legiero, 1920-1945 by Gyula Sarhaidai, G Punka and Viktor Kozlik, Hikoki, 1996, 62pp.

A guide to the Hungarian Air Forces and their campaigns between 1920 and 1945, complete with diagrams and illustrations showing markings and camouflage to help aeromodellers to create accurately painted models.

RAF Bomber Command: 1936-1968 by Chris Ashworth, Patrick Stephens, 1995, 256pp.

A history of the Royal Air Force's bomber force, complete with a selection of orders of battle, a list of aircraft used in each squadron and a selection of wartime statistics.

A short history of the Royal Air Force by Ministry of Defence, 1994, 122pp.

A short history of the RAF aimed at those just joining the service.

Instructors' Handbook of Elementary Flying Training. A.P.1732a, Air Ministry, 1942

RESEARCH

RAE Farnborough Space Department: A History by Bryan Day, British Interplanetary Society, 2015, 148pp.

Starting with the government's space projects that predated the creation of the Royal Aircraft Establishment's Space Department in 1962, it goes on to explore the projects of the department's constituent divisions, including work on satellite launchers, satellites, remote sensors, space radiation and propulsion. Though the book concludes with the closure of the RAE, it also looks at the continuing work on space radiation and electric propulsion.

The Royal Aircraft Establishment: Treasure House of Aviation in 100 Objects and Concepts by Graham Rood, Farnborough Air Sciences Trust, 2021 450pp.

From carbon fibre to blind landing, the Royal Aircraft Establishment was at the forefront of innovation, yet much of the equipment, procedures, materials and techniques that they developed are now taken for granted. This selection highlights a century of achievements from those who served at RAE Farnborough, RAE Bedford and the NGTE with the aid of the FAST Museum's extensive collections.

Winds of Change: Expanding the Frontiers of Flight: Langley Research Center's 75 Years of Accomplishment, 1917-1992 by James Schultz, NASA, 1992, 133pp.

BIOGRAPHIES

Test Pilots of the Jet Age: Men who Heralded a New Era in Aviation by Colin Higgs and Bruce Vigar, Air World, 2021, 172pp.

This book contains interviews with the British test pilots that took aviation into the jet age: John Allam, Godfrey Auty, Roland Beament, Eric Brown, Jim Cooksey, John Cunningham, John Farley, Joe Lancaster, Doug Nicholls, John Ellacombe, William Walker, Dickie Martin, Duncan Simpson and Peter Twiss.

A crunch point for hydrocarbon-powered light aviation?



As more and more electric light aircraft are announced, are we in the twilight of new designs for hydrocarbon-powered GA? **CHRIS WRIGHT** of the RAeS General Aviation Group (GAG) looks ahead to this month's Light Aircraft Design Conference to preview what the 21st Century holds for light aviation.

The general aviation sector is well positioned to demonstrate new technologies: radical power-systems, electronic technology applied to control and navigation, optimised structures and materials plus the latest aerodynamics.

GAG holds a Light Aircraft Design Conference and a Light Aircraft Design Competition each year. The GAG aims to encourage individuals and industry to address current concerns and opportunities by imaginative application of what is possible.

In the past three years the Design Conference has attempted to encompass the wide scope of GA. This year the programme is arranged in three sessions and, because it is web-based, we have been able to add more items and, therefore, widen its spread of topics.

The first session (of three) includes aircraft-related. The first talk is by Norman Wijker of Samad Aerospace, who has previously described the Samad Starling VTOL vehicle. Norman has been involved with Sailwings for high-performance yachts and sailboats and will talk about those which employ highly-developed aerodynamics and structures in their sails. Hania Mohiuddin, the current chair of the British Human Powered Flying Club, will be describing her design for a flying-wing human powered aircraft (HPA). HPAs also have sophisticated aerodynamics and structures relevant to future light aircraft design. A Flylight team led by Paul Dewhurst will describe developing the already-successful Skyranger Microlight into the Nynja version with improved structure and aesthetics.

Dr Guy Gratton with his Cranfield team will

Above: Rolls-Royce's ACCEL's Spirit of Innovation on its first flight in September – an E-Condition Project, as presented in previous Design Conferences. Rolls-Royce.

Below: To round off the conference in a most exciting way, Marc Umbright from Pie Aeronefs will give a talk on its new Air Race E UR-1 racing aircraft. Aeronefs.



discuss Enable which includes work on electrically powering two microlights and certification aspects.

