AERO SPACE

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NOVEMBER 2022

THE ENDURING DUOPOLY

NASA AERODYNAMICS

ACCESSIBILITY AND eVTOLS

AEROSPACE 2035 AND BEYOND

POINTING THE WAY

HOW CIVIL AVIATION IS ACCELERATING INTO A GREENER FUTURE

ROYAL AERONAUTICAL SOCIETY

RAeS CONFERENCE: AEROSPACE 2035
HYBRID – No.4 HAMILTON PLACE, LONDON AND VIRTUAL
29/30 NOVEMBER 2022

ROYAL AERONAUTICAL SOCIETY

A BRIGHT FUTURE OR FIGHTING FOR SURVIVAL

WHERE WILL AEROSPACE BE IN 2035 AND BEYOND?

Join us on 29-30 November in London or online for this exciting RAeS Conference: 'A Bright Future or Fighting for Survival - Where will Aerospace be in 2035 and Beyond?'

The conference will address how the aerospace domain will develop over the next 10-15 years, what opportunities it must grasp and the threats it needs to overcome. The programme brings together visionaries, experts and global leaders to shine a light on the politics of the future of aviation, the new technological tools and their associated challenges, and the implications for those who will make the changes a reality, especially the young professionals upon whom the future depends.

The conference will also provide plenty of opportunities for networking in person and virtually.

Be part of the discussion – check out the programme and book your ticket. We look forward to you joining us for this key event.

To find out more about attending or sponsoring the event, please visit: **https://www.aerosociety.com/aerospace2035**

AEROSPACE

Volume 49 Number 11
November 2022

EDITORIAL

Future shock

Predicting the future is always a challenge – and none more so than in this rapidly accelerating world in which we live – where the 24hr news cycle seems to have been replaced by instant social media feedback measured in minutes. In this special issue, though, in connection with the upcoming RAeS 'Aerospace in 2035 and beyond' conference on 29-30 November, we attempt to preview some of the developments in civil aerospace that are on the horizon in the next 15+ years. It is no surprise that environment and sustainability take centre stage as the biggest challenges that aviation faces, but the solutions are varied – and range from airships to eVTOLs, from better aerodynamics to SAF.

However, there are big surprises too. Perhaps the most significant one is that 15 years ago, it was assumed that new entrants, such as Bombardier, Embraer, Mitsubishi, Sukhoi, UAC and COMAC would succeed in wrestling lucrative slices of the airliner pie from the reigning duopoly of Airbus and Boeing. Today, that duopoly is still 'last airframers standing' and dominates the civil aviation market. Bombardier has now exited the sector and its CSeries has become the Airbus A220. Embraer, for its part, seems content to lower its expectations and take on ATR, while Japan's regional hope, the MRJ went nowhere. Russia's UAC, meanwhile, as a result of the invasion of Ukraine, now faces an uncertain, isolated future of just providing airliners to the small domestic Russian market. Finally, China, once seen as the biggest future airliner market for Western airframers now contends with slowing passenger growth. Its COMAC C919, once viewed as a breakthrough single-aisle product, arrives in service at a time when many Western companies are 'decoupling' from China and the balance between co-operation and competition has shifted towards the latter.

Thus, in a divided world, will Airbus and Boeing still dominate in the next 15 years? Or will small, agile start-ups, with electric, hybrid-electric or hydrogen aircraft on the drawing board, be in a position to challenge these behemoths?

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AEROSPACE INSIGHT

Additional content is available to view online at: aerosociety.com/aerospaceinsight
Including: A tale of two rockets, A hive of activity – insect threats to aircraft and their detection by radar, The 41st ICAO Assembly, Turbulence ahead: what the 'Great Resignation' means for the aviation industry, Hands on 'flying' the VX4 eVTOL, Competing in the new 'Space Race'.

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Blueprint

INTELLIGENCE / ANALYSIS / COMMENT

Fixed landing gear

The Sigma Six would be equipped with a fixed quadricycle wheeled landing gear. This allows it to land into any conventional helicopter landing pad, or be wheeled into position over a passenger/cargo pod. The struts are also hinged to allow for transportation or storage.

AEROSPACE

Tiltwing modular logistics

Unveiled at the Detroit Motor Show in September was this multimodal tiltwing concept from Airspace Experience Technologies (ASX). The Sigma Six uses a tilting wing and underslung detachable passenger, cargo or medevac pod that can be swapped over. With six propellers, the vehicle takes off vertically before transitioning to horizontal flight. At the other end, the Sigma Six will land on its wheels, before an electric robot flatbed trailer docks underneath the pod for onward travel. ASX has also designed it so that it can be collapsed and transported by a standard low-loader truck. The aircraft successfully made its first tethered flight in September, with entry into service set for 2026/7.

Airspace Experience Technologies

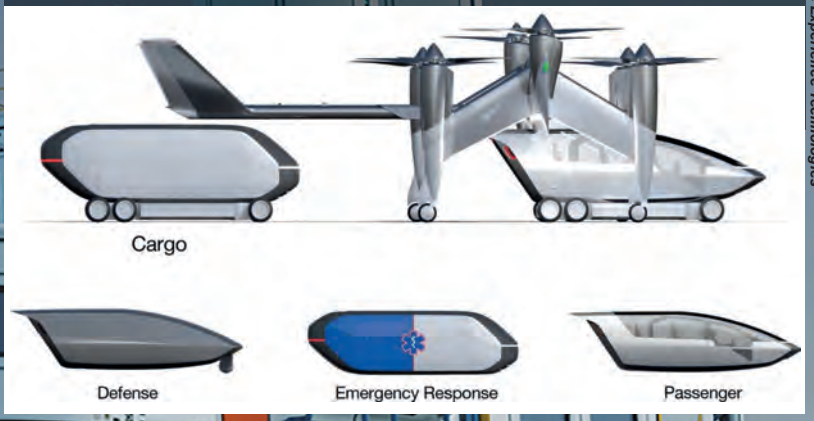
Specifications

Cruise speed	126mph
Maximum speed	250mph
Payload	2,000lb
MTOW	6,000lb
Horsepower	>1, 200hp
Battery energy	200kWh
Passengers	6-8
Range	>150nm
Wingspan	43ft
Length	36.5ft

Propulsors and wing

With the only moving part being the central hinge that tilts the wing from vertical to horizontal, the Sigma Six would use six distributed electric propulsors in nacelles.

Swappable pods



Airspace Experience Technologies

Robotic loading

With rapidly interchangeable cargo/passenger/EMS or military pods, ASX is also developing an automated robotic loading vehicle with omnidirectional movement and Z-axis lifting capability.

Radome

GENERAL AVIATION

First Korean Light Civil Helicopter handed over

Airbus Helicopters and Korea Aerospace Industries (KAI) have delivered the first Light Civil Helicopter (LCH). The landmark machine joins South Korea's Gloria Aviation where it will be used as a medevac platform in the Jeju region. Derived from the Airbus Helicopters H155, the South Korean-assembled LCH received certification in September. Launched in 2015, with its first flight in July 2019, the LCH features updated avionics and Safran Helicopter Engines Arriel 2C2 turboshafts. The sister project to create a Light Armed Helicopter (LAH) version for the Republic of Korea Army is reportedly on schedule to be certified before the end of the year.

AEROSPACE

All-electric Alice makes first flight

Eviation

The all-electric-powered Eviation Alice flew for the first time on 27 September. With test pilot Steve Crane at the helm, the nine-seat aircraft lifted off from Grant County International Airport in Moses Lake, WA, shortly after 7am for a nine-minute flight that reached 3,500ft. Powered by two 640kW electric motors produced by sister company magniX, the Alice is the largest all-electric passenger aircraft to so far fly.

UKRAINE CONFLICT

DEFENCE

TB2 factory to be set up in Ukraine

It has been confirmed that Turkey's Baykar will set up a local TB2 UAV production line in Ukraine to supply the armed drone to Ukrainian forces during a meeting in Kyiv by Ukrainian President Volodymyr Zelenskyy and Baykar CEO Haluk Bayraktar in September. The armed UAV, equipped with precision micro-munitions has proved to be a key weapon in helping to halt the Russian advance and in destroying artillery, vehicles and air defence systems.

Ukrainian MoD

DEFENCE

Russia blitzes cities

On 10 October, Russia launched an ongoing series of missile and 'kamikaze' drone strikes against the Ukrainian cities including Kyiv, Dnipro and Zaporizhzhia as well as power and water infrastructure. Over 19 people are reported to have been killed. The missiles, included air-launched KH-101 cruise missiles, sea-launched Kaliber weapons and Iranian-sourced loitering UAVs. According to the White House, these missile strikes were not in retaliation for the Kerch Bridge attack on on 8 October and had been pre-planned before that.

- Iran is set to expand its support to Moscow by supplying Russia with Fateh-110 and Zolfaghar short-range ballistic missiles with a range of 300km and 700km respectively.

NEWS IN BRIEF

The European Union's new green aviation R&D initiative, Clean Aviation, has awarded €700m to 20 projects to advance sustainable aviation. These projects are focused around three topics – hydrogen-powered aircraft, hybrid-electric regional aircraft and ultra-efficient short and medium-range aircraft.

Virgin Atlantic has announced it will join the SkyTeam airline alliance in early 2023, becoming the first new carrier to join the group in eight years and its first UK member. SkyTeam comprises 26 airlines around the world, including Air France, Delta Air Lines, Lufthansa, KLM, Korean Air and TAROM.

To deal with the ongoing RAF pilot training crisis, the UK MoD will request extra slots on the NATP Joint Jet Pilot Training programme, which takes place in the US. In a response to a Parliamentary question, MoD Minister, James Heappey MP said the RAF would be "working with allies and partners to examine whether UK pilots could be trained overseas," adding that "other measures to increase capacity include reducing the length of Operational Conversion Unit syllabuses and making greater use of synthetic training."

SOFIA, NASA's airborne space telescope, a heavily modified Boeing 747SP has made its last ever scientific flight on 29 September from Palmdale, CA. SOFIA (Stratospheric Observatory for Infrared Astronomy) is equipped with a giant 2.7m telescope for astronomy above clouds and smog. The aerial observatory is being retired after recommendations issued in 2021 by an expert panel that its scientific worth did not justify its costs.

Airspeeder eVTOL pilot Zephatiali Walsh beat fellow-competitor Fabio Tischler in a tense and close final to win the inaugural remotely-piloted race. This was the first time two pilots had been given full licence to race their full-scale racing eVTOLs blade-to-blade in a fully competitive race setting. Racing over a 1km sky-track over the pink salt

DEFENCE

B-21 Raider to roll out in December

Andrew Hunter, the USAF's Assistant Secretary for Acquisition, Technology and Logistics has announced that the Northrop Grumman B-21 Raider stealth bomber will be rolled out during the first week of December – the first time a new US bomber has been launched in 30 years. The invitation-only event will take place at Plant 42 in Palmdale, California, where six Raiders are in various stages of production. The nuclear-capable B-21 is expected to make its first flight sometime in 2023, with flight tests out of Edwards AFB. The USAF is to procure at least 100 of the bombers, with Ellsworth AFB in South Dakota to be the first operational base.

SPACEFLIGHT

Countdown to first UK launch

Royal Air Force

As *AEROSPACE* goes to press in mid-October, the *Cosmic Girl* 747 launch aircraft, LauncherOne rocket (above) and satellite payloads for Virgin Orbit's first UK space launch have all arrived in Britain. The launch window for the first space launch from UK soil opened on 27 October, with the expectation of a launch this month. The payloads for the 'Start Me Up' mission include joint UK MoD/US NRO CubeSats, SpaceForge in-orbit manufacturing probe and Oman's first satellite.

AIR TRANSPORT

Embraer wins first Middle Eastern E2 customer

Embraer

Omani budget airliner SalamAir has signed an MoU to acquire 12 Embraer E195-E2 jets, the largest version of the series. The carrier becomes the first from the Middle East to order the new E2 family of commercial aircraft and will receive the first six examples in late 2023.

AEROSPACE

Russia kicked out of ICAO Council

In an unprecedented move, Russia has been kicked out of the International Civil Aviation Organization (ICAO) Council due to its invasion of Ukraine. The country was voted out at the 41st Assembly in Montreal last month by other ICAO members, which accused Moscow of breaching the 1944 rules of the Chicago Convention by violating Ukraine's airspace, destroying civilian aviation infrastructure, as well as not returning leased airliners to lessors.

- Meanwhile, the 41st ICAO Assembly also concluded with 184 member nations adopting a global agreement on long-term aspirational goals (LTAG) – with the aim of net zero carbon emissions by 2050.

flats of Lake Lochiel near Adelaide, South Australia, Airspeeder plans a series of fully crewed Grand Prix races starting in 2023 with pilots, including former Formula 1 driver Bruno Senna.

Russia's Irkut has flown a MC-21 prototype fitted with indigenously developed Aviadvigatel PD-14 turbofans. The test aircraft had previously flown with Pratt & Whitney PW1400G geared turbofan engines, but these were swapped out for Russian powerplants as the country struggles with international sanctions in the wake of its invasion of Ukraine.

Boeing and Cargolux have finalised an order for ten 777-8 Freighters with options for six additional airframes. The selection of Boeing's newest freighter was announced at this year's Farnborough Air Show as the replacement for Cargolux's 747-400F fleet and specifics have now been confirmed.

A Raytheon/Northrop Grumman team have beaten a rival proposal from Boeing/Lockheed to win a US Pentagon contract to develop a hypersonic cruise missile. The air-launched Mach 5+ Hypersonic Attack Cruise Missile is expected to enter service in 2027 and will use air-breathing scramjet engines. It is also being developed in partnership with Australia with the intention of it equipping tactical fighters, such as the F-18 Super Hornet and F-35.

On 14 October, NASA's Dragon Crew-4 splashed down in the Atlantic Ocean with four astronauts on board, completing the fourth commercial crew mission. The crew spent a total of 170 days in orbit, with Italian astronaut Samantha Cristoforetti becoming the first female European commander of the ISS.

The US FAA has released its initial design standards for vertiports aimed at supporting urban air mobility VTOL operations. The guidelines cover areas, including vertiport geometry and design elements, such as lighting, markings and visual aids, as well as charging and electric infrastructure needed for eVTOLs.

Radome

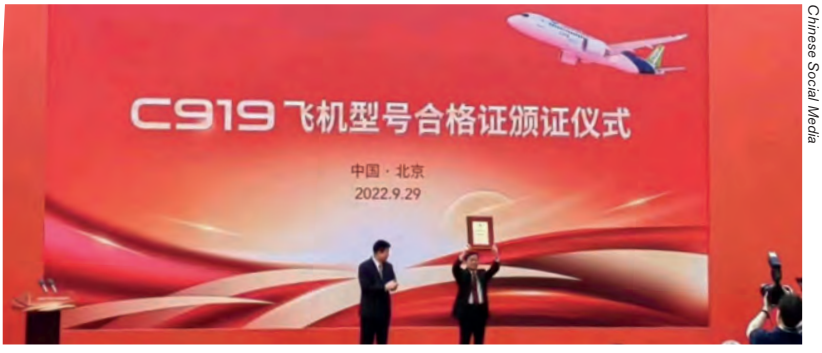
SPACEFLIGHT

NASA's DART scores asteroid bullseye

NASA's DART (Double Asteroid Redirection Test) spacecraft deliberately collided with the asteroid Dimorphos on 26 September in the first-ever planetary defence test to prove whether an asteroid headed for Earth could be deflected. Deputy Program Manager Elena Adams described the impact as "basically a bullseye". Initial observations from the strike showed that the impact had shortened the orbital period of Dimorphos around the larger Didymos asteroid by 32 minutes, successfully altering the asteroid's trajectory. There are estimated to be 4,700 rocks which meet NASA's classification as 'Potentially Hazardous Objects' – ie they are larger than 500ft across, pass within 4.7 million miles of Earth and would cause devastation if they hit.

AEROSPACE

China awards C919 certification



Chinese Social Media

COMAC's C919 single-aisle airliner gained its airworthiness certification from the Civil Aviation Administration of China (CAAC) on 29 September. Launched 14 years ago, the C919 is only the second Chinese-built passenger jet after the ARJ21, and has 815 orders from 28 customers.

GENERAL AVIATION

Wisk Aero

Wisk reveals '6th-gen' eVTOL

Boeing-backed Wisk Aero has unveiled what it says is its 'sixth-generation' four-passenger fully autonomous eVTOL. It has a range of 90 miles, speed of 110kt and a recharging time of 15min. The design changes from its previous two-seat demonstrator include a high-wing, conventional tail, the deletion of a separate pusher prop and the wheeled landing gear swapped for skids. Wisk also says special attention was paid to accessibility for disabled passengers when designing the new machine. (See 'Inclusive skies', p22.)

DEFENCE

First Protector handed over to the RAF

On 6 October it was revealed that General Atomics Aeronautical Systems, (GA-ASI) had handed over the first of 16 Protector RG1 UAVs to the RAF, following the conclusion of the acceptance procedure. The Protector, a next-generation evolution of the MQ-9 Reaper, features double the endurance of the Reaper (up to 40hrs), automatic take-off and landing, de-icing capability and is fully certifiable to fly in civilian airspace. The first airframe will be based in the US for training and tests, with the first UK-based drone to be handed over to the RAF in 2023. An International Training Centre, to support Protector will also be built at RAF Waddington. As well as military ISTAR tasks, Protector will also be available for MACA (Military Aid to Civil Authorities) missions.

NEWS IN BRIEF

Electra.aero flew its 90ft wingspan hybrid, Dawn One electric research aircraft for the first time on 9 September. The solar-battery hybrid-powered UAS is part of the Stratospheric Airborne Climate Observatory System (SACOS) programme.

UK regional airline Loganair has been put up for sale by its owners. The regional carrier, which services Scotland and the Highlands and Islands, operates 44 aircraft and has been operating for 25 years.

The Indian Air Force formally inducted the first four HAL Light Combat Helicopters (LCH), now called Prachanda (Fierce) in a ceremony at the Jodhpur air base on 4 October. Optimised for high-altitude operations, India is to acquire 160 of the twin-engine, twin-seat LCH attack helicopters for the Army and IAF.

The UK Space Agency has awarded £4m to CleanSpace and Astroscale to help develop technology and missions to clean up space debris in orbit. Further funding will be available, with the goal of a UK space junk clean-up mission in 2026. On 28 September, Astroscale, opened new satellite manufacturing facilities at Harwell, Oxford. The factory will build the world's first commercial space debris removal spacecraft, says the company.

Bizjet manufacturer Gulfstream has delivered the 500th G650-family business jet since the variant received its FAA type certificate in 2012. The aircraft was handed over to an undisclosed customer at the company's completions facility in Appleton, WI.