GAG initiated and worked with the CAA to produce Experimental Conditions. The object of E-Conditions is to benefit light aircraft designers and manufacturers by reducing the red tape and financial burdens associated with securing airworthiness and approval for new aircraft designs, encouraging the growth of new design concepts. A number of projects have been pursued under E-Conditions, including the recently flown ACCEL *Spirit of Innovation*. John Edgley was the driving force behind E-Conditions and his update will start session two.

GAG has also been working on a 'Design/Make/Fly' initiative which Dr Mike Jump (Liverpool University) has been steering and will describe. It is hoped that this, combined with our annual GA Design Competition, and aided by E-Conditions, will encourage fresh design and development impetus in universities and associated manufacturing groups, along the lines of the long-running and successful German Akafliags.

In conjunction with the Design Conferences the recent annual Design Competitions, run in parallel with the conferences, have also had an electric theme. The competitions are based not only on design and performance but also the quality of the supporting documentation.

In 2020 the Design Competition specified Electric Powered Humanitarian Rescue VTOL aircraft suitable for evacuating casualties between islands in the Caribbean. Some elegant designs resulted, the winner being the high-aspect ratio APTOS BLUE being capable of flying up to 463km.

Tim Watkins (from ETPS) will describe the Design Competition which this year has been brought in line with the academic year. As a result, the competition runs through this year and next, with the results being announced in time for presentation at next year's Design Conference. The competition is once again an aid-related design competition, for a relatively simple design that many designers and students are likely to feel able to tackle. It brings together two key changes in aeronautics – the popular new 600kg category and electric power. The aim is to design a piloted electric aircraft that will deliver a passenger or essential supplies in equatorial countries from short soil airstrips.

Session two is rounded off by Brian Stirr and Bernie Wulle, both of Purdue University presenting: ABLE Flight, Adapting Light Aircraft for the Disabled.

Session three returns to the electrification theme and looks at the influence and pressures due to Climate Change. This session will look at maximising range with electric and hybrid hydrogen solutions from Sergey Kiselev of Zeroavia. A panel discussion on this vital topic – for the continuation of GA flight – will complete this session.

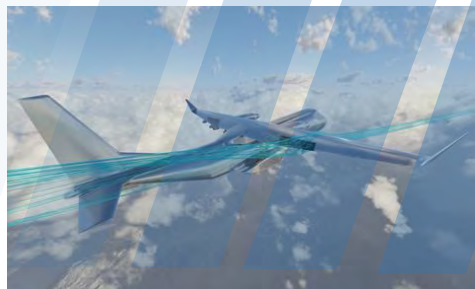
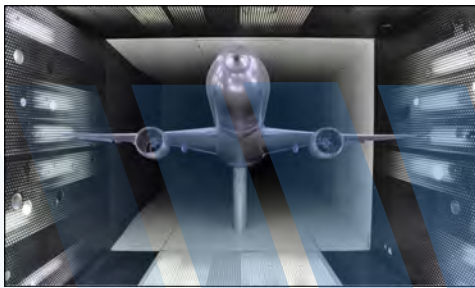
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On a bright sunny day in August, members of the Hatfield Branch Committee ventured out to the David Lloyd Club in Hatfield. This Grade-II listed building was constructed in 1952-3 and the offices and tower completed in 1954. The building served as the de Havilland flight test hangar, offices, fire station and control tower. One of the aims of the Royal Aeronautical Society is to celebrate technological or operational achievements that made an original and unique contribution of world significance. Therefore, our mission was to find out whether we could nominate it for a Royal Aeronautical Society Heritage Award in co-ordination with English Heritage for the siting of a plaque.

Our tour of the impressive sports facility owned by David Lloyd Clubs was a brief insight into its current use but also an opportunity for Steve and Peter to recall past employment and visits to the offices and aircraft assembly area. The sports club was busy but we were able to visit all the public areas. It was also possible to view the building externally, including the control tower, re-purposed accommodation above the fire station and the great concertina doors giving hangar access at each end.

The Venue

In 1941-2 de Havilland began to develop a jet engine, the Goblin, which was incorporated into the design of the Vampire jet fighter in 1943-4 and developed further as the Ghost. De Havilland's prime interest was in civil aviation and, in 1946, it designed the world's first jet passenger airliner, the Comet. Filling a gap in the market, and seen as the

Above: The first de Havilland DH106 Comet 4, G-APDA, of BOAC, in front of the flight test hangar and tower at Hatfield in August 1958. RAeS (NAL).

future of British aviation, 16 were ordered as early as 1947. The first commercial service was in May 1952. The Comet 4 was inaugurated in 1958 – just ahead of the Boeing 707 – and was followed by the de Havilland Trident.

The hangar was commissioned for testing and maintaining the Comet. 'Here is a structure every bit as dramatic as the jet liners it shelters' (*Aluminium in Modern Architecture*). The aluminium alloy span of 200' is only one seventh the weight of an equivalent steel structure. Apart from the savings in material, the light weight of the structure permitted prefabrication of unusually large sub-assemblies. The main structure was erected in only 13 weeks. The Comet hangar was the most sophisticated example of aluminium construction and was also the world's largest permanent aluminium structure at the time.

This giant aluminium hangar accommodated the Comet jet. It has a floor area of 66,000 square feet, sufficient to house up to eight airliners. The light weight of the construction materials enabled ease of transport and quick erection. The main part of the hangar was erected by 18 men in 13 weeks using only two five-ton cranes and little scaffolding. The de Havilland's hangar consists of 12 aluminium alloy portals, each with a span of 217ft and giving a floor width of 200ft. Electrically-driven concertina type doors give an unobstructed door opening of 200ft wide and 45ft high.

According to the Historic England website, the hangar architects were James M Monro and Son, with Structural and Mechanical Development Engineers Ltd designers of the aluminium structure, and J Bak engineer for the foundations. The control

tower of six storeys was noted for its early use of non-reflective plate glass and its air conditioning. Below it there are four floors with curved balcony fronts whose pattern of diagonal bracing is repeated in the fenestration. The three-bay fire station has a similar curved front with double doors with deep eaves canopy. The interior of the main shed is a clear-span space. The staircase to the control tower has a 'molecule and lightning' steel balustrade distinctive of 1950s' styling.

As you enter the building, a prominent feature is a large British European Airways (BEA) sign positioned on the Trident corridor. BEA was the launch customer for the dH Trident.

The RAeS Hatfield Branch Committee would be pleased to hear from those who wish to support our application for a heritage award.

Keith Gowland
CEng MRaES



Left: The hangar today, in use as a David Lloyd health club.

Right: From left: Keith Gowland, Chris from the David Lloyd Centre, Peter Elliott and Steve Rogers.

Sources

<https://historicengland.org.uk/listing/the-list/list-entry/1376561>

https://en.wikipedia.org/wiki/British_European_Airways

<https://www.youtube.com/watch?v=GNBXLFF80tI>



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NEW MEMBER SPOTLIGHT

Name: Umer Mahmood ARaES, 26.

Location: Bedford, UK.

Job title: Senior Inspector.

What inspired you into aviation? I wanted to be involved and participate in models for future aircraft programmes. I also wanted to get the hands-on experience which would enable me to develop my career and gain plenty of knowledge. I am interested and keen to work within different parts of the engineering process such, as design and manufacture, inspection and the testing phase. I wanted to experience a variety of environments and technologies while working with multiple cross functional teams to deliver projects. The aerospace sector offers a wide variety of opportunities and is often at the cutting edge of technology.

What is the best thing about your current role? The role of Senior Inspector is a critical point in the manufacturing process, where I get to see and check, the high quality, precision engineering produced by my colleagues. Working as a key part of a small but highly skilled team of people is extremely rewarding. As well as working with a great bunch of people and seeing the final model assembled and inspected, I also get the opportunity to liaise with the final customer. Being able to see and appreciate the skill and detail of all the hard work that has gone into each model, from start to finish is very satisfying and makes me proud to be part of the team.

What made you join the Royal Aeronautical Society? I've always been keen to develop my skills and career through personal development and when I was invited by some work colleagues to an open day event for the RAeS I understood the opportunities it could offer. I enjoyed the presentation and wanted to know a bit more about the qualifications and professional registration. Joining the Society seemed to offer a route to registration with support from a large network of engineers, an opportunity too good to miss. With several colleagues from work actively involved in the local Branch, there is lots of support easily available to me.

What do you hope to get out of your membership with the RAeS? I hope that membership and registration will give me a higher profile and level of recognition for my skills than I had before I achieved them. I believe that it will also open up other opportunities for my career and development. As well as progressing through



IEng towards CEng, I want to develop as a mentor to help others with their professional registration. Membership of the RAeS will give me access to a wide network of engineers with a huge variety of skills, raising my awareness of the aerospace sector and the opportunities available.