Paris-based Aura Aero has announced the signing of letters of intent (LoI) for more than 130 of its 19-seat ERA electric airliners. The orders come from various operators and cover passenger, VIP and cargo variants. New customers include: Brazil's DUX (20), Swiss-based FMS (10) and French companies Elit'Avia (20), Flying Green (10) and TwinJet (25). The aircraft is scheduled to fly in 2024.

President Biden has proposed to simplify and

DEFENCE

African COIN aircraft gets orders

Paramount Group

The Paramount Group has sold the first military aircraft made in South Africa since the 1980s (when state-owned arms maker Denel produced the Rooivalk attack helicopter). Following 11 years of development, Paramount – which is Africa's biggest privately owned defence and aerospace company – has received orders for nine of its two-seat Mwari reconnaissance and precision-strike COIN aircraft. The aircraft will be supplied to two so-far unnamed air forces.

AEROSPACE

First hover hop for VX4

Bristol-based Vertical Aerospace's VX4 eVTOL performed its first (tethered) take-off on 26 September. Chief Test Pilot, Justin Paines, was at the controls for the maiden flight and said: "This test represented the culmination of many months preparation by a huge team and being at the controls of the VX4 for the first time was an honour and a proud moment for us all." Vertical decided to conduct its first flight tests with a pilot on board, rather than controlled remotely, to prove it could meet the most stringent safety standards. To do this, Vertical Aerospace received regulatory approval in the form of a Permit to Fly from the CAA, after demonstrating the test could be conducted safely. Vertical has already received more than 1,400 conditional pre-orders. (See 'Hands-on flying the VX4 eVTOL' p18.)

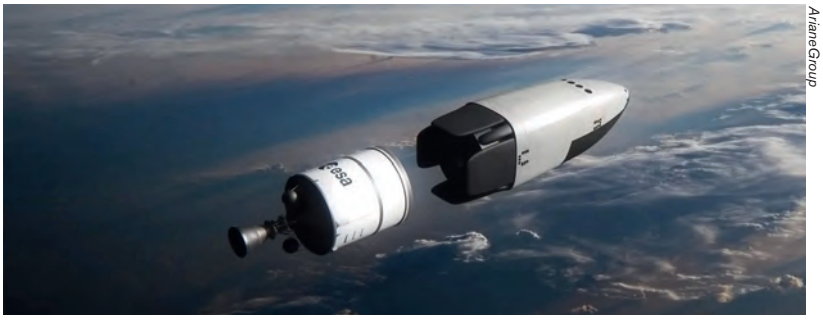
AIR TRANSPORT

Doncaster Sheffield Airport to close

Doncaster Sheffield Airport – the former RAF Finningley – is set to close later this year despite local authorities offering public funds to offset losses until the end of October 2023. Following a strategic review, the site owner, the Peel Group, announced: "No tangible proposals have been received regarding the ownership of the airport or which address the fundamental lack of financial viability." Steven Underwood, CEO, Peel Group said: "We will not accept any public sector grant to cover the costs of an airport that is not viable due to its lack of adequate forward revenues and high operating costs." Aviation services "will begin winding down during the week commencing Monday, 31 October 2022," said a statement from the Peel Group.

SPACEFLIGHT

ArianeGroup announces SUSIE



ArianeGroup

European rocket manufacturer ArianeGroup has unveiled a new concept for a multi-mission reusable spacecraft, capable of transporting five astronauts or 7t of cargo to orbit. SUSIE (Smart Upper Stage for Innovative Exploration) would replace the rocket fairing on the upcoming Ariane 6 launcher and land vertically using retrorockets.

clean up the confusing state of airline fees, where booking websites with fees for extra bags, changes and seats and other ancillary charges can be difficult to understand. Biden told reporters that: "You should know the full cost of your ticket when you're comparison shopping" with the aim of forcing airlines to show the 'true cost' of the ticket and aiding consumers.

Korea Aerospace Industries (KAI) has unveiled a model of its proposed new military multirole cargo aircraft. A model of the aircraft, dubbed MC-X, was unveiled during September's Korea 2022 exhibition with KAI claiming the aircraft could be operational in the Republic of Korea Air Force (RoKAF) within a decade. It is also aiming the MC-X at the export market which is expected to be sized somewhere between the C-130 Hercules and Airbus A400M.

NASA abandoned a third attempt to launch the Artemis 1 uncrewed test of the Space Launch System (SLS) and Orion spacecraft due to Hurricane Ian. Scheduled for 27 September, the adverse weather resulted in NASA rolling the rocket back to the Vehicle Assembly Building (VAB). The current launch window runs from 17-31 October. However, NASA admits that any October launch could still be 'difficult' pushing the flight into November.

ON THE MOVE

Gregory Davis has been appointed as Eviation's Chief Executive Officer. He has been company president since May 2021 and has served as interim CEO since February 2022. Davis previously worked as VP of customer service and product support for Viking Air Limited.

Brad Pedersen, who previously worked for Boeing and Sikorsky, will take over as CEO of MD Helicopters. Edward Dolanski becomes Chairman of the Board.

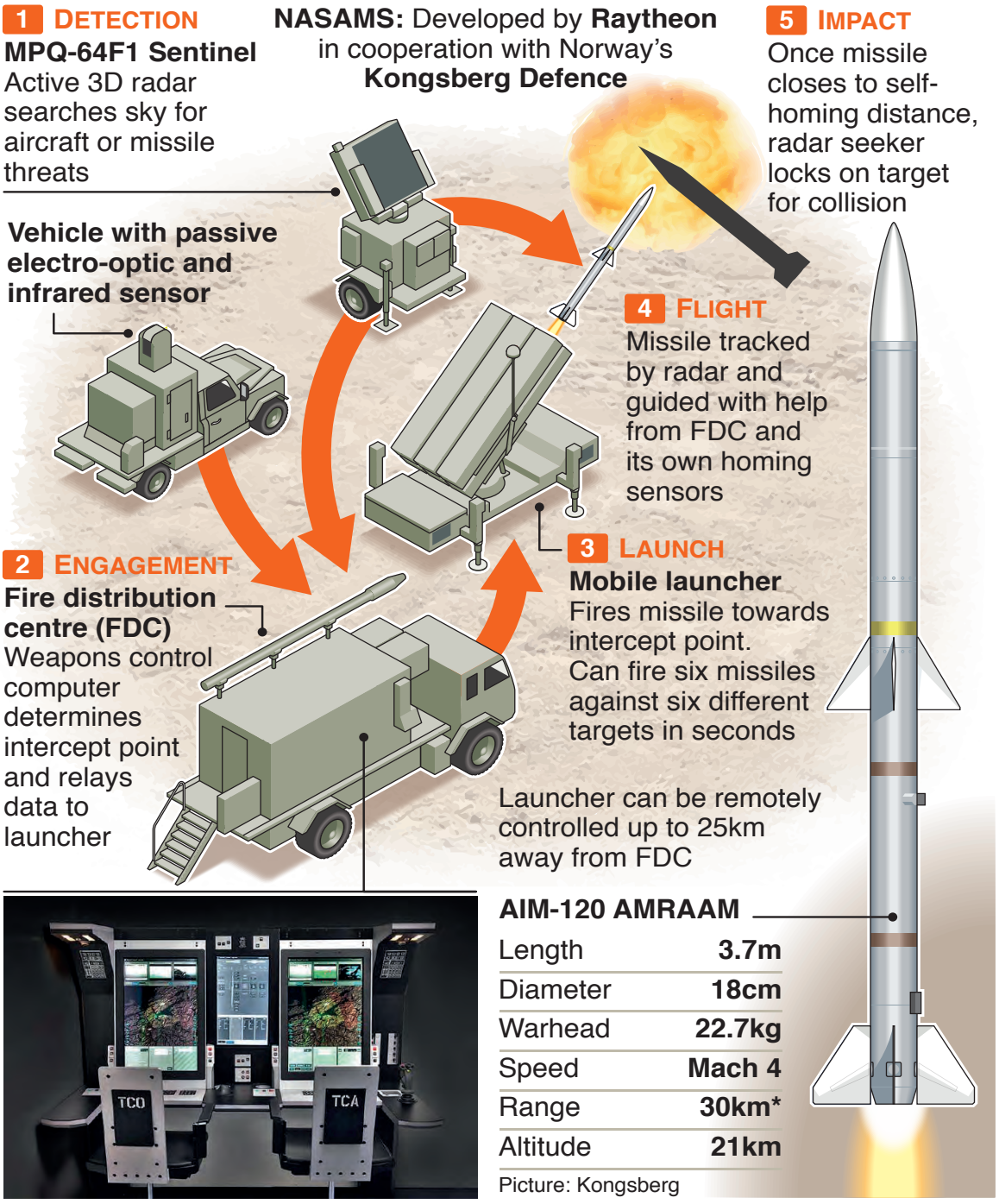
The International Association of Aircraft Dealers (IADA) has named Zipporah Marmor as Chair of the organisation. Phil Winters will become Vice Chair. Both will serve in their new leadership positions for a year.

By the Numbers

Understanding the world of Aerospace through data

Ukraine receives US air defence systems

NASAM (National Advanced Surface-to-Air Missile System) an advanced surface-to-air missile system, will help Ukraine to defend its cities from Russian missile and drone strikes. In early October, the UK said it would donate surplus AIM-120 AMRAAMs for use with the system.



Sources: Raytheon, Kongsberg *Effective range for ground-launched missile

Pushing the Envelope

Exploring advances on the leading edge of aerospace

Robert Coppinger

Seeing around corners

In the years to come, the urban canyons of the cityscape are expected to be buzzing with flying taxis and insect vision and the ability to see round corners could make flights safer.

The vision system has been tested on a laboratory bench and the next step is to use small experimental drones. They will fly with a palm-sized bionic 3D camera that can even determine the size of objects hidden around corners.

Bats and flies

This nature-inspired collision avoidance system is based on the fly's multi-view vision and the bat's sonar. Insects have bulbous, compound geometric-shaped eyes which give them a near 360-degree view. Each eye is composed of up to tens of thousands of individual units for vision, meaning it is possible for them to see the same object from multiple lines of sight. This is the key characteristic for the bionic 3D camera. Meanwhile, bats visualise their surroundings using a form of echolocation with their high-frequency squeaks bouncing off their surroundings and being picked up by their ears. This form of sonar uses the minuscule differences in how long it takes for each echo to reach the ear, and the echo's intensity, to tell the bat in real time where things are, including prey.

Bionic 3D

Researchers in the Intelligent Optics Laboratory at the University of California, Los Angeles are developing the bionic 3D camera that mimics and combines a fly's sight with a bat's sonar. This combination is called compact light field photography (CLIP) and, in addition to a 3D camera, the application uses light detection and ranging (LIDAR). The laser scanning the surroundings creates a 3D map of the area but without CLIP there would be hidden objects that would be missed. With the compound eye's many multiple lines of sight, the reflected laser light can overcome the limitations of nature's original eye which has a fixed focal length.

Using this combination of LIDAR and CLIP, the imaging system is able to achieve the bat echolocation effect enabling the electronics to detect hidden objects as quickly as it takes for light to bounce back to the camera. The camera itself can use visible light or short-wave infrared (SWIR) light, both of which are safe for the human eye, which is important because the other traffic will have pilots and passengers. The SWIR is also a good frequency for a longer LIDAR range, allowing the system to cut through fog to see obscured aircraft. The imaging system can run at 30 frames per second using deep learning computing architectures.

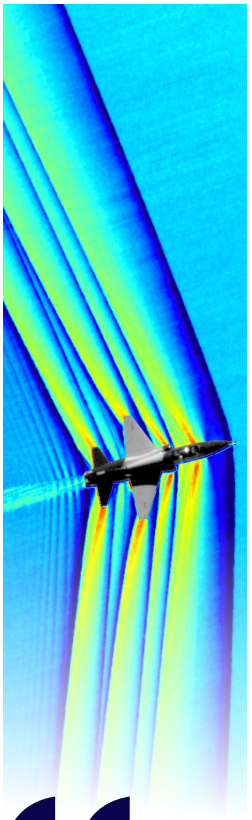
Computational imaging framework

In the city's urban canyons – where those flying drones without the necessary safety systems, or even air clutter, such as balloons, could cause a hazard – such a system would be a welcome supporting sensor to confirm the location of other aircraft perhaps already communicated by Automatic Dependent Surveillance–Broadcast (ADS-B).

The system uses seven LIDAR cameras with CLIP and this array takes a lower-resolution image of the scene. The computer then processes what the individual cameras see. The head of the Intelligent Optics Laboratory, Professor Liang Gao, an Associate Professor of Bioengineering, explained that a laptop computer can process this image data. This means any vehicle will be able to carry out on-board sensor computation for a quicker response and there is no need to use a distant data centre's computational power.

A 'novel computational imaging framework,' as Gao calls it, can acquire wide and deep panoramic views with simple optics and a small array of sensors has been developed by his team. The data is then processed to reveal the hidden objects. With their array, Gao's researchers demonstrated the camera system could image a complex 3D scene with several objects, all set at different distances. He added that aviation applications had always been a focus of the work, and hence the camera system was developed to be compact. Gao is at an early stage of talks with NASA and other colleges about drone testing.

While Gao is looking to apply his imaging system to autonomous vehicles both in the air and on the ground, the research was supported by the US National Institute of General Medical Sciences, which is part of the National Institutes of Health. Aviation is a field that has long been inspired by nature, and AAM will be no exception, owing its success, in part, to the likes of the humble house fly.



> AVIATION IS A FIELD THAT HAS SEEN MANY IMPROVEMENTS INSPIRED BY NATURE, AND THE WORLD OF ADVANCED AIR MOBILITY WILL BE NO EXCEPTION, OWING ITS SUCCESS, IN PART, TO THE LIKES OF THE HUMBLE HOUSE FLY

Transmission

LETTERS AND ONLINE

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BALPA: grab opportunity to reduce contrails

Here in the British Airline Pilots' Association's Environment Study Group, we have been following the research into contrail avoidance with great interest, so I was pleased to see Prof Ian Poll's excellent article on the subject in your July issue and also read with interest pilot Nigel Hitchman's response in August. His objections sound reasonable, and I hear them often, but in reality there are no such impediments to contrail avoidance.

Research shows that just 2% of flights are responsible for 50% of the contrail-induced warming, and that the most damaging flight segments are largely predictable. Most occur from a few hours before dusk to a few hours before dawn, in winter, from aircraft types with a high exhaust particulate count and, critically, during a cruise through a region of super saturated air (ISSR). Of these factors, only the last presents any planning difficulty. Our ability to forecast ISSRs is still far from perfect – but it does not need to be. The benefit of avoiding the most warming contrails is so powerful that it outweighs any extra fuel burn, even if it fails most of the time.

Picture a global contrail avoidance scheme that increased overall fuel use by a typical 1% but that failed nine times out of ten, ie it only managed to prevent 10% of the targeted contrails from forming (highly unlikely). Even with such a poor success rate, the annual mitigated global warming would be equivalent to 260 million tonnes of CO_2 at a 'cost' of just 10 million tonnes extra CO_2 actually emitted.

Personally, I have yet to see a flight plan with a direct route, at optimum altitude, with no tankering fuel and at cost index zero. Clearly, potential fuel savings still exist, enough I think to offset any extra burn that might arise from contrail avoidance, which some estimates put at just 0.15%.

Regarding the North Atlantic, technological improvements have now made variable Mach numbers, random routes and ad hoc level changes all possible. A recent research paper that brought together expert researchers and air traffic controllers addressed exactly this issue: Molloy, Stettler et al *Aerospace 2022*, 9(7), 375 [1], and I recommend it to all readers.

Finally, I often hear the complaint that CO_2 persists in the atmosphere for hundreds of years, whereas contrails only last a few hours. Not true – we are constantly replacing contrails, thus making them a permanent feature of the atmosphere and one that warms the Earth on a daily basis by approximately two and a half times more than all the CO_2 that aviation has amassed in the atmosphere over the past century.

Contrail avoidance has massive potential – our industry could halve its global warming almost overnight, and in the longer term possibly even achieve a net cooling effect. All at modest cost and using current equipment and fuels. No other industry can make that claim. We must grab this opportunity. The science and the tools are available – we just need to persuade the politicians and airlines. I urge the RAeS to do all it can to work with BALPA and Prof Poll to make it happen.

Jeremy Thomson
Chair, Environment Study Group, BALPA

Inspiring tomorrow's aerospace professionals

The Air Cadet's 172 (Haywards Heath) Sqn has recently come up with an innovative and engaging opportunity for youngsters to gain insight and experiences in aviation and aerospace. Over the past three years they have restored a dilapidated old ex-RAF Scottish Aviation Bulldog (XX520) and converted it to a ground instructional airframe, undertaking the engineering hand skills themselves (under supervision) with training provided by aircraft engineers that were part of the staff team.

Cadets experienced riveting, cutting aluminium skins, spars and ribs, filing, drilling, working with pneumatic tools, assembling and disassembling components and learning to use a range of hand tools. In 2022, the team exhibited XX520 at the Royal International Air Tattoo and Farnborough International Airshow's Pioneers Day.

Flt Lt Dave Emsley
AfCGI MRAeS RAFAC

Is the future upon us?

[On Vertical Aerospace VX4 and Eviation Aerospace Alice maiden flights].

Robin Trewinnard-Boyle: I was impressed by the Vertical team at Farnborough, great to hear that they got airborne.

Alan Longstaff: As long as there are any airfields left in the UK to fly them from....

Lukas Willcocks: Just a few battery issues (energy density & sustainability) and how to charge them to overcome, but good stuff!

Will Jarman: Is Alice something that could operate in an Islander/Twin Otter kind of short-range use? Aesthetically, it has a nice Dragon Rapide-ish style... in an abstract way.

Sandy Tweedie If we don't innovate we won't get anywhere. I think hybrids need to happen first, especially with SAF as the alternative fuel. We need to change. Jet A1 is going to run out.

Airbus is working hard on hydrogen. I don't know what Boeing are doing. I think electric has a nearer-term future for third level work with 9-10 passengers up to 200 miles. Beyond that, then hybrids. I just don't see lithium and other metals being particularly green to mine, harvest and process.

Budget interceptor


Magnus Aviation

[On 'The MF-212 was clearly designed for air forces on a budget.'].

Todd Shugart: Nice AA-11 Archer! Got to be a joke?

Chris Jefferson: That looks like a one-way ticket to Smoking Crater Airport!

Lee Lacey: Taking *Iron Eagle* to a whole new level.

Neil Gascoigne: "Old geezers start building world's premier UK Republican AF to be based at RAF Luton? [Photo from a Canberra?]"