What three items would you take with you to the space station? I would like to take my mobile phone as it would let me take photographs, have my music collection with me and pictures of family and friends. I would also like to take a book as I enjoy reading. A set of juggling balls because I can't juggle on Earth but maybe in zero gravity I stand a chance!

What's your favourite aircraft? My favourite aircraft is Concorde, as I like the design and shape of it. It is beautiful to look at and it was a fantastic engineering achievement. The collaboration across two teams from different countries also inspires me in what is possible. I love many types of aircraft and I love travelling. Travelling is an emotional and spiritual experience. The more I see the world the more experience I get and to enjoy different cultures. I would have loved the opportunity to travel on Concorde and experience travelling at Mach 2 in such an iconic design of aircraft.

Who is your biggest inspiration? My biggest inspiration in aerospace/aviation/space is Neil Armstrong, as he was the first person to walk on the Moon and had a significant impact on the aerospace sector. I admire the dedication, skill and perseverance required to train to be an astronaut. I also admire the courage required to put your faith in the hundreds of other scientists, designers and engineers who build the rocket and supporting technology to get you safely to the Moon and back. To work so closely for so long with a large multi-skilled team and put your life in their hands while achieving a first in human history is inspirational.

Piece of advice for someone looking to enter your field? Just do it and enjoy yourself! Whether you choose to focus on developing a career in inspection, aeronautics or take your career 'out of this world' as an aeronautical engineer. A career in aerospace engineering offers hundreds of potentially rewarding paths. Aerospace is a very exciting and challenging sector to work in, offering great development and learning opportunities. If you find good people to work with and make the most of each chance to learn a new skill or experience a new area you will have a fun and rewarding career. Just set your ambitions high. The universe is the limit!

Diary

EVENTS

www.aerosociety.com/events-calendar/

2 November

Operation Jericho 1944 – The Attack on Amiens Prison

Roger Beazley

[Boscombe Down Branch online lecture](#)

2 November

Tempest – New Technologies, New Partnerships

Michael Christie, Director, Future Combat Air Systems, BAE Systems

[Loughborough Branch lecture at Room U020 \(Brockington Building\), Loughborough University, Epinal Way, Loughborough LE11 3TU](#)

3 November

Careers in Aerospace & Aviation LIVE 2021

[Online event](#)

9 November

Orbital Debris Removal

Xander Hall

[Solent Branch online lecture](#)

10 November

Young Persons Network Mini Lecture Competition

[Preston Branch online event](#)

10 November

Beechcraft T-6C Texan II – Entering Service with the Royal Air Force

Iain Chalmers, Managing Director, Affinity Flying Services

[Brough Branch online lecture](#)

11 November

Alex Gray Lecture: Role Models in Aerospace Engineering

Dr Ruth Mallors-Ray OBE

[Highland Branch online named lecture](#)

14 November

Maverick Aviation: Advanced Aerial Mobility Systems

Antony Quinn

[Solent Branch online lecture](#)

15 November

General Aviation Design Conference 2021

[RAeS online conference](#)

16 November

Returning a UK-built Mosquito to our Skies

[Boscombe Down Branch online lecture](#)

16 November

Lion Air Flight JT610 – A Loss of Control Inflight Accident Case Study (Boeing 737-8 MAX)

Dr Mike Bromfield, Associate Professor in Aerospace/Flight Safety Researcher and Deputy Aerospace Programme Director, University of Birmingham and Captain Nils Jamieson, Technical Pilot – Boeing, Jet2.com and GASCo Regional Safety Officer Gloucester & Cheltenham Branch lecture

17 November

Military Aircraft Certification

Wg Cdr Paul Regan, MAA Certification – Structures & Aircraft Design Standards

[Hatfield Branch online lecture](#)



Royal Air Force Beechcraft T-6C Texan II, ZM323, at RIAT in 2017. The Texan is the subject of a lecture by Ian Chalmers at the Brough Branch on 10 November. Airwolfhound.