Aligning ATM & UTM

@farra521 [on Royal Mail now looking at 500 airmail drones] Drones are also currently being trialled by the NHS to carry medicine across the Solent to the Isle of Wight.

@TyphoonTornado Obviously uncrewed aircraft won't be affected by weather?

@kerissa_k You can read my full report with @UKRI_News and @PwC_UK [3]

Cosmic Girl in Cornwall

@Tim_the_Pilot [On *Cosmic Girl* 747 is now in the UK] As ex-G-VWOW, she had almost the perfect registration. Now as N744VG one wonders if the intention was to operate her as part of Virgin Galactic (VG) before Virgin Orbit (VO) was created, hence she's not registered N744VO?

@robskievans Correct, VO spun off from VG as a separate entity after acquisition.

RAF training overseas?

@ianmac67_SE [On 'RAF to explore overseas pilot training options'] Is there value in the RAF considering other countries who fly the Hawk T.2? I can think of one country that might have capacity and has a pool of instructors who would meet the RAF's standards.

RAF retirees in China?

@catdog202 [On 'China has recruited dozens of former RAF fast jet pilots as instructors'] Is it the UK MoD's fault that those guys decided to pocket $250k+ a year from China to train its pilots to defeat western aircraft/tactics and – essentially – how to kill their own people? No, that's plain old greed, lack of honour and treason – it's as simple as that!

Retention vs resignation

@pilot_grumpy [On Turbulence ahead - the great resignation and aviation?[2]] Pay peanuts and most of the time you get people who are not up to the job. Pay more, employ less as you have more efficient and quality staff.
I see it every day.

@SouthernFairy16 Treating staff as people rather than numbers would be a good start. Pay them for their qualifications and experience, you can't train an engineer in a handful of quick courses, it takes time and commitment.

@GgAviation What is the Management retainment percentage vs the 'Coal Face' retainment % in Aviation industry?

The great resignation

Mike Simkins [On "What the Great Resignation means for the aviation[2]]. "Simple, many pilots who are professional concluded they no longer wished to work in a corrupt industry that treated them so badly

Welcome to the new world of inexperience and crew willing to prostitute themselves to get a uniform and some braid."

An Australian Air Tractor advocate

I read with interest your article about firefighting aircraft [*AEROSPACE* September 2022].

A few years ago, I designed a modification for the Air Tractor AT-802 which was performed at Pay's Air Service at Scone in New South Wales and received an Australian STC, then also FAA and Canadian STCs.
The extinguishant tanks were mounted within the wing leading edge in a large rib lightening hole that goes all the way out from root to tip. So as not to affect wing flexibility, the tank was made from high density polyethylene (HDPE) and mounted on slit rubber hose that ran around the rib hole edge. HDPE can be welded and machined and most of the components were commercial and a releasing procedure for these had to be developed.

This changed the wing mass and wing ground vibration testing was therefore required.

The extinguishant was mixed at 100:1 with 3 tons of water in the main hopper. About seven water sorties could be flown for each extinguishant tank refill. The dosing of the water had to be accurately measured and rapidly mixed with the water, this being done with the slipstream driven pump.

The advantage of the AT-802 is that it can be operated from agricultural airstrips close to the fire.

Charles William (Bill) Whitney MRAeS

From the RAeS photo archives

John Robertson Duigan (1882-1951) at the controls of the first Australian-built aircraft, circa1911. After seeing a postcard of Wilbur Wright's flights in France in late 1908, Duigan began experimenting with aviation, first constructing a Wright-type glider, and then a powered aircraft. The Farman-type biplane illustrated made a short flight at the family farm in Mia Mia, Victoria, on 16 July 1910, but Duigan never considered this to be a fully controlled flight, regarding his longer flight of 7 October 1910 as his first successful attempt. These were followed by ever longer and higher flights and Duigan eventually donated the historic Australian aircraft to the Industrial and Technological Museum of Victoria in 1920. Later absorbed into the Museum Victoria collection, the museum also preserves a flying replica of the Duigan biplane, built by Ronald Lewis and flown in 1990. The latter was donated to the museum in 2000.

1. https://www.mdpi.com/2226-4310/9/7/375
2. https://www.aerosociety.com/news/turbulence-ahead-what-the-great-resignation-means-for-the-aviation-industry/
3. https://www.ukri.org/wp-content/uploads/2022/01/UKRI-140122-

Going fast but staying green

Can 'The Need for Speed' coexist with the need to save the planet? Sqn Ldr (R) FAHAD MASOOD MRAeS reports on the return of supersonic passenger flight.

It is now over two decades since that fateful Tuesday afternoon of 25 July 2000 when Air France Concorde Flight 4590 crashed in Paris. Today, most of the world considers the Aérospatiale/BAC product as the only successful supersonic commercial aircraft but the Soviets had their own SST project in the form of the Tupolev Tu-144 which, interestingly, beat the Anglo-French Concorde into the air by two months, flying on 31 December 1968, from Zhukovsky Airport, near Moscow.

Yet both programmes had outlived the necessities of the time by the new millennium, the regulatory requirements of noise abatement being just one. Since then, the aerospace industry has looked forward to a new generation supersonic commercial airliner or 'Concorde 2.0', brought to life with new materials and new technology, and there are now a few projects on the drawing board.

The lure of faster travel for passengers exerts a powerful pull but the goal of making it 'sustainable', as with the rest of aviation, needs to take the lead and not be on the back burner.

Contemporary SST projects

Today, there are a handful of aircraft under development that promise high-speed flight for tomorrow's passengers. In the US, NASA is working on the X-59 QueSST (Quiet SuperSonic Technology), the latest X-plane in its long history of research into the supersonic domain.

The X-59 is a research prototype from Lockheed Martin's Skunkworks, forming part of a programme which began in 2016. It is aimed at solving one of the main challenges of commercial SSTs – the sonic boom which is considered enemy number one for any overland flights under the present strict 'sound' rules

Boom Supersonic

> THE LURE OF FASTER TRAVEL FOR PASSENGERS EXERTS A POWERFUL PULL BUT THE GOAL OF MAKING IT 'SUSTAINABLE', AS WITH THE REST OF AVIATION, NEEDS TO TAKE THE LEAD AND NOT BE ON THE BACK BURNER

of international operations under ICAO and all NAAs (National Aviation Authorities).

The X-59 is designed with a long, narrow nose and delta-shaped wings, made from carbon fibre-reinforced composites. These features are intended to spread out supersonic shockwaves, therefore reducing the amount of noise that can be heard on the ground below. The engine is positioned above the wings for the same reason which helps to further decrease noise. The Mach 1.5-capable X-plane is scheduled to make its first flight early next year.

Elsewhere, the XB-1 – cutely nicknamed 'Baby Boom' – is a sub-scale technology demonstrator for Boom Supersonic's Overture SST which is aiming to enter service by 2029. According to Blake Scholl, founder and CEO of Boom Supersonic, XB-1 has now completed the majority of its 'ground runs' and is expected to be flight-tested in the Californian skies at the Mojave Air and Space Port imminently. The three J-85 engines used in the Baby Boom will be replaced by more eco-friendly propulsion systems in the four-engine Mach 1.7 Overture airliner which had a new configuration unveiled this summer at the Farnborough Airshow.

It is planned that the 65-88 seat Overture will use only 100% biodegradable sustainable aviation fuel (SAF). However, the engine supplier is still unknown, with Rolls-Royce publicly backing away from the project in September after completing a research project for Boom. Other engine manufacturers, such as GE Aviation, Safran and Honeywell, have also, at the very best, appeared lukewarm about developing a custom jet engine for the Overture. For his part, as this article is written, Scholl promises that he will announce an engine supplier before the end of the year.

The 1990s – the false dawn of SSBJs

Supersonic business jets (SSBJ) were the talk of the town in the 1990s. The small size and limited passenger load were big factors for the interest in developing a commercial supersonic aircraft with an incremental approach. It was predicted that extremely wealthy passengers would be willing to pay a handsome amount to utilise a five to ten-seat VIP aircraft, able to connect them at more than the speed of sound. Gulfstream with its proposed X-54 research aircraft was one of the contenders with its 'quiet boom' technology.

NASA, meanwhile, tested two technology demonstrations in support of SSTs and SSBJs. The 'Quiet Spike' and 'Shaped Sonic Boom' demonstrators used fighters (F-15 and F-5Es) with altered external shapes to test boom mitigation ideas and get full-scale flight test data.

Meanwhile, another SSBJ project, Supersonic Aerospace International (SAI) QSST, also went nowhere. The Sukhoi S-21 business jet was initiated with the same intent by Gulfstream and Sukhoi but ended with the same results of its predecessors. Finally, Tupolev, Dassault and Japan's JAXA also toyed around with the idea of developing their own SSBJs – but, despite the seemingly high-end market where price was not an issue, nothing came of these.

The return of supersonics?

With the new millennium came a new SSBJ project, named Aerion. There was extensive research and wind tunnel testing of 'short stubby F-104 wings' but it was all in vain. Despite the Aerion wing design

Above: The latest iteration of Boom Supersonic's Overture design was unveiled at the 2022 Farnborough International Airshow but it still remains without a named engine supplier.

Right: NASA's X-59 QueSST X-plane is projected to fly before the end of 2023.

NASA

going through several iterations and collaborations with Boeing, Airbus and Lockheed Martin, 2021 saw the closure of the company due to lack of funding.

Another contender, Spike Aerospace, launched its Mach 1.6 S-512 project soon after Boom emerged and is gaining momentum. Interestingly, the S-512 features no passenger windows, instead using large-area digital displays on the cabin walls and ceiling to give the illusion of looking outside the aircraft. Another new start-up is Exosonic which promises a Mach 1.8 passenger airliner, with 70 seats and certification planned for 2029.

Meanwhile, Hermeus Aerospace, with its Mach 5 plus design concept, is technically a 'hypersonic' aircraft rather than supersonic. The conceptual design looks more like a spaceplane than a traditional supersonic airliner. Finally, there is a 9-19 seat supersonic project from Virgin, announced in 2020. The idea of billionaire Richard Branson, the aircraft is being developed at his Virgin Galactic company, which is also readying its sub-orbital spaceplane for space tourism. Virgin's conceptual SSBJ design is slated to fly at Mach 3, and it has signed a development agreement with Rolls-Royce for engines.

Technological improvements

What these projects have in common is that they plan to incorporate many contemporary and futuristic technologies to ensure sustainability in operations. Since Concorde was developed in the 1960s, aerospace technology has advanced greatly, and three areas of innovation will greatly improve the fuel efficiency through improved engines for propulsion, materials, like lighter carbon composites easily shaped into aerodynamically optimal forms, as well as CFD aerodynamics with advanced computing allowing thousands of iterations of testing. These also include:

'Quiet' Sonic Boom: SSTs of the past had the major non-compliance issue of the loud sonic boom heard while flying over populated areas. Noise abatement procedures could not help in this respect but a major breakthrough in technology relates to having a sonic 'thump' instead of a 'boom'. To quantify sudden, sharp sounds, NASA uses a measure called 'perceived level decibels' (PLdB). A conventional sonic boom is around 105PLdB, while a car door slamming six metres away is just 75PLdB. That is the level the X-59 is aiming at: when it is flying at Mach 1.4 (around 925mph) at a typical cruising altitude, all you should hear is a mild thump, no worse than your neighbour slamming a car door.

External Vision System: Concorde famously had a 'droop snoot' nose to assist forward vision for the pilot on take-off and landing and some designs will now include a virtual version of this with an External Vision System to view what is coming ahead. This will see an HD video display showing the view ahead.

Sustainable Aviation Fuel: A vital tool for making air travel more sustainable, SAF is jet fuel made from sustainable and renewable sources as an alternative to fossil fuels, such as Jet A, which is made from crude oil (also called liquid petroleum). SAF, available today, is considered 'drop-in' because it meets the same characteristics of Jet A and can be used safely on existing aircraft within current airport systems. It is made from a wide range of 'feedstocks', including waste products, like used cooking oil, forestry and agricultural waste, fast-growing plants, such as algae, and now carbon from the atmosphere through direct air capture.

Currently, commercial aircraft are only approved to operate passenger flights on a 50/50 blend of

> A MAJOR BREAKTHROUGH IN TECHNOLOGY RELATES TO HAVING A SONIC 'THUMP' INSTEAD OF A 'BOOM'

Spike Aerospace


Virgin Galactic

SAF and Jet A by regulators but those percentages are expected to change within the coming years, with the goal of 100% SAF-powered commercial fights. Currently, SAF can reduce CO_2 lifecycle emissions by up to 80%, compared to Jet A.

Interestingly, Boom's XB-1 test programme is intended to be carbon-neutral through the use of SAF and carbon offsetting. "Since Boom's founding, we've been on a mission to make the world dramatically more accessible through supersonic travel," said Scholl. "With our commitment to a carbon-neutral XB-1 test programme, we're laying the groundwork for a sustainable supersonic future with Overture." Boom has already successfully carried out a series of ground tests of XB-1 engines using 80% SAF blend.

Integration of HMMH & Envirosuite: Measuring the environmental and societal impact of SSTs and proving their green credentials will be key. In that respect, Harris Miller Miller & Hanson (HMMH) will support NASA's X-59 Community Response Testing. This bodes well for the programme in sustainability aspects for the company maintains an impeccable track record of assessing and guiding sustainable solutions for the various HROs (high reliability organisations), especially in noise and vibration control, air quality analysis, airport and airspace planning, and sustainable energy solutions. Along with HMMH, Envirosuite is looking at quantifying and performing high-altitude data analysis on noise production.

Challenges

However, there remain major challenges. The International Council on Clean Transportation (ICCT), has gazed into the crystal ball and forecasted limited use of SSTs in about a decade and half from now. The independent nonprofit organisation considered the number of supersonic aircraft, potential operations, and overall fuel burn under four scenarios in 2035, using a modelling suite from the MIT Laboratory for Aviation and the Environment. The GEOS-Chem global chemistry transport model was used to derive the radiative forcing (RF) impact of ozone, water vapour, methane, and black carbon and sulfate aerosols from those operations.

It found that, even in the most optimistic economic case, there is a limited supersonic airliner market because airlines will be unable to operate SSTs profitably with overland flight restrictions or using synthetic 'e-kerosene' produced from renewable electricity. The ICCT concluded that environmental considerations are likely to tightly constrain supersonic markets for the foreseeable future and both low-boom designs and ultralow cost SAF will be needed for a sizeable supersonic market to develop. In the near term, any supersonic aircraft developed are likely to be operated on fossil fuels, not e-kerosene, after being delivered.

Others point out that, as well as overland restrictions and noise abatement procedures around airports, the high altitude at which SSTs will cruise, compared to normal airliners means that any emissions will have an exaggerated effect, even in tiny fleet numbers.

Conclusion

Considering the unpredictability of both socio and economic scenarios, it is safe to say that there is renewed consumer interest in bringing back a successor to Concorde and for passengers to get to their destinations faster. Regular 'click-bait' articles of exciting shapes and headlines, like 'London to New York in 80 minutes' have conditioned the public to expect that SSTs are just around the corner.

However, the industry needs to embed sustainability in these projects at a systemic level. It cannot be incorporated at the final stages. Better said, the design phase is where 'going green' needs to be taken as a policy direction. Anything going against it will result in a 'white elephant' in the latter part which is not at all valuable risk management. Hazards need to be assessed and analysed from the word go, keeping in mind all the probable misgivings that can be found on the road to mission success. A single aspect disregarded will result in everything going down the drain and failure. Looking at the numbers, that could be hundreds of billions, if not trillions of dollars.

Top: Rolls-Royce has entered a partnership to study engines that could power the Virgin Galactic SSBJ from London to New York in as little as 90 minutes.

Left: For its Mach 1.6-capable S-512 SSJ, Spike Aerospace has teamed up with ultrasonic glass technology specialist Innovasonic to explore wiper-less windshields and self-cleaning touchscreens.

Hands-on flying the VX4 eVTOL

What's it like to fly an eVTOL? Following successful initial tethered hover trials of Vertical Aerospace's VX4, student pilot CHARLOTTE BAILEY visits its Bristol factory to experience its simulator and explore what a pilot training pathway might look like.

Looking out across London, the iconic outline of the river Thames below, I grip the control column in my right hand and gently ease it backwards. Eight tiltrotors whir into life and we ascend vertically before a touch of rudder and throttle input guide us west, London City Airport receding as our craft passes City Hall on the right, our shadow slipping across the water, and we prepare to round the Greenwich Peninsula.

Among my eager onlookers is Dominic Jackson – Market Development Manager at Vertical Aerospace – the company behind the VX4 that I'm currently in command of. "It can fly like a helicopter but it's not a helicopter. It can fly like a fixed-wing aircraft, but it's not a fixed-wing aircraft," he explains. Indeed, although there is nothing ambiguous about the concept of an eVTOL (electric vertical take-off and landing) craft, there are certainly a lot of questions and answers yet to be defined prior to this project approaching entry into service. So just how are Vertical – through the development of an entirely new category of aircraft such as this – aiming to 'open up urban air mobility and transform how we travel'?

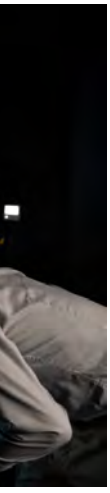
'Where the toys are kept'

Amid the company's ambitious plans to achieve initial type certification for the VX4 as early as 2025, I'm clearly preoccupied with the complexities of this novel form of aerial conveyance – at least, that's what I'll later claim – as the Emirates cable car looms large before us. I bank sharply, but in my mind's eye, a single, sad, spinning rotor in the ensuing collision – tangled in a contortion of cables – when the screen goes blank, has given us the first absolute answer of the day: whatever the pilot training pathway, I won't be among the candidates.

Perhaps it's just as well this is only a simulation and I haven't just crashed an expensive (although as-yet-undisclosed just how costly) aircraft.

The VX4 is the latest evolution of Vertical's eVTOL concept: a four-passenger, single-pilot, unpressurised craft, proposed to operate out of primarily urban areas. With a reported range of up to 100 miles and a top speed of around 200mph, the VX4 is the latest in a line of prototypes aiming to fulfil CEO Stephen Fitzpatrick's vision of 'opening up urban air mobility to a whole new range of passengers'.

VERTICAL



> THIS ULTIMATELY IS NOT A COMPLEX AIRCRAFT TO CONTROL AND, WITH A LITTLE PRACTICE, THE CONTROL INPUTS ARE EASY ENOUGH TO ASSIMILATE

Top left: A milestone hover test saw the craft lift around a metre from the ground for a duration of just over ten minutes, using ground power rather than internal batteries.

Top right: 'Pilot in the loop' simulator in action.

Here in the hangar at Bristol – "where the toys are kept," jokes Jackson – I spy the VA-X2, a full-scale prototype airframe which conducted its first free uncrewed flight in 2019. However, working on the assumption that these vehicles will (initially, at least) require a pilot, the expectation that the commercially viable iteration of carrying "four passengers economically over any useful distance" ultimately informed the five-seat VX-4 variant currently in development and for which more than 1,400 conditional pre-orders have already been placed.

Testing times

This hangar is also home to the full-scale VX-4 mock-up, an undisputed Instagram success at this year's Farnborough International Airshow but a type which had yet to prove its function as well as form. That was to change on 26 September 2022, when the prototype aircraft – having received a CAA Permit to Fly – conducted its first tethered hover tests at the company's Kemble base, with Chief Test Pilot Justin Paines reaching a height of just under a metre in an initial flight lasting a little over ten minutes.

The test marked stage four of a projected pathway towards type certification, with sights now set on a move towards low-speed, forward-flight trials. Vertical are coy on whether this prototype will be adapted or what the size of a potential flight test fleet might eventually be.

Paines' appointment to the project would seem apt, given his background on the Lockheed Martin F-35B Lightning II, a craft also capable of short take-off and vertical landings and one which shares the same underlying flight control philosophy. However, although precious few potential VX4 pilots will share such expertise, Vertical notes that initial training pathways will likely consist of a type conversion for existing commercial licence holders. I was, therefore, curious: although I may only be working towards a fixed-wing PPL, just how intuitive is the VX4 to control?

Simulator set-up

Armed with a basic understanding of the principles of flight, I step into the simulator control room with what I'm soon to discover is a misplaced confidence in my own flying capabilities. The 'pilot in the loop' simulator is an exact replica of the cockpit: a dedicated set-up comprising a curving panoramic screen surrounding a cockpit fuselage framework, controls and seat, into which I clamber. The visuals are run by flight simulation stalwart, X-Plane, although the flight physics are the product of an in-house simulation using MATLAB Simulink, networked between several different computers.

Although it is stressed that this set-up is still a work in progress and not necessarily representative of the final flight controls, it is also suggested that this is an 'easy aircraft to fly' (certainly far simpler than rotorcraft or existing fixed-wing platforms). "You'll have a good job trying to make it go out of control," explains the simulator engineer, famous last words that further echo the value of the simulated training environment.

Certainly, the fly-by-wire control inputs seem simplistic enough. In my right hand is a control column, my left hand a throttle, and my feet are firmly planted on the pedals. Pulling backwards on the sidestick unit in my right hand (good news, Airbus aficionados) causes the VX4 to lift vertically, whereas to push it forwards returns us to the ground. Moving the stick to the left, say, translates into a movement to that side: we roll to the left while thrust simultaneously increases before the roll quickly stabilises. The pedals do not control a rudder in the conventional sense, as there is no need for what I would recognise as a co-ordinated turn; here, the computer balances roll and yaw, leaving my feet to simply suggest a heading command. Releasing the right hand stick, we hover steadily on the spot; there's no need to hold control inputs and I can essentially spin around 360 degrees with little more than my big toe. So far so good, at least.

Lost in translation?

The control lever in my left hand has three positions: forward, neutral and backwards, more of an indication of intention than the sort of throttle that incrementally increases the power in my Piper Super Cub. Pushing it forwards translates a command to the flight control systems that we want to fly forwards, angling the tiltrotors on our wings and instructing the eVTOL to advance horizontally (capped in this simulation at 40kt); pulling it backwards translates into a reversing motion, albeit limited to 5kt.

To land, it is left hand in neutral, right hand forward, also limited to a speed of around 5kt (just as well as my first few 'hops' culminate in harder landings than I'd have liked).

Above: Test pilots Simon Davies (left) and Justin Paines (right) with the VA-X2 full-scale prototype airframe in the hangar at Bristol, "where the toys are kept," according to Dominic Jackson, Vertical's Market Development Manager.

All images: Vertical

I'm told Vertical's two test pilots are using the simulator to test the landing gear configuration the day after my visit to test the air-ground logic.

Possibly the single most significant stumbling block I find while flying the sim is that my habit of keeping a firm grip on the stick at all times seems superfluous here. With the exception of last-minute landing adjustments, my right hand is relatively redundant, and I seem to instinctively want to overenthusiastically roll into turns: a mistake.

Admittedly, I should have stuck to the estimated optimum cruising height of 1,000m ASL (a little over 3,300ft), but I'm also banking too steeply when I snag the cable car and require a system reset. However, by the end of about 20 minutes, I manage a passable series of 'hops' along London City's runway.

Embarrassed at my own ineptitude, I spend the remainder of the afternoon wishing I'd paid more attention to my partner's video game obsession (a skill set seemingly of more relevance than my own fixed-wing forays aloft). However, this ultimately is not a complex aircraft to control and, with a little practice, the control inputs are easy enough to assimilate. Maybe driving the DLR train would be better practice than hours in an aeroplane; if a 'zero-hours' training pathway could eventually be agreed upon down the line, it does not seem an utterly impractical change of career.

Moving towards certification

It is also reassuring to know that the three independent flight control systems, which are responsible for making constant calculations before translating my inputs to flight control surface movements, are being repeatedly tested on a stand-alone system test bench adjacent to the simulator room. Comprising all of the electronics in the vehicle and integrating successive Honeywell software patches, issues of reliability and redundancy can all be safely explored here on the ground, leaving the simulator to inform handling qualities and human factors issues.

> "AFTER ANNOUNCING A PARTNERSHIP WITH CAE (WHO WILL "PROVIDE THE BULK OF THE TRAINING ACROSS THEIR GLOBAL NETWORK") IN JULY, VERTICAL HOPES TO SET UP ITS OWN TRAINING ACADEMY IN THE UK,

Vertical is aiming for concurrent CAA / EASA SC-VTOL ('Special Category') safety certification, some parts of which are 'still being written,' many of which concern battery safety issues and range reserve requirements. (The inaugural hover test was, notably, also conducted using ground power rather than on-board batteries.) However, it is planned that the VX4 will be certificated to meet the same probability of fatal accidents as large commercial airliners.

Although Vertical is 'in discussions' with the FAA – good news for American Airlines, who have committed to a conditional pre-delivery payment for 50 aircraft (of a conditional 350 in total) – it is "much more likely the first 50 aircraft [built] will be deployed in the UK or Europe".

An inaugural UK user might well be Virgin Atlantic, whose option to purchase up to 150 VX4s could "enable sustainable, price competitive, regional connectivity" airport connections. Setting to one side the as-yet answered issues of airspace integration, these operators will require pilots for their vehicles – be it through their own training organisations or outsourcing arrangements – and Vertical is 'gearing up' to support both models.

Training partnerships proposed

After announcing a partnership with CAE (who will "provide the bulk of the training across their global network") in July, Vertical hopes to set up its own training academy in the UK, stressing the importance of keeping a "tight loop between the original OEM who's developing this novel aircraft".

This set-up would see 'home-grown' chief pilots and instructors then dispersing to teach subsequent trainees at other facilities globally. In terms of pilot training, Jackson explains: "we think we'll have to use full-motion simulators initially, simply because they're certified." But over time, we hope to be able to move to more synthetic, mixed-reality training solutions that are also cheaper. Alongside the stand-alone simulator set-up I've just experienced, Vertical is also experimenting with a mobile version – a 'mixed-reality' set-up feeding visuals through a VR headset (which is also informing ongoing testing at Kemble).

In conclusion, there are inevitably a lot of as yet undefined issues on the pathway to type certification (let alone a projected entry into commercial service) that will ultimately be defined through a close working relationship with the relevant regulators. But in terms of physically flying the thing?

Although the VX4 did not feel intuitive to the low-houred pilot who spends most weekends at the controls of octogenarian technology, I am perhaps not indicative of the prospective pilot pool, most of whom should 'grasp it' with the enthusiasm I had for the sidestick in my right hand.

After all, Vertical is going up in the world – a whole metre at a time – and I, for one, am looking forward to seeing it translate this momentum into forward flight.

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Embraer

Inclusive skies

GORDON WOOLLEY FRAeS, of the Society's Flight Simulation Group, looks at how the emerging urban air mobility sector needs to address the issue of disabled passengers – and how the RAeS is working with Aerobility in a unique inclusive flight simulation challenge.

Concerns for improving diversity and inclusivity have become increasingly prominent within aerospace, an industry which traditionally has had high barriers to access and entry into its more technological sectors. Minimal representation of professionals from varied backgrounds and abilities can make it even more daunting for young people or professionals to enter a fast-paced, yet traditionally conservative, aviation industry. Young people from under-represented communities (eg diverse ethnic backgrounds or individuals with accessibility needs) who feel like they 'can't be what they can't see', are often limited to a reduced pool of connections and opportunities, making it difficult to find a way in. To remedy this, change is essential, particularly to increase the involvement of the disabled community within the sector. This will not only inspire the young community, but increase their ability to network, and to find their way into and invigorate an already dynamic industry.

The RAeS has made diversity and inclusivity a policy priority, and several initiatives are under way to translate that policy into results.

Falcon 2

The Society launched Project Falcon 2 on 20 September 2022, a competition for young people's groups to design and build a flight simulator for individuals with special educational needs and disabilities.

One of the primary aims of Falcon 2 is to stimulate interest among marginalised young people of visible and perhaps unnoticed disabilities to gain more understanding of their interests and concerns, and to look constructively for ways to involve them in the world of aviation through one of its most accessible avenues – flight simulation.

For this project, the RAeS has teamed up with Aerobility, a charity which aims to 'provide anyone, with any disability with access to the magic and wonder of flight' and also provides advice, knowledge and advocacy for disabled people who wish to fly and is the representative body for disabled aviation within the UK. Aerobility uses several modified aircraft to provide people with disabilities with the joy of live flight, as well as flight simulators to widen opportunities for experiencing many of the same sensations.

In a similar vein, the RAeS Flight Simulation Group invited Nurina Sharmin ARAeS, the Industry Research Lead at Flight Crowd, to present on the topic of creating an inclusive environment for novel air platforms at its 2021 conference. Flight Crowd is a global Urban Air Mobility (UAM) community which brings together enthusiasts and experts both to educate and grow the wider public interest in the future flight industry. This not-for-profit ensures that UAM is built on inclusivity, accessibility and transparency, where the general public is empowered to shape the future of flight.

These novel aircraft platforms are energising interest in aviation in a way not seen since the dawn of the jet age. Additionally, the so-called 'air taxi' industry has the potential to provide greater accessibility, and a wider scope to fly, to develop skills, and to experience being at the controls, should the vehicles be implemented and operated correctly.

Certain characteristics of the future flight industry stand out:

- Distributed and articulated electric propulsion makes possible an enormous array of potential aircraft designs, unencumbered by conventional airframe and undercarriage design and engine placement. Entry and egress, cockpit and passenger seating, etc can, thus, be far more flexibly designed, with fewer limitations on who can access the aircraft, and what assistance might be needed.
- Electric air vehicles (EAVs) are designed to be environmentally friendly, both green and quiet; they are also capable of vertical take-off and landing, and this combination enormously expands the range of potential operating sites, including in city centres. The need to travel to large out-of-town airfields, and the difficulties to be overcome in doing so, would be removed. The aircraft could go to the user.
- A key feature of these novel aircraft is that they are designed to be fully autonomous. This will facilitate a full range of pilot assistance from full pilot control, through 'carefree handling' and flight envelope protection, to fully pre-programmed or remotely controlled flight paths. The level of automation could, therefore, be tailored to a much wider range of flying skills, with automatic recovery, or 'come home and land' fail-safe options built in.

EAVs also open other aviation disciplines in such aspects as design, operations, passenger and freight handling, and the interchanges between air vehicles and ground and surface transport systems. People with disabilities or other disadvantages must navigate their way through complex systems on a daily basis, and their insights could make a significant contribution to improving the efficiency and safety of connected mobility, its physical infrastructure, and the seamless booking, ticketing, identification, etc procedures envisaged for it.

Mike Miller-Smith, the CEO of Aerobility, and his colleague Marcus O'Shea, have anticipated this trend and begun to spread the message of what Future Flight offers to a wider audience. Marcus summarises it this way:

"Aerobility has been enabling disabled access to aviation for nearly 30 years. We have modified aircraft; we have trained instructors to the specific needs of those with disability and we have advocated on behalf of disabled aviators.

All of this has had to be done, simply because accessibility was not a consideration when basic aircraft design was put in place decades ago. Since then, the fundamentals have not really changed either and, as a result, air travel in the 21st Century is a difficult and often undignified experience for people with disabilities.

The promise of EAVs is easy: direct travel for everyone. We have been looking at this space for some time because from where we are sitting, this technology has the capacity to transform the lives of those living with disability the most. Point-to-point transport that comes to you, is autonomous and accessible, is gamechanging for someone with a disability. With one in five of the world's population having a disability, it is also gamechanging commercially.

Above opposite page: Embraer's proposed eVTOLs are, in its words, 'designed with a universal cabin with easy access for everyone.' This includes those using wheelchairs.

Below left: The Supernal eVTOL Vehicle Cabin Concept.

Below right: Wisk's eVTOL airframe.

Supernal

Aerobility

Top left: Students working on the RAeS Falcon 2 project.

Top right: volunteers from the Aerobility charity assisting an aspiring pilot.

However, having looked at the industry in 2020, our assessment was that there was not enough happening with accessibility in mind. We could see little evidence of accessibility design considerations; we could see little understanding of the social obligation to design with accessibility in mind. No one seemed to demonstrate an understanding of the social impact beyond clean convenient travel – admittedly, no small achievement.

We moved to address this, first with a White Paper highlighting the need to tackle the absence of accessibility considerations.

We have now moved to advising engineers and manufacturers, as well as working with the Vertical Flight Society to launch the first global, student design competition for an accessible eVTOL taxi. This has engaged aeronautical engineering students around the world with the concept of accessibility within aviation. All of this has helped put accessibility on the EAV agenda."

Flying for all

Ensuring the industry considers this group now will reap rewards for everyone. This is not just about wheelchair access either. The industry must ask itself, how will someone with visual impairment interact with their aircraft, how will someone with poor motor control use touchscreens? What emergency evacuation procedures are in place for people with reduced mobility?

The penny must drop for the industry if it is to avoid the mistakes made by conventional aviation; this is not just a new mode of transport, it is a huge social enabler, if we bake accessibility into the DNA of the industry now.

UAM is the biggest opportunity for decades to transform the mobility options for millions of people who struggle daily with the current inaccessible ground transport services. However, if the promise and indeed the full market value of the opportunity is to be truly realised, it can only be done based on inclusivity – at every stage of the industry's development.

Inclusive flight ecosystem

During her presentation at the Flight Simulation Conference 2021, Nurina Sharmin ARAeS spoke about creating an inclusive future for the flight ecosystem. She emphasised the considerations and actions required to ensure the diversity and inclusivity in all aspects of the emerging EAVs sector. She summarises her thoughts below:

Mobility is not a privilege, nor should it be. It is the fundamental right of all people, regardless of background, abilities, needs and experiences. We should work to actively ensure that everyone is provided with equal opportunities, enabling them to use their creativity, skills and talent to shape their own future.

An individual's abilities or disabilities should not limit the number of options available to them in following their chosen career paths, differentiating them from their peers and further increasing the access gap. A solution would be to encourage and provide a varied range of opportunities to ensure fair and equal chances. This will allow for an individual's talent to thrive, so that their capabilities are only defined by their talents. In other words, having a disability does not mean those options should be reduced to one or none.

In aviation, where individuals of certain nationalities, genders or educational backgrounds are already limited in ways they can shape the industry, people with hidden or visible disabilities should not be disadvantaged any further. The future flight ecosystem should be built on diversity and inclusivity from the get-go, so that everyone is able to participate in a variety of activities and have a say in the way the industry is built.

This could be the ability to experience flight as a passenger or a pilot, or even building and designing the aircraft. Having a disability should not be a barrier and, if it is, this barrier should be eradicated before it is too late.

A human-centred approach

Applying a human-centred approach would enable designing the systems that reflect the needs of the end users. Making technology by people for people will significantly reduce adoption barriers and create an inclusive environment. In turn, this will help provide several socio-economic benefits, paving the way for the diversity of future talent and professionals to thrive.

Flight Crowd is developing its internal strategies and engagement programmes to increase access and participation, ensuring diversification of vision and voices. It has been collaborating with multiple organisations to deliver workshops and STEAM outreach activities. A step towards this direction was to have its Industry Research Lead be a part of Project Falcon 2. Following from this Nurina will contribute more closely to the project by interning with the RAeS as a project co-ordinator.

> “THE FUTURE FLIGHT ECOSYSTEM SHOULD BE BUILT ON DIVERSITY AND INCLUSIVITY FROM THE GET-GO, SO THAT EVERYONE IS ABLE TO PARTICIPATE IN A VARIETY OF ACTIVITIES AND HAVE A SAY IN THE WAY THE INDUSTRY IS BUILT

Flight Crowd is already creating a variety of resources to ensure that all members of the public (from primary schoolchildren to experienced professionals) have a platform where they can 1) learn about the future of flight industry and 2) get involved in shaping the future of electric aviation.

An example of this is the collaboration with the National Saturday Club, where young people from disadvantaged backgrounds and under-represented communities took part in a Flight Crowd-led workshop. Students had a chance to learn how to pilot a drone, found out about the design and engineering aspects of a vertiport, and created their own vision of the future flight infrastructure. Flight Crowd is looking to further expand its portfolio to do more work on engaging with the disabled community and partnering with organisations, like Aerobility, to further promote an accessible future flight industry. Plans include bringing the benefit of the above and similar projects and workshops to students from the disabled communities to further excite their spirits about electric flight technologies.

We shall hear more of Nurina’s ideas and Flight Crowd initiatives in the next Future Flight Conference.

Airship resurgence

After several unsuccessful projects over the decades, airships finally seem to be on the brink of returning as viable green modes of transport of transport, for both passengers and freight. ALAN DRON looks at the return of lighter-than-air travel..

OceanSky plan to begin luxury 'air cruises' to the Arctic using the HAV Airlander in 2024.

Four years from now, the first passengers are scheduled to lift off in a mode of transport that has been almost completely in abeyance since the early 1960s.

Airships have periodically been put forward as returning to service in the intervening years, but only now does it appear that they will reappear in the skies over Europe.

The craft have long been mooted as a 'new' method of transporting heavy or outsize freight to remote locations, particularly in regions with poor surface transport infrastructure. However, it appears that, if final trials and certification go to plan, they will be used initially as passenger transports.

The UK-conceived and developed Airlander 10 is scheduled to complete certification in late 2024 and enter commercial service in 2026.