18 November

Flight Testing eVTOL Aircraft

Dean Moore, Flight Test Specialist, Vertical Aerospace
[RAeS webinar](#)

18 November

Future Aero Manufacturing Technologies

David Holmes

[Manchester Branch online lecture](#)

18 November

Miles M-52 Project

David Holmes

[Birmingham, Wolverhampton & Cosford lecture](#)
[RAF Museum Cosford, Shifnal TF11 8UP](#)

23-24 November

Integrated Air Traffic Management – towards a fully digitised airspace management system

[RAeS UAS Group online and at No.4 Hamilton Place conference](#)

23 November

The Implementation of Digital Air Traffic Control Towers

Pierre Truter

[Canberra Branch online lecture](#)

24 November

Handley Page Lecture: The A350 Flight Test Campaign: new ways of testing

Professor Fernando Alonso

[Online and Cranfield Campus](#)

25 November

Trenchard Lecture: RFC Recruitment and Training, 1912–1920

David Spruce

[Online lecture](#)

1-2 December

Alternative Propulsion Systems – The Challenges and Opportunities for Aircraft Design

[RAeS Propulsion Group online and at No.4 Hamilton Place conference](#)

For further information and booking:
www.aerosociety.com/events-calendar/

Elections

FELLOWS

Marcel Chad
Rodney Ewels
Kenneth Kota
Thomas McGrath
Tony Payne
Jeremy Radcliffe
Cameron Stone

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Chiranjeevi Aradhya
John Binding
Callum Clowes
Nitin Farmah
Philip Garrett
Christopher Hall-Roberts
Daniel Hayes
Kieran Hayward
Robert Hogg
Mabruk Kuweir
Donal Lalor

Oleksandra Molloy
Wayne Mullan
Jyothis Gopalakrishnan
Nair
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Marius Stanciu
Niraj Wadher

WITH REGRET

The RAeS announces, with regret, the death of the following members:

Sir John Charnley HonFRAeS 98
Russ Francis Cole CEng MRAeS 70
Philip Morgan Davey CEng MRAeS 94
John Samuel Fay MBE MRAeS 99
Vernon Stuart Stuart-Smith CEng FRAeS 95
Frank Webber CEng MRAeS 90

STUDENT AFFILIATES

Rose Bamford
Robert Biles
Fidel Bravo
Mohamed Cardenas
Anupe Dha

Matthias Struyf
Witold Szaters

AFFILIATES

Castello Chetty

Safran open the new Safran Green Room

Marie de Saint-Cheron, SVP, Europe and Multilateral Affairs, Safran; Nigel Woodford FRAeS, UK Managing Director, Safran; with RAeS CEO David Edwards, left, open the new Safran Green Room on the second floor at RAeS HQ on 21 October. The Room is equipped with the latest in hybrid videoconferencing technology for central London networking and business meetings.



COUNCIL ELECTIONS 2022

Would you like to help guide the Society?

The Society would like to hear from members who are interested in standing for the Council in the 2022 elections to be held next spring. Only by having a good number of candidates from all sectors of the aviation and space community can the Council benefit from a variety of backgrounds and experience.

As members will be aware, the Council now concentrates on the outward facing aspects of the Society's global activities. Indeed, as the Society becomes ever more global, it is critically important that our offerings to members, to Corporate Partners and especially to the public are of the

highest quality. To lead output of the highest quality we need members of Council from every part of the aeronautical community and this is where you come in.

Please give serious thought to whether you could serve the Society in this most important role. If you are interested, or require further information, please contact:

Nigel Dingley, the Society's Head of Governance and Compliance, nigel.dingley@aerosociety.com

Please note that all nominations must be submitted no later than 31 January 2022 at 23.59 GMT.

NOMINATIONS FOR THE 2022 RAeS COUNCIL ELECTIONS ARE NOW OPEN

Obituary

JOHN SAMUEL FAY



MBE MRAeS RN Ret'd
1921-2021

John Fay died recently at the age of 99, only a few months before his 100th birthday. John was a professional pilot who enjoyed flying, although he did not convey the carefree image of Chuck Yeager or *Top Gun*. He approached his task with quiet confidence that made one feel safe with him. John was born in Brazil in 1921 and brought up in New Zealand until the age of nine when he came to England.

He was educated at Bradfield College and went straight from there to join the Fleet Air Arm in 1940. His training was on Miles Magister, Fairey Battle and then on to Swordfish and Albacore.

He was appointed to 832 Squadron in HMS *Victorious* and operated firstly on the Arctic convoy runs to Murmansk and subsequently to the Mediterranean. He also had a short spell at Manston operating in the English Channel. *Victorious* crossed the Atlantic at the end of 1942 and after some modifications joined the US fleet in the Pacific. In the meanwhile, 832 Squadron converted to

Grumman Avengers and had the distinction of being the first British squadron to operate from an American carrier, which was the USS *Saratoga*.