The 'hybrid air vehicle' – the company developing it shares that name – will initially be used for tourist flights, but Spanish regional airline Air Nostrum has reserved ten examples of the Airlander 10 to use as commercial airliners for up to 100 passengers. (See opposite page).

The later, larger, Airlander 50, which Hybrid Air Vehicles (HAV) aims to have in service by the early 2030s, will be a freighter, as will a French rival being developed by Flying Whales.

Return of the Airlander

HAV CEO Tom Grundy believes that the Airlander 10 is an idea whose time has come. Unlike traditional airships, the UK-developed Airlander is heavier than air and gains close to half its lift from its aerodynamic shape. That lift is combined with buoyancy from helium and vectored thrust from engines.

Hybrid Air Vehicles

> HAV CEO TOM GRUNDY LIKENS AIRLANDER AS BEING LESS LIKE A SLOW AIRCRAFT, MORE AKIN TO A FAST SHIP

Also different from traditional airships is that Airlander lands on large 'skids' below the envelope. Traditionally, airships have tied up to a mooring mast above the ground; being able to load and unload passengers and cargo at ground level makes this a much easier process.

Airlander is currently powered by four combustion engines. Even these produce 75% fewer emissions than an equivalent aircraft, but HAV plans to replace the first two, then all, of the engines with electric motors in coming years, cutting emissions to zero.

Grundy describes the aircraft as "production-ready" and advanced discussions are under way with local authorities in South Yorkshire to build a factory there. He sees Airlander 10 as having three main roles: passenger transport, freighter and, in military service, surveillance.

He believes that one niche transport role Airlander can fill is carrying passengers over geographic impediments, such as bodies of water. For example, flying from a location in northwest England to Ireland will be only slightly longer than taking a conventional aircraft. Airlander is significantly slower than a conventional passenger aircraft but can offset this disadvantage by

AIR NOSTRUM

In what may be a breakthrough development for HAV, Spanish regional airline Air Nostrum, has signed up to acquire the Airlander 10.

The airline is a part of an organisation that has interests in several different forms of transport, including high-speed trains and is considering using the Airlanders to create a new route network of towns and cities that do not currently have an airport.

The company announced in June that it had reserved ten of the platforms, with the aim of starting passenger operations in 2026. "We like to think of ourselves as a mobility platform. We are interested in any vehicle that can serve the purposes of our business," Air Nostrum vice-chairman, Miguel Angel Falcon said at the Farnborough Airshow in July. "We have regional jets for longer distances, turboprops for shorter distances and now we have Airlander."

Air Nostrum, which describes itself as Europe's largest privately owned regional airline, currently operates a fleet of more than 30 MHIRJ (formerly Bombardier) regional jets, plus five ATR 72 turboprops. "We fly aircraft between 50-100 seats. The Airlander 10 can seat 100 passengers, so it fits perfectly."

The airline is looking at opening up new destinations, making use of the Airlander's ability to land on any flat piece of ground, or even water: "We could consider flying into a city with a harbour, rather than an airfield. It opens up a lot of opportunities in terms of route network."

The Airlander 10, which is powered by four combustion engines – which will switch to electric motors later this decade, thus making it 100% emission-free – has a maximum speed of 80mph. Falcon does not consider this modest top speed a disadvantage.

"We appreciate it's not a fast aircraft. It's quite adequate for our average stage length," he said. The airline's average stage length is 500km, but contains a segment of routes of just 200km.

The Airlander 10 will be capable of carrying 100 passengers in a large gondola under the envelope. Renderings of the cabin show seats considerably larger than those of aircraft. This, combined with large picture windows and extreme sustainability – an increasingly important factor for passengers – will make the aircraft an attractive proposition for passengers, believes Falcon. The ability to board and disembark close to a town or city, rather than travelling perhaps 50km outside a city to an airport, will also be a plus factor, he adds.

Falcon also points to the aircraft's versatility, either in carrying cargo, or in serving the Air Nostrum Group's firefighting division in the surveillance role. "Our ambition is to be the leader of regional aviation in Europe. This fits perfectly."

A brief history of airships

Mention the word 'airship' to anyone and it is a fair bet that the first thing to pass through their mind will be the images of the fiery end of the Hindenburg at its mooring in New Jersey in 1937.

R101 wreckage.

Coming after the loss of the UK's R101 at Beauvais, France, in 1930, airships largely disappeared from sight, especially as the Second World War and the advent of turbojets made speed, rather than stateliness, the most important features of flight.

The CargoLifter CL160.

The only operator of airships – blimps, to be strictly accurate – during the war was the US Navy, which used them for anti-submarine patrols (and, throughout the 1950s, for airborne early warning).

In general, however, the only recent airships to impinge on the public's mind have been the Goodyear Blimps, which generally operate as aerial camera platforms at major sports events, and the Zeppelin NT (Neue Technologie) models that are usually operated for tourist flights with a capacity of up to 16 passengers.

There have been several false starts in attempting to bring the airship back into vogue. The one that came closest to succeeding was the CargoLifter CL160, a German project based south of Berlin in the late 1990s. This was intended to develop a heavy freight-carrying airship.

Considerable funding was ploughed into the project, but several iterations of the design meant that the project fell behind schedule. The delays meant that the company encountered the economic dip shortly after the millennium, exacerbated by the chill in aviation circles (following the 9/11 attacks) and the company ran out of cash.

operating from brownfield sites close to city centres, or even from water.

Grundy believes that the pandemic has changed people's preconceptions and they are now more prepared to look at new options in many areas of their lives, including transport. He likens Airlander as being less like a slow aircraft, more akin to a fast ship.

Airlander 10 will have a cabin the length of an Airbus A320, but rectangular in cross-section and considerably wider. Grundy says that the much greater cabin space compared to a conventional aircraft will allow operators to offer business-class seats but without business-class fares.

However, the initial use for the vessels will be luxury tourism, with 16-passenger configurations allowing for overnight journeys: "We've got three aircraft that are going to be serving the needs of a small group of customers, each of whom has reserved time on board."

The much larger Airlander 50, meanwhile, will be capable of handling up to six standard 20ft shipping containers. "How much air freight really needs to be flying at 500mph?" asks Grundy. He foresees containers being transported from docks to inland points – returning to the oft-suggested plans for airships to move heavy or outsized loads to remote locations, particularly in nations with limited road or rail infrastructure.

Whales swimming in air

That is exactly the role envisaged by HAV's French counterpart, Flying Whales. "Our mission is to unlock remote areas around the world," said spokesman, Romain Schalck.

Those areas could be closer to home than many people realise. "In Europe especially, we have a dense weave of communications and we believe can transport anything we want, but that's not actually the case." Transporting huge windmill blades to the top of a hill, for example, can be problematic.

Moreover, in areas, such as northern Quebec (from whose regional government Flying Whales is receiving funding), French Guiana or Indonesia, "You have a big lack of transport infrastructure that prevents those regions or countries to develop what they'd like to develop and triggering social problems."

One reason for Flying Whales deciding to opt initially for a freighter was to cut the amount of time certification would take, compared to a passenger-carrying vehicle. "We knew from the beginning that working on a passenger version would take way more time to get certification and talking with EASA, we decided it wasn't the best way for us."

Flying Whales' LCA60T will be capable of lifting up to 60 tons in what the company describes as a cargo bay of unprecedented size (96m long). As well as lifting outsized cargo, Flying Whales is also

Flying Whales

The Flying Whales LCA60T airship.

in discussions with the UN's World Food Program over undertaking humanitarian missions.

The intention is that, when operating, the vehicle will not land; rather, cargoes will be winched in and out of the bay on slings.

The aircraft is composed of more than 7km of composite beams that form the backbone of the vehicle and anchor the propulsion points. It will be covered with technical textile panels.

The LCA60T's shape is the result of several complex compromises, says the company. Firstly and most importantly, good aerodynamic performance was required to combine a high cruising speed of around 100km/h with easy in-flight handling.

The propulsion system, which uses little energy but which is designed to generate 1.5MW for continuous operations and up to 4MW during peak performance, is designed to distribute this power to 32 electric motors at 7 propulsion points. This will allow the LCA60T to stabilise itself precisely above the operations area. In the absence of wings, power-generating turbines are placed inside the lateral winglets. The cockpit will be inserted into the front section of the airship and will accommodate a pilot and a loadmaster.

Flying Whales intends to make use of lessons learned by a previous airship project, Germany's CargoLifter CL160 (see sidebar). "We know the [CargoLifter] story pretty well and we have several people who worked with them," said Schalck.

"They got pretty far and [the project] was pretty advanced. One problem was that they wanted to have the perfect aircraft, able to do everything. Every time they found a new, interesting market segment to serve, they tried to modify the aircraft."

The French company is aiming for a maiden flight in late 2024, followed by around two years of ground and flight tests, culminating in certification. It believes there is a worldwide market for around 800 craft in its category. It hopes to produce 152 in the first decade of production.

Flying Whales has several 'commercial agreements', mainly with the wind turbine industry, that Schalck describes as "pre-contracts" that allow the company to plan for a certain volume of activity. "Today, that's the industry most interested in the solution and at the moment is the biggest market for us."

Unlike HAV, Flying Whales has opted to try to source funding from the public sector, as well as private interests. The French and Monegasque governments have joined the project, while the Quebec government has invested: "Since the very beginning we wanted to rely on both the private and public sector. We're not just developing a new aircraft, it's a new method of transportation."

Development costs are estimated at €450m. Perhaps, by the middle of the next decade, huge, airships moving passengers and freight silently above the world's cities once again. And perhaps people will look up and wonder: 'What took us so long to bring them back?'

The enduring duopoly

Only a decade ago, many predicted the end of the Airbus and Boeing duopoly with new airliner manufacturers entering the market. Today the 'Big Two' still dominate the landscape, but will they still be there in 2035? Analysis from Professor **KEITH HAYWARD** FRAeS FAAF.

Thanks to a combination of good fortune in capturing a wave of sales, and the perhaps culpable failings of its main rival, Airbus has begun to scoop up well over half of the key narrowbody airliner market. A combination of the A220 and A320neo is winning out over the still troubled Boeing 737 MAX 8 and uncertainties over its long-range variants.

Airbus, remember, has also been on the back foot with an initially half-cocked response to the Boeing 787, and has had to bite the bullet of the premature termination of the A380 programme, so what goes up can seriously come down. Building and selling civil airliners remains what John Newhouse called *The Sporty Game*. Decisions over the next generation of airliners, whose 'green' requirements will pose technological challenges greater than those of the jet age, are also pending with all sorts of unknowns about future demand if environmental factors lead to some form of demand management (flight rationing or other curbs on flying). This might fundamentally undermine the perennially optimistic business models based on the mantra of 'five per cent per annum for ever' prediction of traffic growth.

These issues, if persisting for some years, could have the effect of radically challenging the primary structural assumptions that have underpinned industrial dynamics over the past two decades: that is to say, the emergence and durability of the Airbus-Boeing duopoly.

This could open the door to a new major player – the ever-present Chinese. Or perhaps, given that the environmental problem is not about winning an individual competitive edge but protecting the viability of the whole sector, it could encourage co-operation to facilitate a systemic conversion of the air transport industry from dependence on a kerosene energy source to something more sustainable, both practically and ethically.

> CHINA IS THE ONLY REALISTIC THREAT TO THE AIRBUS-BOEING DUOPOLY AND THAT DEPENDS ON A RAFT OF 'IFS'

Building the duopoly

The current duopoly took a long time in building – over 50 years in fact. The rise of Airbus from yet another 'political project' to global commercial powerhouse is well known. It remains moot whether the consistent support of European governments contributed to the parallel narrowing of the US civil aerospace industry.

The cry of 'unfair subsidies' has certainly accompanied the rise of Airbus from the 1980s, but the exit of Lockheed and then McDonnell Douglas cannot be entirely blamed on the absence of government support. More positively, the success of the A320 family, the core of Airbus' contemporary market power, rests on a degree of technological innovation, initially dismissed by both Seattle and Long Beach as unnecessary and over-elaborate. The sad saga of the Boeing 737 MAX is one of stretching a 40 year old design at least one step too far under pressure from a management more concerned about shareholder values than technological innovation.

In passing, if the launch of the original Airbus A300 was fraught, nearly killing the project at birth, the British government (or at least the Treasury) also came within an inch of torpedoing the A320.

Since the turn of the century, the world's commercial aerospace industry has, thus, been shaped by the battle between Airbus and Boeing. This duopoly has remained the dominant model for the past two decades. Airbus' absorption of the Bombardier C-Series into the A220 increased supply-side concentration but, until recently, the overall market share has shown little movement across roughly a 10% range between the two companies.

The duopoly has not led to what classical economists term 'collusive behaviour' to fix

Below left: Airbus' A380 has ceased production with the final one delivered to Emirates on 16 December 2021.

Below right: The final ever Boeing 747 is due to be rolled out before the end of 2022. With the A380 programme terminated in 2021, both of the 'Big Two' are focusing on smaller more efficient airframes.

Airbus

Boeing

prices. Anti-trust watchdogs on both sides of the Atlantic have kept a close eye on any cartelisation tendencies. There has also been enough intrinsic rivalry and an asymmetry of competitive success across a broad family of products to keep prices sharp. For example, Airbus long accused Boeing of exploiting its monopoly at the end of the market dominated by the 747, but that issue has faded away.

Barriers to entry

The civil aerospace sector offers many wide-ranging economic benefits, especially to governments looking to move up into the higher value aspects of manufacturing. At the same time, the barriers to entry are formidable in terms of technological complexity and, perhaps more important in the long term, building up a reputation for product quality and support that convinces airlines to buy the product and to return as repeat customers.

Europeans, predominantly France and Britain, found that even with the right design (worse still if, as in many British cases, with too narrowly conceived products) it was a struggle to make and to maintain a market breakthrough.

This, of course, drove the collaborative logic underpinning Airbus, reinforced by an organisational format that offered a solid guarantee of corporate resilience and satisfied reluctant customers that the Airbus 'system' would be around long enough to deliver and to support its aircraft.

It should be noted that these conditions are even tougher in the civil engine sector, with still only three suppliers dating from the 1960s. Notably the Russian civil engine sector has failed to deliver a world-class product, and the Chinese will struggle to match an airframe with an indigenous engine.

It has not stopped countries from trying, usually employing a 'European' style of government-supported programmes. Japan has made several attempts to break into the civil aerospace business. In the 1960s, investment in a military aircraft to further its civil ambitions triggered US countermeasures. However, Japanese civil aircraft proved to be commercial failures and Japan has, so far, had to be content with being a high-quality, risk-sharing partner under Boeing leadership. Taiwan had a flutter, with MDD as a partner but that too soon fizzled out. Brazil has stayed within more modest means and has had some success with Embraer's range of small-medium airliners.

COMAC

Above: COMAC's C919 took its maiden flight in May 2017 and the first production example is headed for Chinese carrier OTT Airlines.

Chinese aspirations

China is the latest contender aiming to break the Airbus-Boeing duopoly. This is the most serious challenge to the 'Big Two', with an emerging economic superpower to pay for the technological acquisitions needed to match Western aircraft. It has, in principle, a domestic market large enough to launch a range of civil projects – and a central government with the power to command Chinese airlines to buy the domestic product, even at

some cost to their competitiveness. It also has a broader strategic commitment to indigenous military aircraft development, which has historically accompanied every major civil contender. While the direct transfer of technology from military to civil development has diminished, there is still a useful set of common basic technologies and, perhaps more importantly a research and personnel infrastructure available to support either aspect of the business.

Finally, the Chinese government has so far shown a commitment to the long term that is largely compensating for the technical inadequacies of the COMAC C919 and earlier attempts to build a viable airliner.

United Aircraft Corporation

The C919 is the first Chinese-produced narrowbody airliner and received its type certification from the Civil Aviation Administration of China (CAAC) in September 2022. Originally started as a project in 2008 with a targeted maiden flight in 2014, it would be plagued with budgetary overruns and technological issues that meant it was May 2017 before the prototype finally flew.

A hint of future co-operation with Russia to develop a widebodied CR929 would add to the potential of breaking the duopoly over the next decade. Notionally set to fly in 2023 (it is now delayed until 2030 at the earliest), the CR929 would incorporate several key Western-built subsystems. However, Ukrainian war sanctions have forced their Russian partner to rethink this approach, but the Chinese still want to go ahead with internationally sourced equipment, if only to improve its marketability outside of the launch nations. There are also tensions between COMAC and the United Aircraft Corporation over work sharing (there is nothing new in that if one remembers the history of Airbus). This state of affairs does not bode well to see an alternative 'family' of airliners any time soon.

In general, even without the troubled CR929 to complicate matters, China will still struggle to break into wider world markets, although list price discounting may attract orders from some of the world's financially poorer airlines or those dragooned into orders by governments looking to secure aid under the Chinese 'Belt and Road' initiative. A commercial support system may yet emerge, but this will be a major problem at least in the short term for Chinese airliners hoping to make a sustained bid for global market share.

Above: United Aircraft has re-engined the original Pratt & Whitney-powered Irkut MC-21 (right) with a pair of Russian PD-14s in reaction to tightening economic sanctions by the West.

What if market share slips?

So far, the assumption has been that the duopoly remains stable, or perhaps evolves into an oligopoly similar to the engine sector. But what of an 'Armageddon' scenario where one of the 'Big Two' suffers a major or catastrophic business crisis?

Both Airbus and Boeing have faced difficulties in recent years. Airbus has had to face up to the commercial failure of the A380 and the financial problems associated with the A400M military transport fixed price contract. These, and some problems with the A350, have caused major headaches in Toulouse and the threat of World Trade Organization sanctions may also limit, even if

asked for, future government assistance to launch a new project.

Airbus as a company is also heavily dependent on the civil sector, with few world-beating products and a problematic future beyond its share of Eurofighter. It does not have a foothold inside the US defence market which, despite current problems with some programmes, still benefits Boeing hugely. The Airbus Helicopter division historically does well but revenues are modest, compared to a healthy combat aircraft sector. Still, like Boeing, huge civil order backlogs afford a useful cushion against further market setbacks.

Boeing's position is arguably more critical. Continuing access to the huge and well protected US defence market will always help Boeing, even if it has taken a recent hit costing over $1bn from DoD and NASA programmes. However, there is a view that once civil market share drops substantially below 50% (Airbus currently leads Boeing by about 10% in terms of overall sales), the follower tends to lose economies of scope and scale, adding costs and losing agility to ramp up if and when sales pick up. The effects flow down the supply chain, with similar problems hitting smaller companies especially hard if they have expanded in anticipation of higher production rates.

In Boeing's case, the situation is eased by the sheer size of existing backlogs. These are unprecedented in modern market history (and, of course, applicable to Airbus as well). Breaking down the market into segments also reveals, all things being equal (that is, if problems with the Boeing 787 are fully resolved and no other horrors are lurking in the wings), Boeing still has a 5% market lead in the higher value widebody market slots. The US company has so far captured over 70% of widebody sales and there are signs that the widebody market has begun to recover from its Covid crisis.

Narrowbodies

This is not to downplay the gap in the narrowbody market, which Airbus currently leads by 15%. Here, volume provides the profits (assuming efficiently delivered products) but it does give Boeing some breathing space and the continued buoyancy of civil sales overall are seen as compensating for current problems in its defence business. Nevertheless, aerospace industry analyst Charles Armitage feels that Boeing will not recover overall parity for at least two years and this will depend on a full recovery in the 787 programme and a successful launch of an upgraded 777.

In the longer term, Boeing faces continuing issues to compete more effectively in the narrowbody segment. Even if the MAX 8 does claw back a bigger share of the market, the 737 design must have finally reached an end of its 40-year saga (although a 4,000-unit backlog may help). Continuing political and regulatory problems with China – a major MAX 8 customer – will also affect deliveries.

The crux of the matter is that Boeing needs an all-new aeroplane somewhere in the lower end of its family sooner than Airbus. In short, while

Mitsubishi Aircraft Corporation

Above: Japan's Mitsubishi Regional Jet (MRJ) first flew in 2015 but development was halted indefinitely during the pandemic.

we should not write Boeing off just yet, its new management team will have to do rather better than its predecessors.

Achieving carbon neutrality

Airbus still has room for further updates of the A320/220 designs but both it and Boeing will soon face decisions on alternative fuelled airliners, a situation also dependent on the engine companies and problematic choices between sustainable alternative fuels (SAF) or hydrogen. Electric propulsion may not be much of an option other than providing ancillary power for the bigger airliners.

Pessimists (this author included) conclude that in the short term – measured by the current carbon neutrality targets – demand management may be unavoidable, either through price or ticket rationing. If implemented on a large scale, this would constitute a challenge to the fundamental air transport economics of the past 60 years. Again, this has rested on assumptions of pretty well consistent growth of 5% per annum forever – allowing, of course, for unforeseen and limited time events, such as a pandemic.

In the worst-case scenario, some of the backlog cushion might melt away as capacity needs fall, leaving both Airbus and Boeing more vulnerable and stretched to finance the launch of all-new 'green' designs. Even a moderate fall in the rate of growth, let alone a fall, would be painful throughout the civil aerospace sector.

Sukhoi

Above: Despite entering service in 2011, fewer than 200 Sukhoi SSJ100 SuperJets have been produced. Sanctions against Russia could offer an opportunity for domestic sales but, with Western content accounting for 60% of the original SSJ100, the manufacturer is 'Russianising' the airframe as the SSJ-New variant.

There are no easy routes to sustainable aviation. Achieving anything like carbon neutrality implies a comprehensive shift in the basis of modern civil aviation; there is as yet no grand consensus on a solution that has implications for every aspect of the air transport system infrastructure.

Kerosene remains the most energy-efficient source of fuel for aviation and the opportunity to make a special case for aviation in environmental policy terms is long gone. Hydrogen is probably the most likely approach as the ultimate solution, but not for several decades, and with greater implications for both the air and ground elements of the system. Although there are some promising lines of work, SAF still has drawbacks, especially if its sources compete with food supplies, but it might offer a transition route to more viable alternatives.

In these circumstances, if the Chinese are still in the market, a friendly and dedicated state-backer might prove a very advantageous asset. China might also delay shifting to a carbon-neutral aviation sector, allowing more leeway in developing new technology aircraft – perhaps waiting to see which of the alternative fuels becomes a global standard. On the other hand, the Chinese government, with an accelerated R&D programme, might sense an opportunity to 'leapfrog' into a kerosene-free environment.

Either way, China is the only realistic threat to the Airbus-Boeing duopoly and that depends on a raft of 'ifs'. I would not bet against either of the current market leaders, but the next few years are likely to prove challenging for both.

Bracing for the future

NASA discussed its sustainable aviation overview and plans for a truss-braced wing X-Plane during the RAeS Applied Aerodynamics Conference. STEPHEN BRIDGEWATER reports.

The RAeS Applied Aerodynamics Conference took place at 4 Hamilton Place on 13-15 September with delegates from around the world also viewing the live feed. The highly successful event included presentations as varied as: 'The FCAS Challenge for BAE Systems Air: an Aerodynamics Perspective' by Ian Whitmore (Senior Specialist in Aerodynamics at BAE Systems Air); the 'Smooth Body Separation Experiment' by Boeing's Jeffrey Slotnick: and 'Geometry Modelling: Perspectives on 10 Years of Progress' by Nigel Taylor FRAeS (Capability Leader, Aerodynamic Tools & Methods at MBDA). Other sessions included spirited round table discussions, including one considering 'the future of wind tunnels'.

However, among the many fascinating speakers was Dr Richard Wahls, who spoke in detail of NASA Aeronautics' sustainable aviation overview. Dr Wahls is NASA's Sustainable Flight National Partnership (SFNP) Mission Integration Manager responsible for long-range strategic technical planning and he gave a fascinating insight into NASA's sustainable aviation efforts in the near- to mid-term.

While NASA Aeronautics is perhaps one of the best-known elements of the US agency – and the oldest, dating back to 1915, it is now the smallest part commanding just 3 to 3.5% of NASA's overall budget.

Over the last century the department has been at the forefront of aviation development and Wahls cited critical airfoils, winglets, the area rule, icing and air traffic management as examples of its diverse portfolio.

"Today, we are focused on sustainability, greater mobility and economic growth," explained Wahls. The agency is currently investigating high-speed commercial flight, including supersonic and hypersonic transport technology, as well as ultra-efficient subsonic transport and the urban air mobility (UAM) sector.

Need for speed

"In terms of hypersonics, we work closely with the (US) DoD," explained Wahls. "There's a lot of US corporate knowledge within the NASA staff that is important to the defence sector, but we still have to advocate to our Congress that the commercial side of our business reveals some of our knowledge to the space side of the agency. There are several start-up companies that are pursuing hypersonic transport [technology] and this is also where the X-59 low boom demonstrator aircraft is involved."

Below from left to right: An artist's concept of the transonic truss-braced wing aircraft configuration.

Boeing has also proposed modifying a McDonnell Douglas MD-80 variant as the demonstrator and has even suggested it could use the same airframe to test a series/parallel hybrid electric geared turbofan propulsor producing 1.5 MW (2,000hp).

A TTBW model in the wind tunnel at NASA's Langley Research Center.

NASA

"We are on schedule for a first flight early in the calendar year 2023 and it is really a large test article and our aim is to operate test flights over communities and we'll be out there measuring the acoustic response, analysing the data and recording it to ICAO international standards centres. The goal is to remove supersonic overland limitations for transport by the end of the decade."

NASA is also active in the development and evaluation of the UAM sector and Wahls described its work as focusing on "the safety of flight, the controllability, the acoustics of those vehicles and design tools." While there are more than 300 different groups working on very different concepts and Wahls surmised that "there's four or five, maybe six different architectures that they fall into, so we've been evolving our tools to be able to help that community."

Perhaps most crucially, the agency is currently involved in developing methods to integrate all areas of future flight, "from subsonics to potential super-high-speed flight to urban air to high altitude flight and even looking at what happens when [space] launch vehicles want to fly through airspace."

Subsonic priority

While the agency is engaged in this broad range of work, Wahls was keen to emphasise that its current priority was subsonic transport. "This is the backbone of air transportation, and that's not going to change anytime soon. It is also where most of the emissions are, where most of the impact on the environment occurs and is, therefore, key to a sustainable aviation future. So right now most of our budget is [being spent] in this area.

"Everybody has their own meaning for sustainability. A lot of people go straight to the environment and the natural world, which is important, but I think you really have to consider sustainability from the perspective of society, business and economics too. The reason we have aircraft is to provide value to people, to allow businesses to operate and make money. If you can't meet all those requirements and protect the environment, then you're not going to be sustainable."

> THERE'S NOT BEEN ANYTHING LIKE THIS IN THE CIVIL WORLD SINCE BOEING FLEW THE DASH 80 (707 ANCESTOR) IN THE 1950S – THIS IS A BRAND-NEW CONFIGURATION THAT IS INTENDED TO BE A REAL GAMECHANGER

He also emphasised that while the environmental impacts of aviation are generally thought of as CO_2 and water emissions, as well as the depletion of fossil fuels, it is worth remembering that aircraft noise also impacts the environment. Likewise, Wahls was keen to point out that any 'emissions' from an aircraft also need to factor in the energy used to produce both the aircraft itself and its method of propulsion, saying: "The whole lifecycle of the energy, the environmental impacts of how you create the energy, how its transported and how to use it in the aircraft need to be accounted for. People talk about pure electric aircraft but you have to remind them that depending on where in the world you charge the batteries it can be 'dirtier' than jet fuel."

Braced for the future

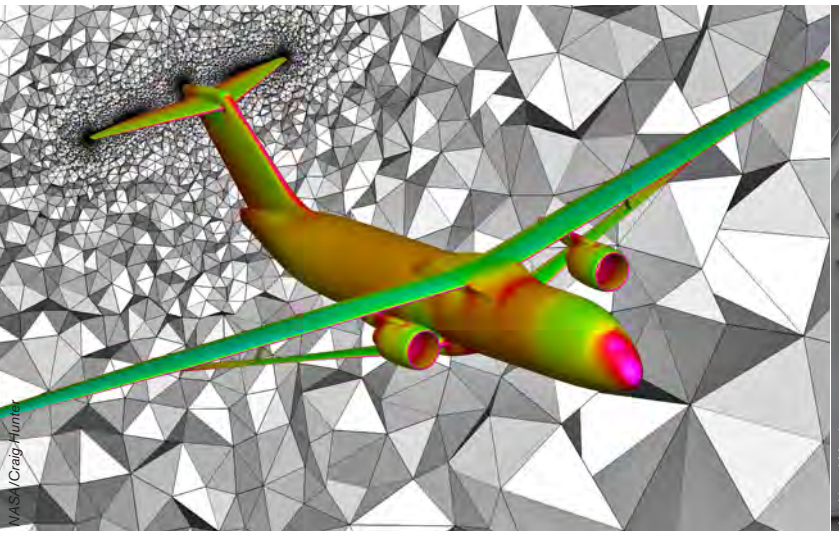
NASA's current focus is its transonic truss-braced wing (TTBW) concept, which has been undergoing wind tunnel testing at the Ames Research Center in California.

The TTBW's extra-long and thin wings are stabilised by diagonal struts that NASA says should make it lighter than a traditional airliner and create less drag. The agency proffers that the TTBW – which forms part of its sustainable flight national partnership – will burn 8-10% less fuel than aircraft with a traditional wing design. "The exact configuration hasn't quite been selected for the demonstrator at this point," explained Wahls, but what you see in the artist's impressions is a leading candidate.

Testing in the wind tunnel has advanced the TTBW to Technology Readiness Level (TRL) 5 "but the idea is to do 'honest to God' TRL 6 integrated demonstrations and get key technologies in the hands of industry to get them on products as soon as we possibly can because time matters. To have a realistic chance of doing that you have to do the big expensive, integrated demonstrations."


NASA


Harlen Capen / NASA


NASA/Craig Hunter


Lockheed Martin

From left to right: A digital rendering of NASA TTBW, created using data from a computational fluid dynamics simulation. The red and violet colours show areas of higher drag, and the green and blue show areas of lower drag. The triangular cells represent airflow around the aircraft.

In addition to TTBW X-Plane, NASA is also preparing to fly its X-59 QueSST demonstrator to evaluate quiet sonic boom technology. The aircraft is being built by Lockheed Martin's Skunk Works facility in Palmdale, California and is seen here undergoing structural stress tests in Fort Worth, Texas.

"We're [also] working on advanced engine efficiency and emission reduction, airframe efficiency and manufacturing rate times. We're working on integrated trajectory optimisation and we're supporting the use of 100% SAF. We think that with these contributions we can make a generational leap, skipping an evolution where instead of the next aircraft being 15 to 20% better it can be maybe 25 to 30% better or more."

Of course, many of these proposed developments are far from new and Wahls admitted that NASA has been evaluating subsonic transport technology for decades. "The subsonic fixed-wing project (SFWB) was created 15 or more years ago now and the study looked at advanced concepts aimed at the early 2030s."

"This is where things like electrified propulsion really became a thing for transport aircraft," he continued. "There was a hybrid electric contract with Boeing and General Electric that introduced what was called the H fan [and] it started off the Environmentally Responsible Aviation (ERA) project that took some technologies and did higher TRL demonstrations."

However, budgets and changes in US administration meant NASA was unable to commission a full-sized demonstrator to validate the study. "In my career I've seen us get close to a full-scale 'X-Plane' four or five times," admitted Wahls, "but then you don't get enough funding."

X-Planes

However, things have changed in recent years and NASA's X-59 QueSST (Quiet SST) aircraft is expected to fly in early 2023.

Meanwhile, the SFWB spawned five different concepts – three of them blended wing vehicles, one 'double bubble' design and an airframe with a truss-braced wing. Speaking during the RAeS Applied Aerodynamics Conference, Wahls confirmed that NASA was commissioning a full-scale X-Plane to validate the TTBW project's testing to date. "We're talking something the size of single-aisle transport roughly," he announced proudly. "This is not a 20ft remotely-piloted vehicle, like the X-48. That had a lot of benefit, but to really elevate the technology and find the unknown unknowns you've got to do something big."

He also confirmed that, as well as changing the airframe configuration, the programme would focus on small core gas turbine or highly efficient core engines, increasing the power density to help with future electrification.

The deadline for proposals to produce the TTBW X-Plane was 1 September and during the conference (on 15 September) Wahls said NASA hoped to announce the award of contract(s) by "the end of the calendar year or early next calendar year. We'll set off on a path to create this integrated technology demonstrator, which will be something that looks completely different to the low cantilever wing with underlying engines configuration we are used to."

He went as far as claiming: "There's not been anything like this in the civil world since Boeing flew the Dash 80 [707 ancestor] in the 1950s – this is a brand-new configuration that is intended to be a real gamechanger."

NASA has been maturing technologies for the TTBW for many years with emphasis on areas, such as buffet boundary icing and high lift system integration, but there is more to do and this is where the full-scale flying demonstrator comes into its own.

"High-rate composite manufacturing" is also a focus with Wahls telling the conference audience: "we're focusing on single-aisle transports because that's what's most ready for kind of a radical change – but you need to be able to build them fast if you're going to be at that market having impact."

Whereas funding could only be secured for a scale demonstrator of the X-48 blended wing body aircraft, a full-scale X-Plane is planned for the TTBW programme.

Dr Richard Wahls addresses the RAeS Applied Aerodynamics Conference at No 4 Hamilton Place on 15 September.

"Pre-pandemic, manufacturers could roll out metal single-aisle aircraft at a rate of 60 per month but just ten composite aeroplanes. We must be able to get composite aeroplanes out quicker into the fleet, so that's also a focus of this project. The High Rate Composite Aircraft Manufacturing programme is looking at thermal sets, thermal plastics and resins that have some legacy to TRL 3. This isn't where we go to look at exotic designer materials, nanotubes and the like; we're looking at things that we can transfer into industry pretty quickly."

Future propulsion

When it comes to propulsion, Wahls told delegates that NASA was working on increasing the efficiency of bypass ratios. "We have a project called the hybrid thermally efficient core (HyTEC) and there are contracts right now with Pratt & Whitney with the General Electric at TRL 4 & 5 level. There'll be a phase to down-select to an integrated TRL 6 engine ground demo. The key component of this is the hybridisation – being able to achieve the thermal efficiency but also to extract a percentage of the power to be used in other parts of the aircraft. This could be back into the propulsion system if we were to pull it off, store it in a battery and then put it back in when it's needed."

Although currently unrelated to the TTBW programme, Dr Wahls also touched upon NASA's experiments in electrified propulsion. "We have three products that are working towards this," he revealed. "One is working further out beyond the next generation."

NASA's Electric Aircraft Test Bed facility at Glenn has the capability of allowing developers to test components and systems at simulated altitudes and this has led to two contracts with MagniX and General Electric. "They're both heading towards the PDR [preliminary design review] stage right now" confirmed Dr Wahls, "and the goal is to create megawatt class power trains and components and and fly them in 2025 timeframe. The megawatt class is important because we see that as the sweet spot for single-aisle commuter and regional aircraft."

SUGAR Volt

As these words were written there was still no news as to which company or companies had been successful in their bids to create NASA TTBW integrated technology demonstrator. However, Boeing originally conceived a TTBW concept as long ago as 2010 and has been working with NASA on the programme. The Seattle-based manufacturer's Research & Technology division unveiled its plans for a demonstrator code named SUGAR Volt in 2019 with the SUGAR acronym standing for Subsonic Ultragreen Aircraft Research. The Volt element relates to the fact that the aircraft would use two hybrid turbofans that burn conventional jet fuel when taking off, then use electric motors to power the engines while flying, a system Boeing claims would cut emissions by about 70% compared to average airliners today.

Crucially, the possibility of being awarded a NASA contract to develop new airliner technology could come at just the point where Boeing finds itself in a position where it needs a viable replacement for its 55-year-old narrowbody airliner design. Could the TTBW be the new 737?

With NASA's new X-Plane expected to be commissioned in the coming months, the inevitable question revolves around when can we expect the aircraft to take to the skies? "We have targeted having these demonstrations complete in the 2025 to 2028 timeframe," confirmed Wahls during his time at the RAeS. "We need to do that if we want to have impact by the mid 30s. But the really good news – the exciting part of this – is that everything is funded and active and working. It's not a dream. It's happening."


Honeywell

Electrifying, but challenging: The path to sustainability

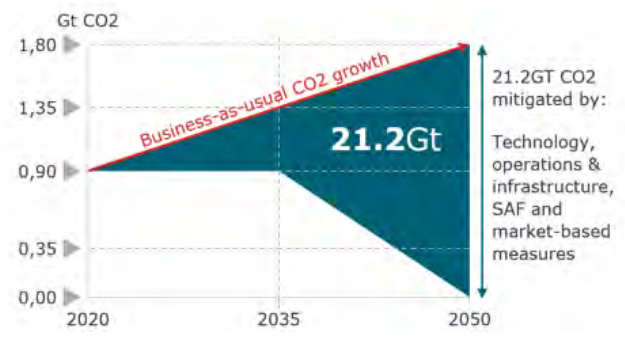
Alix Partners' Managing Directors PASCAL FABRE and MICHELE MAURI, along with Directors JAMES ELLIS, DOUGLAS MCIVOR and MATTEO PERALDO, reflect on what the aerospace industry needs to do to achieve its sustainability pledges.