After returning from the Pacific he joined the Service Trial Unit at Crail until being appointed to the first helicopter course in Britain at Hanworth in March 1944.

With the war over, he joined the British European Helicopter Unit, which carried out pioneering work, such as mail, passenger instrument flying and pilot training.

On joining Westland aircraft as a test pilot and instructor, he flew the aircraft being produced there, such as the Dragonfly, Whirlwind, Widgeon, Wessex, Bell 47 and Hughes 269. He also trained some 300 service and civilian pilots from Britain and foreign countries, including King Hussein of Jordan.

He demonstrated many Westland aircraft at Farnborough Air Shows in the 1950s and 1960s.

He has published several books on helicopters, notably *The Helicopter: History, Piloting and How it Flies*, which achieved four editions and was translated into several languages.

Dave Gibbings OBE MRAeS

**Planning on applying for membership,
upgrading or applying for Professional
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The Last Word

COMMENTARY FROM

Professor Keith Hayward
FRAeS



Anglo-French defence export rivalry

Not perhaps a usual topic for an aerospace magazine, but the Australian multi-billion submarine deal could have a significance beyond the naval interests of BAE Systems and Rolls-Royce, assuming that is, that the American and Australian demands for onshore production will leave some crumbs for the British contingent. The fallout so far indicates that Paris will not take this lying down and might look for revenge 'taken cold'. At least so far French anger seems mostly directed at the US and Australia – *Private Eye* suggests this might be linked to the invaluable air transport Britain affords to French forces in Africa.

There is some history here

There could be some old UK defence sale veterans who might be taking a more amused perspective about putting one over the French. The late Freddie Page – doyenne of BAC's military outfit – recalls how selling the Anglo-French Jaguar became more difficult once Breguet was absorbed into Dassault. Marcel's team always seemed on hand to make a better offer for sales of its own products than the co-operative venture.

The saga of the Anglo-French Variable Geometry (AFVG) fighter – the British-led pairing with the Jaguar – was an even more problematic example of a difficult Anglo-French aerospace relationship. In this case, the French bailed out of the project in favour of another Dassault project – Not that the UK covered itself with collaborative glory during this period, dumping both the Airbus and the European satellite launcher. The UK would remedy these *faux pas* by rejoining Airbus in 1978 and taking a leading role in the European Space Agency, albeit not its rocket programme.

And decades of competition

Generally, as two well-matched competitors, the UK and France have been contesting the world

fighter market for the better part of 60 years. Since the early 1970s, the UK has had a bit of help from European partners but the French, led by (or following) Dassault, have ploughed a determinedly national furrow. Lacking any serious competition, the UK did very well in the early post-war period but soon felt the French impact on world markets. The British did not always do themselves any favours – UK procurement officials claimed that their remit did not include backing projects 'purely for export'. The French had fewer qualms and, by the middle of the 1960s, the Mirage III was doing very well, including sales to Australia.

The link with Saudi Arabia, the Tornado and collaboration with the US on the Harrier helped to redress the balance. And of course the Typhoon and Rafale have continued the contest.

By my reckoning, the Typhoon has 144 third-party sales/orders compared to the Rafale's 96 – and again the Saudi market has helped to account for a large chunk of the difference. Rafale is now back on the offensive, with sales logged to Croatia and confirmation of Greece's order. Rafale was also boosted by a second tranche order from Egypt and a strong showing in fighter competitions in Finland and Switzerland.

What might have been?

But how much better things might have been, had the original four-nation fighter programme, debated in the early 1990s, had produced the military equivalent of Airbus. Sadly specification divergence and Anglo-French industrial conflicts put that concept to flight and the breach then sealed by the F-35. The division now seems to extend into the next generation, with France and the UK leading separate European UCAV programmes.

Looking back over the history of Franco-British rivalry, one can only despair over lost opportunities properly to pool efforts and make a proper fist of developing a competitive core of European combat aircraft better able to take on the Americans and others in world markets.



GENERALLY, AS TWO WELL-MATCHED COMPETITORS, THE UK AND FRANCE HAVE BEEN CONTESTING THE WORLD FIGHTER MARKET FOR THE BETTER PART OF 60 YEARS

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