As the global aviation industry re-emerges from the impact of the pandemic, focus has turned to accelerating the future of aviation and, critically, the topic of sustainability.

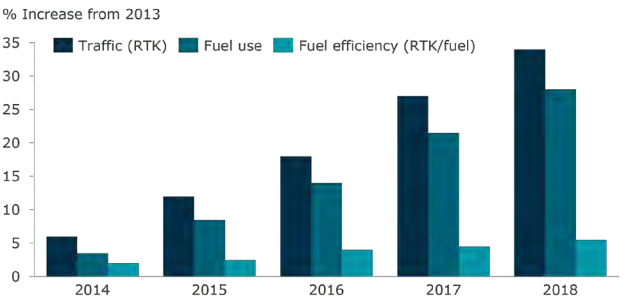
Last year, at the 2021 IATA Annual General Meeting, aviation recommitted to its plan to abate emissions by 2050. The goal is now aligned with the Paris Agreement of net zero carbon emissions by 2050 to limit the increase in global temperature to less than 1.5C by 2100.

In 2019, the global aviation industry was responsible for c.900 million tons of emissions. Commercial air traffic has increased nearly four times faster than fuel efficiency improvements over the last few years, and air traffic is expected to double every 20 years until 2050 – even after accounting for the effects of the pandemic.

While aviation has already achieved significant efficiencies over the last few decades – with each new generation of aircraft bringing up to 15-20% improvements approximately every 20 years – the ambitious target ahead demands a dramatic acceleration.



% increase in traffic, jet fuel use, and fuel efficiency, 2014 to 2018



As one of the five largest aerospace export markets in the world – and home to some of the largest and most crucial OEMs and suppliers in the value chain – the UK plays a critical part in driving forward progress. The UK government has also started to map out its own 'Jet Zero' strategy against the same target of 2050, with an accompanying investment flight path.

Given the size of the task ahead, the development, adoption, execution, and industrialisation of new technologies will critically define success towards 2050.

Existing aircraft and engine programmes are reaching maturity, and next-generation programmes in commercial and defence aviation are being defined now to emerge into the 2030s and beyond. The path ahead will require pulling on all available levers – some existing, some emerging – coupled with significant investment to help bring them to reality.

Unanswered questions

The challenge ahead is rich with unanswered questions:

- What key levers are available for aviation decarbonisation?
- Which technologies will emerge as gamechangers?
- What are the timeframes for introducing these technologies and will they affect all missions, from commuter to long-haul?
- Will governments force a roadmap toward net zero emissions through incentives and/or mandates?
- Who will fund the massive investments required in a context of interest rate increase, an indebted aviation value chain, and increased defence spending for governments?

To move forward, five key areas come into sharp focus, each of which can significantly contribute to an aviation decarbonisation roadmap.

> WITH COMMERCIAL CERTIFICATION ALREADY AVAILABLE, SAF USAGE IS GROWING, YET IT STILL ACCOUNTS FOR LESS THAN 0.1% OF TOTAL AVIATION FUEL CONSUMPTION

Fleet renewal

Fleet renewal is the most accessible lever to reduce emissions for airlines. Replacement of a maturing fleet with the latest generation aircraft can still bring 15-20% improvements in fuel burn. Only around 20% of current widebody and narrowbody fleets are latest-generation aircraft, but this trend will accelerate as we move towards 2030.

However, airlines continue to face difficult decisions on fleet renewal sizing, timing, and aircraft type focus as they weigh up headwinds on further air traffic recovery and movement into an uncharted new world of air travel, funding availability and priorities, and timing of when new breakthrough technologies may be available for extended fleet renewal cycles. This lever is, however, limited by airlines' current financial condition post-pandemic and will likely result in an even higher market share for lessors

Improved flight and ground operations

A reduction of up to 12% in CO_2 emissions can be achieved via friendly routing through shorter flights, flying at lower altitudes, formation flying, and a continuous descent approach. This goal could be realised in the medium term if there were to be alignment among relevant regulators, but pertinent projects, such as NextGen in the US and Single European Sky are extremely complex and have historically been slow to deploy.

Further improvements can come from reducing fuel-related emissions on the ground, including electric and hydrogen technologies. The key to success is to provide sufficient charging infrastructure for ground equipment and supply to aircraft to support efficient operations and maintain aircraft turnaround times. Challenges for operations in addition to turnaround performance include ensuring power supply at the point of use, handling

Below left: World Energy has announced plans to convert its existing facilities in Houston to a sustainable aviation fuel hub capable of producing 250 million gallons of cleaner jet fuel annually by 2025.

Below left: Earlier this year Airbus described the assembly of its EcoPulse demonstrator as 'well under way, paving the way for its first test flight later this year.' Based on the Daher TBM it has six distributed electric propulsion units and a new high-voltage Lithium-Ion main battery system.

World Energy


Airbus

of batteries/hydrogen, safety issues, and resilience against disruption.

Sustainable Aviation Fuel (SAF)

Maximum Addressable Emissions Reductions (MAER): up to 55%; Timeframe: current to 2030; Scope: A massive scaling of production is needed, to be secured by demand visibility; retrofittable. Sustainable aviation fuel (SAF) is not only the easiest available option but can be a real gamechanger. For the most part, it is a 'drop-in' solution – it can be used with existing airport infrastructure and with limited modifications of aircraft/engines, which are already certified for 50% SAF blends. SAF comes in biofuel form, which is produced from biological or renewable sources, such as waste oils or agricultural residuals, and synthetic form. Both Airbus and Boeing target certification of 100% SAF-compatible aircraft by 2030 for commercial aircraft (and for Airbus Helicopters)

To be widely successful, SAF requires a significant production increase, as well as price reduction – its current price is three to five times that of Jet A1. With commercial certification already available, SAF usage is growing, yet it still accounts for less than 0.1% of total aviation fuel consumption. Policies mandating a minimum percentage of SAF blend have been voted in in Europe, which will soon force airlines' hands and create demand for the massive industrial capacity investments required to bring down unit costs. The US has taken a different path with tax incentives favouring SAF usage. The UK has targeted at least 10% SAF blended in the UK jet fuel mix by 2030 and targets at least five SAF plants under construction by 2025.

Aircraft technology

New aircraft technologies and architecture can significantly reduce CO_2 emissions in the mid-to-long term only, while aerodynamics optimisation and use of next-generation materials can incrementally reduce CO_2 emissions.

FIGURE 1: BREAKDOWN OF SUSTAINABLE ENERGY TECHNOLOGIES

ENGINE TECHNOLOGY	ENERGY CARRIER/STORAGE			
ENERGY CONVERSION	Jet fuel	SAF	Electricity	Hydrogen
Combustion	Jet engine (Legacy)	Jet engine (SAF)	N/A	Jet engine (Hydrogen combustion)
Electric	N/A	N/A	Battery electric	Hydrogen electric (Fuel cell)
Hybrid electric	Combination of electric and combustion engine			

■ SAF ■ Hydrogen combustion ■ Hybrid electric ■ Electric

Source: AlixPartners analysis

Solution 1: New Airframe Shape & Configuration. MAER: 20%; Timeframe: 2045+; Scope: Widebody – Long-Range; not retrofittable.

Both major aircraft manufacturers have presented concept studies, with blended wing-body configuration designs one of the most promising options so far. Transonic truss-braced wings are another option – explored by Boeing. However, this solution brings hurdles of existing airport and traffic management infrastructure, which are designed for classic configurations – extending operational timelines into the medium/long term.

Solution 2: Optimised aerodynamics. MAER: 6% +; Timeframe: current to 2030+; Scope: Various; partially retrofittable. Further optimisation of aircraft aerodynamics through new technologies – including laminar flow on wings, aeroelastic wing configurations, and active aerodynamic flow control – will likely only incrementally improve fuel consumption while adding to operational complexities.

Solution 3: Next Gen. Materials & Composites MAER: 2%; Timeframe: current to 2030; Scope: all AC types and mission profiles; not retrofittable. Composites enable weight reduction of 20%, with a significant impact on fuel consumption. Sophisticated materials with the lowest specific weight (eg CFRP) already account for more than 50% of the weight for both 787s and A350s – a

Below, from left to right: Airbus has signed an MoU with Air New Zealand to research a hydrogen-fuelled aircraft, while in Europe Airbus will focus on hydrogen aviation infrastructure with Air Liquide and airport operator Vinci by 2030.

Boeing Transonic Truss-Braced Wing (TTBW) prototype will have a 170ft span ultra-thin wings supported by a truss which also provides lift.

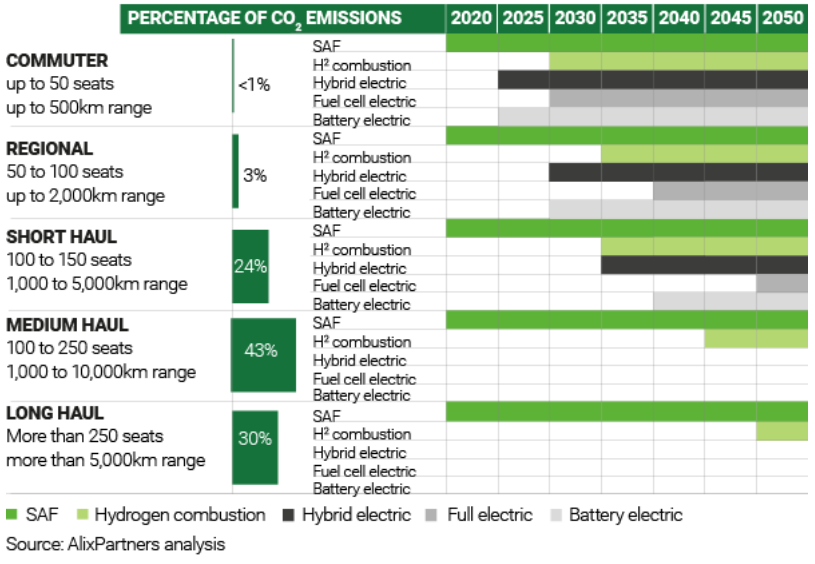
The shape of light aviation to come? Beam's EV-ARC solar-powered electric vehicle charging equipment can be moved from one airport to another and used on aircraft and cars.

German start-up Volocopter recently flew its craft from Italy's first advanced air mobility testing vertiport at Rome's Fiumicino Airport, demonstrating what a service between the airport and the city of Rome would

Airbus


Boeing

FIGURE 2: APPLICATION AND ESTIMATED COMMERCIAL AVAILABILITY OF DISRUPTIVE ENGINE TECHNOLOGIES



Source: AlixPartners analysis

huge step compared to the 1-2% for the 747 and 10% for the 777.

Propulsion technology (Next-gen jet engines)

Engine OEMs are driving performance-focused improvements in traditional jet engines, as well as new architecture – including geared turbofan, higher pressure, higher bypass ratio, smaller cores, advanced materials and open rotor concepts. Almost 40% of new-generation narrowbody engines that have come to market over the last five years use Pratt & Whitney's geared turbofan technology. An open rotor programme called RISE, which leverages hydrogen and promises fuel-burn reduction of 20% over present-day turbofans, has just been launched by CFM International. Key challenges to these solutions are around airframe resilience and ground clearance requirements, MRO requirements and costs, speed and noise impact.

Propulsion technology (liquid hydrogen combustion)

Hydrogen has a very high energy density fuel and can replace jet fuel in a conventional combustion engine with limited adaptations. While it also has added benefit of being lighter than jet fuel, hydrogen takes up around four times more volume – a clear challenge for aircraft configuration and the position of tanks in the aircraft. Other hurdles include the vast engineering challenge of building a cryogenic fuel distribution system on board the aircraft to take hydrogen from cryogenic tanks to the engine, and the huge storage and delivery infrastructure required at airports. Only 0.1% of global hydrogen production is currently carbon-free or "green hydrogen", so the challenge is also on the production side. Airbus is leading the industry with plans for hydrogen-powered aircraft to enter service by 2035.

Propulsion technology (batteries)

Increasingly well-established technology in automotive, batteries are an area which has attracted significant investment and focus in aviation.

Key benefits include high efficiency of electric powertrain with low noise – however, current industrialised batteries have low energy density which adds significant weight and sharply limits the range of applications and missions. There have been several successful test flights and many new ventures covering commuter aircraft, including retrofitting existing platforms, as well as new electric aircraft. There is also the red-hot part of air mobility – electric vertical take-off and landing (eVTOLs) – the first aircraft have been certified (Pipistrel in 2020), and several small regional aircraft projects – typically fewer than 19 passengers – are on the horizon, targeting entry into service in the 2020s.

Propulsion technology (full electric /fuel cell)

Fuel cells have the benefits of battery electric, but their first likely applications are not expected until 2035-2040. H2 fuel-cells present specific challenges,

Pipistrel


Volocopter


Airbus

Airbus has announced plans to test hydrogen fuel technology using a modified A380 as a testbed. It has partnered with CFM International, a joint venture between GE and Safran Aircraft Engines, on the programme.

including the development of durable aerospace-grade fuel cells and their performance and durability potentially limiting long-range applications.

Propulsion technology (hybrid-electric)
Combining traditional turbofans and electric engines can reduce emissions by optimising engine technology choice along the flight. Electric engines (battery or fuel-cell powered) can provide power during take-off and climb, allowing combustion engines to be made smaller and lighter and optimised for cruise flying. Several approaches to hybridisation are currently in development, which could bring electrification to larger commercial aircraft more realistically than full electric propulsion.

A concerted effort

The automotive industry has been forced to embark on an accelerated and very expensive decarbonisation transition because of strong government regulation and heavy fines driven by fleet emission levels. A concerted effort from the aviation industry, research institutions, governments, finance, and energy sectors is urgently required to avoid a similar situation. Sustainability targets are extremely ambitious and meeting them will demand substantial changes in mindset.

The challenging path to sustainable aviation will be very expensive and require support from governments in terms of research funding for new technologies, and a regulatory frame of incentives or mandates enabling an SAF production ramp-up, or hydrogen infrastructure. It will also likely result in more expensive air travel in the mid-term.

SAF development together with fleet renewals are the two cornerstones of the aviation decarbonisation roadmap in the challenging path towards net-zero in 2050. All players in the aviation ecosystem and value chain – legacy as well as new – must think ahead and articulate a clear strategy before it is too late to adapt. This becomes all the more challenging while the industry continues to face continued ramp-up and recovery, impact from labour shortages, cost inflation, and supply chain disruption/ constraints.

> ALL PLAYERS IN THE AVIATION ECOSYSTEM AND VALUE CHAIN – LEGACY AS WELL AS NEW – MUST THINK AHEAD AND ARTICULATE A CLEAR STRATEGY BEFORE IT IS TOO LATE TO ADAPT

Legacy players

For legacy aerospace players, OEMs and suppliers, several key success factors must be mastered to ride this new wave.
Strategy and operating model: Proactively prepare for what sustainable aviation means for the business from end-to-end – potential commercial models, implications for footprint, people, suppliers, and technology to deliver.
Investment: in the right technologies and based on a robust business case
Careful management of funding: Balancing current operating pressures with prioritised investment in developing next-generation technologies, through to industrialisation of technology to make them a reality (eg R&D, engineering approach).
Leverage partnerships: Work with agile start-ups to accelerate research and development and cover capability gaps. Ensure collaboration mechanisms are set up to leverage the potential of partners, with clear objectives and targets set.
Focus on talent and critical skill sets: Manage and retain the talent required to deliver advancements. Identify new and increasing skill sets needed (eg software, cyber security) to deliver requirements and ensure a pipeline of talent is in place with mechanisms to retain over the long term.
Supply chain: Redesign and ramp-up requirements reliably and at a competitive cost.
Clear digital roadmap: Detailing the transformation required to develop and deliver technology and operating model changes.
A systematic approach: Not only looking at the aircraft, the platform, and the engine, but at the overall aviation ecosystem (infrastructure, airport, fuel, etc.).
Mindset change: Consider this an unmissable opportunity to play a new role in the value chain, receive funding from third-party investors, and as a business development initiative.

Emerging players

For emerging and new players, the success factors are quite different – although securing the right talent and expertise will be a key common theme:
Focus not only on the technology: Consider the business model too, the operating model, and choosing to make versus to partner versus to buy. First flight is not the end game.
Secure design-to-cost principles early on in development: Embed modularisation and production scale goals from the start when degrees of freedom are still available. Digital design, manufacturing, and operations are competitive advantages to go to market at scale.
Secure funding: The road to certification and operation is a long and expensive one.

Further down the value chain, airlines, airports, and service providers will also need to look at how new transportation modes can impact their business and operating models, identifying both threats and opportunities to steer how their business and operating models need to adapt.

All players in the industry must continue to accelerate the development of clear and focused roadmaps that deliver the right mix of solutions in an efficient, reliable, safe, cost-effective, and sustainable manner. The road to a truly sustainable future for aerospace and aviation will be long, expensive, and challenging – but also, at its heart, critical and electrifying.

No.4

Hamilton Place

Christmas at No.4 Hamilton Place

Have you booked your Christmas party yet?

No.4 Hamilton Place is a magnificent setting for a Christmas party, in the great location of Mayfair. Many of you are aware of our beautiful venue, so why not hold your festive event with us.

We are offering a seated or standing package, so whether you would like a casual reception or a more formal seated option, we can provide either. Guests will be greeted by a beautiful Christmas tree on arrival, framed by our stunning staircase and the ornate features throughout the building lend themselves perfectly to a festive occasion.

Our Christmas packages include hire of either the Argyll Room & Terrace or the Bill Boeing Suite and a DJ to get the party started. Food is provided by our excellent in-house catering team, Blue Strawberry and varies from a traditional three-course dinner with all the trimmings, to receptions accompanied by canapés and bowl food. All packages include a glass of sparkling wine on arrival and drinks throughout the evening.

Don't forget we can also accommodate other events too, so if you are interested in holding a private or work event, please do get in contact with us at **hello@4hp.org.uk / 020 7670 4314/4316** to start planning your festive booking now.

No.4 Hamilton Place, London W1J 7BQ

Advertorial

Human-Machine Teaming Key to Aerospace Engineering's Digital-Driven Future

By Scott Fouse from AIAA

Machines that can surpass human intelligence? Today's artificial intelligence (AI) systems promise to outmatch certain aspects of human brainpower by developing thinking skills of their own. From digital twins to digital threads, aerospace systems are increasingly complex and AI-dependent. How do we find systems engineers (SEs) equipped to manage this complexity – while ensuring our growing reliance on AI doesn't replace us? Tapping into the full potential of the data revolution for aerospace systems requires us to leverage the best of machine learning models and human ingenuity by harnessing the strengths of each to achieve what neither can do alone.

The world has changed dramatically since I began working in AI and human decision support in 1984. The computational horsepower and the world's access to data have been game changers – and will no doubt lead to revolutionary breakthroughs in the next five to ten years. While some elements of machine perception have exceeded human performance, one area where machines lag is recognising and managing context – an area in which humans excel.

Great SEs have been exposed to multiple kinds of systems and bring all that experience to bear when tackling a new problem. How do we tap into SEs who have the right blend of experience in today's fast-evolving AI environment? To achieve this needed expertise in future aerospace systems will require human-machine teaming (HMT). The new AIAA Transformative System Engineering Task Force is looking at how we accelerate the skillsets of this new breed of engineers. This will be the topic of many sessions during the 2023 AIAA SciTech Forum in National Harbor, Maryland, 23-27 January 2023.

Successful collaboration between humans and intelligent machines depends largely on trust. But as you apply human trust to machines, you begin to anthropomorphize them, asserting other human-like capabilities that aren't there. It's better to view AI not as a human, but rather as a different kind of contributor with unique characteristics.

Additionally, as the aerospace community embraces AI, we must ensure we don't lose the art of design. Instead, we must leverage AI to amplify our ability to do design. Back in 1998, I worked with a car manufacturer that had embraced

digital design. They had become reliant on their automated design tools after ten years and they had lost the art of design, meaning they could only produce designs that the tools allowed them to do. This carmaker's experience serves as a wake-up call for the aerospace community to avoid similar mistakes on its own AI journey.

The future of HMT is both about changing the way we engineer the system, and the way we operate the system. AI in the cockpit is one of the factors that makes the systems engineering process so complex. Making AI systems more transparent, perhaps through explanation, will allow SEs to train alongside these intelligent systems. In the case of aircraft (or spacecraft) pilots, they'll develop instincts about how to work more effectively with this kind of intelligent support.

As we get more effective at developing digital system models, we'll become better at modelling and characterising risk. We are already seeing promising potential with digital twins and digital threads, which allow us to recognise potential design issues earlier in the process.

People are now looking at designing a digital twin of a human-machine team. Instead of only monitoring sensors on an aircraft, for instance, the digital twin also would model a pilot's workload and performance. If the digital twin sees that the pilot is experiencing overload, some tasks could be taken off the pilot's plate, with the AI acting as an intelligent co-pilot.

In 20 years, this will be the future of aerospace operations: leveraging human-machine teaming to accelerate design and engineering processes from conception to operational capability, resulting in lower costs for ever-more complex systems.

Afterburner

www.aerosociety.com

Diary

24 November 2022

Sleeping and Living in Space

Prof Siobhan Banks
Adelaide Branch

The Expedition 67 crew aboard the International Space Station pose for a photograph during a meal. From left: Denis Matveev, Dr Kjell N Lindgren, Dr Jessica Watkins, Bob Hines, Samantha Cristoforetti, Sergey Korsakov and Oleg Artemyev. ESA/NASA/Roscosmos.

Message from RAeS

OUR PRESIDENT

Peter Round

This month the first thing I want to say is thank you to those who have contacted me via **president@aerosociety.com** to comment on my column. It's great to get some feedback and to know that my monthly ramble is actually read. The communications channels all remain open so please get in touch.

The next month is filled with conferences and the opportunity to go to a number of Named Lectures, which gives me the chance to visit a number of Branches. I regret that I could not go to the October Branches Conference in Paris but it clashed with my daughter's 18th birthday and my family came first. I mention this because I see our Society as a family. In my mind, a family is somewhere we should all feel safe and supported. With all my previous mention of change I know that some of our membership feel unsettled and, as a result, perhaps not as safe and supported as they should be. Others, of course, are ready and waiting and asking why we cannot move more quickly. I don't think this range of positions is unusual in a family. Nevertheless, it is important that we realise that discomfort exists and those of us recommending the changes must be clear in explaining the reasons why we want change and take into account the views of as many stakeholders as possible. I assure you that the Council is not the only source of good ideas nor are we necessarily able to recognise all the risks and concerns. If I can be forgiven for part quoting Donald Rumsfeld, this is about 'unknown unknowns' and that's why I make my repeated call for comment and engagement. In my view, comment after the event fits into the same category as runway behind you.

> THE NEXT MONTH IS FILLED WITH CONFERENCES AND THE OPPORTUNITY TO GO TO A NUMBER OF NAMED LECTURES

As usual I am travelling and I write this from a seat on the Eurostar. It is a mark of the current difficulties of travelling around Europe by air, especially as a UK passport holder, that has driven me onto the train. In the past, a transfer at Schiphol Airport in 45 mins was entirely doable (not without risk, but doable). Today, its sensible to allow three hours if you have to pass through passport control. This is good news for a train company but rather less for the airline industry. We have reached a situation where it is quicker and more reliable for me to spend over two hours getting to London and use Eurostar or a direct flight than fly from one of the three regional airports within a quick drive of my house.

My reason for travel was to attend a defence and security conference in Brussels associated with my day job. Here I witnessed the rather contented expression on the faces of major defence manufacturers as they watched their product being used. The look was not just because of sales volume (although undoubtedly that played a part) but also about how effective and reliable their products were proving to be. This incredible capability has come about because of wise past investment, as well as a great deal of international co-operation. This is something we forget at our peril: international co-operation is a must. On that theme, let's take a moment now to remember all those who have lost their lives or suffered in pursuit of our freedoms and remind ourselves how, even in 2022, war has returned to Europe and our support for the Ukrainian people must be unfaltering. Returning to co-operation, I am glad to report that relations between the Society and its international partners are at a high and all the elements of the Society worldwide are as close to one another now as they have ever been.

I have not yet mentioned my themes for the year, but there is no escape:

- Looking after young prospects to bring them into our sector and sustain them thereafter.
- Making sure the Society is relevant and the go-to place for learned advice.
- Reform of the Society's governance.

Very near my words you will see a column by Lucy Price which gives an insight into her work as Head of Governance and Compliance. I urge you to read it and you will get an inkling into how complex it is to run a charity with a membership of over 26,000. I also ask you to take note of the plea to stand for Council. As a member you are already a supporter; just go the extra step and become a volunteer. If you want to talk about what is involved then Lucy, any Council Member (past or present), Dave Edwards or I will happily chat it over.

FROM THE EXECUTIVE TEAM

Lucy Price – Head of Governance & Compliance

This month marks my one-year anniversary of having started work at the Society as the Head of Governance and Compliance. Previously, I worked for the Engineering Council as the Licensing and then as the Governance Manager. In those roles, I was always impressed by the enthusiasm and professionalism of the volunteers and staff from the Royal Aeronautical Society. It was clear this was a membership who knew what they were doing and could get stuff done.

Over the past year I have been getting my feet under the table, learning about and providing secretariat for the Board of Trustees, Council, Nominations Committee and Audit Committee. We have been navigating the joys of technology in hybrid meetings, largely successfully, as well as conducting a Governance Review.

You may remember that in May there was an article in *AEROSPACE* where we asked for your feedback on proposals to changes to the Society's governance. I would like to say a big thank you to everyone that provided feedback on the Governance Review proposals and particularly the Governance Review Steering Group, who had the unenviable task of going through the By-Laws line by line. It was due to their diligence that the Trustees have been able to approve draft revisions. As we hold a Royal Charter, we are required to consult with the Engineering Council and Privy Council about changes to our Constitution. We are now awaiting their feedback before we can share the changes with you, the membership, via a Special General Meeting. Next month, we will provide some more detail on the proposed changes to keep you all in the loop. The changes should make the Society more open, with more members able to vote and a clearer route to applying to some key voluntary roles.

The Nominations Committee has been reviewing its role in the Society as a part of the Governance Review. In the future, the Committee wants to focus on bringing talent into the Society and will have a role in managing the processes around recruiting key voluntary roles. The Committee has also been working on identifying what skills are essential and which are desirable for the key voluntary roles across the Society, such as the Trustees and Chairs of Boards and Committees.

The Nominations Committee is also responsible for providing nominations for the UK Honours List. If you know of an individual in the aerospace, aviation or space industries who has gone above the line of duty in their day job to serve and help others, then contact me on **governance@aerosociety.com** and the Committee can potentially help with the nomination. However, remember, the key rule with nominations for UK Honours is not to tell the individual concerned.

The role of the Audit Committee is to support the Trustees in monitoring the adequacy of the Society's governance, risk management and control processes through offering objective advice on issues concerning the risk, control and governance of the Society and associated assurances provided by internal audit and other processes. This year, the Audit Committee has, thus, been developing the risk review and internal audit processes, as well as reviewing some key policies, such as whistleblowing and declaration of interests.

I would like to encourage everyone reading this to please consider running in the Council Elections next year. Or if you are not able to, please encourage your colleagues and friends that could provide their viewpoint on the sector and the Society. Your views will be better represented in the strategic debates of Council if you join in. We need your support but also critiques to help make the Society achieve its objectives and serve you and the general public better.

Council meets four times a year in March, June, September and November. The meetings are hybrid so members can join virtually if they are not able to meet in person at No.4 Hamilton Place. Members are provided with an agenda and papers at least a week in advance of the meeting, but preferably two, and therefore have the opportunity to prepare for the strategic topic to be discussed. Council members are also encouraged to participate in other important work across the Society, as much as their diaries permit!

Nominations close at the end of January, which will soon sneak up on us. Members are then given the opportunity to vote over March and April until the AGM at the beginning of May. If you have any questions please don't hesitate to contact me at **governance@aerosociety.com** or to apply please visit: **www.mi-nomination.com/RAeS2023**.

Finally, for those parts of the world observing Remembrance Day this month, I join you in expressing my gratitude to all those who have lost their lives in service. I am very appreciative of the freedoms I enjoy as a result of their sacrifice.

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> I WOULD LIKE TO SAY A BIG THANK YOU TO EVERYONE THAT PROVIDED FEEDBACK ON THE GOVERNANCE REVIEW PROPOSALS AND PARTICULARLY THE GOVERNANCE REVIEW STEERING GROUP

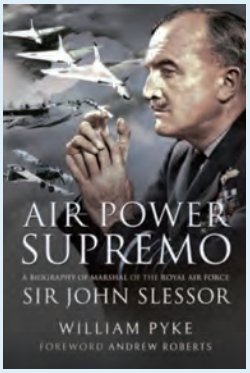
Book Reviews

AIR POWER SUPREMO

A Biography of Marshal of the Royal Air Force Sir John Slessor

By William Pyke

Pen & Sword, 2022, 288pp, £25, Kindle £7.99.



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William Pike's biography of outstanding British airman, Sir John Slessor, is thoroughgoing and authoritative. In fact, after reading Pyke's excellent account, one wonders why Slessor should have had to wait so long for a biography of this calibre. It is hard to think of another figure whose service spanned two world wars and the nuclear age. His distinguished career started in the second year of WW1, a conflict where he became a decorated airman, gallantly fighting with frail aeroplanes bearing hand-held projectiles, continued with crucial operational commands and establishing close relationships with those concerned with Anglo-American aerial strategy, before culminating in the championing of British jet-powered V bombers carrying nuclear weapons. He retired in 1952, after serving for 37 years and achieving the rank of Marshal of the Royal Air Force.

Following a thought-provoking introduction, its 15 main chapters take us along a measured but comprehensive chronological journey through Slessor's remarkable service life. In the course of this we are led to believe that he was the thinker on strategic aviation that Bertram Dixon might conceivably have been, had he lived longer, and that he was undoubtedly more coherent than the RAF's great champion and Slessor's early mentor, Hugh Trenchard.

Neither, of course, were privileged to be at the centre of British strategic defence policy in the early part of the nuclear age, and William Pyke's book is timely in that hostilities in Ukraine have once more raised questions about whether nuclear weapons are *per se* apocalyptic, or whether they can be seen in terms of graduation beyond conventional weapons. Here Pyke draws attention to Slessor's prognosis that, as the ultimate sanction, the thermonuclear option is only to be used "when great nations are mortally threatened [as] it is by its nature an unlimited instrument."[1] Although, as a pragmatist, he understood that there would be local wars, like Korea, below the nuclear threshold.

To the benefit of the world, Slessor's optimism about deterrents preventing thermonuclear war has held. However, as Sir Michael Howard observed 19 years after Slessor's death, the essential problem with such Cold War reasoning and with others of the same persuasion is the credibility of the West's first use of the nuclear option in defence of its vital interests. This debate continues to the present day, and Michael Howard acknowledged that, as a thinker, Slessor "was indeed, a truly great man."[2]

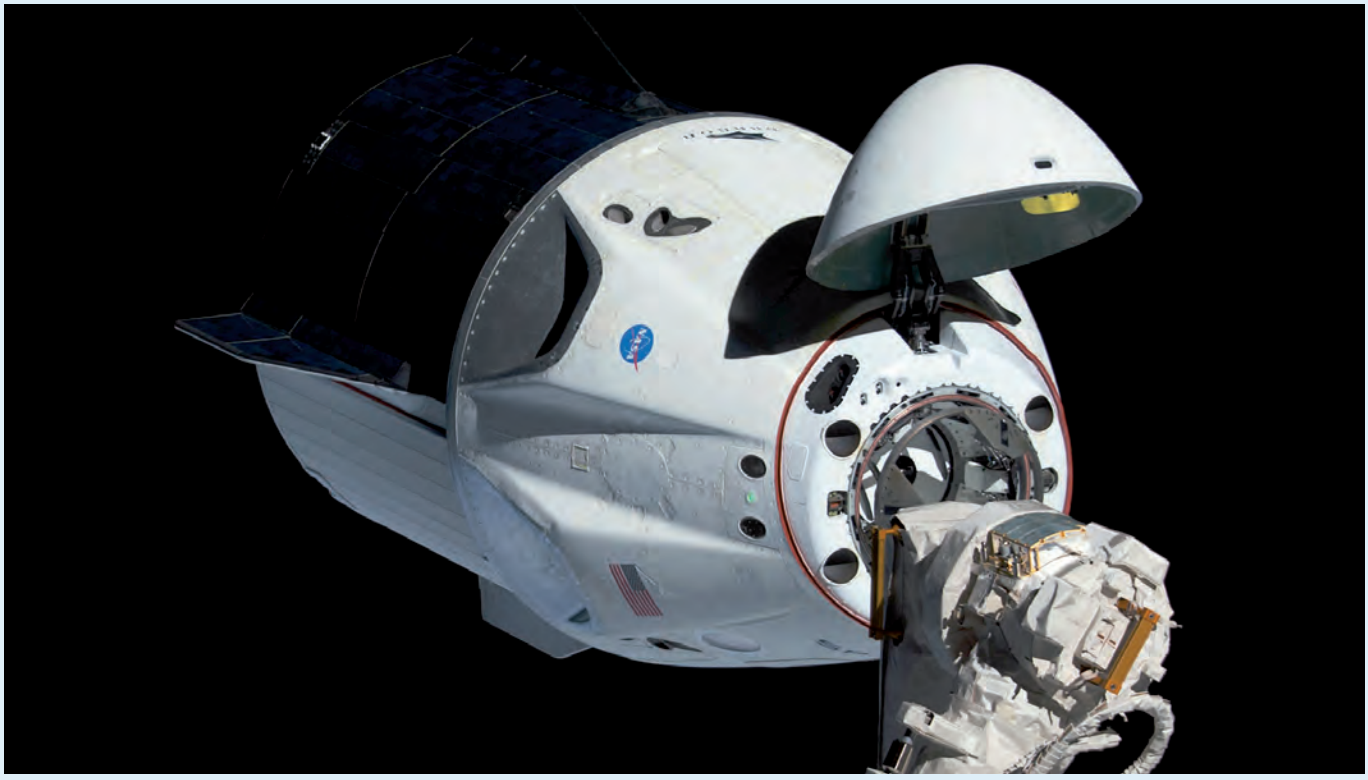
Here Pyke draws attention to Slessor's prognosis that, as the ultimate sanction, the thermonuclear option is only to be used ''when great nations are mortally threatened [as] it is by its nature an unlimited instrument.''

Another mark of a noteworthy biography is its ability to provoke further thought and comment. William Pyke's book succeeds in doing this, and, like all good publications, its painstaking notes and comprehensive index, enable a reader to test the validity of its assertions to the limit. Thoroughly recommended.

Peter Reese
AMRAeS
Author of *Sir Henry Royce: Establishing Rolls-Royce, from Motor Cars to Aero Engines* and *In Turbulent Skies: British Aviation Successes and Setbacks, 1945-1975*

[1]Sir John Slessor, The great deterrent and its limitations, *Bulletin of Atomic Scientists*, May 1956, 12 (5):140.
[2]Sir John Slessor and the prevention of war, *Royal Air Force Society Journal*, number 19, p 150.

THE POLITICS AND PERILS OF SPACE EXPLORATION



Who will compete, who will dominate?

By Linda Dawson

Springer Praxis, 2021, £24.99 book, £19.99 e-book, £16.39 Kindle.

This second edition provides a view of current issues and trends in world spaceflight systems as seen from the perspective of the human space flight activities of NASA. The subject is important because NASA is the world's foremost non-military space agency and its priorities have usually been dominated or heavily influenced by the enormous costs of human space flight. Other countries' astronaut programmes make sense only if seen in the context of what NASA is doing and/or planning.

The plans to send American astronauts to the Moon and, eventually, Mars, are discussed in the context of America's historical human spaceflight programmes, especially the Apollo Moon landings and the Space Shuttle. In a particularly useful chapter, the medical problems encountered by humans in space are summarised and their consequences (especially for missions to Mars) explained. The private sector initiatives of SpaceX (Elon Musk), Blue Origin (Jeff Bezos) and Virgin Galactic (Sir Richard Branson) are outlined,

Above: An uncrewed SpaceX Crew Dragon spacecraft approaching the ISS's Harmony *module.* NASA.

Below: The Artemis I Space Launch System (SLS) and Orion spacecraft on Launch Complex 39B at NASA's Kennedy Space Center on 14 June. NASA/Cory Huston.

illustrating that the future of humans in space is not restricted to publicly funded programmes.

The author has a strong background in the space sector, having worked in NASA, industry and now academia. Not surprisingly then, the main strength of the book is in her solid understanding of NASA's astronaut-related activities, making for a coherent and readable story. However, the lack of substantive coverage of robotic space exploration, military space programmes, and commercial communication and imaging systems, and incomplete coverage of non-US human spaceflight, means that the book is not as comprehensive as its title implies.

The timing of the book's publication has reduced its value to some extent. It just pre-dates the changes introduced by President Biden in 2021-2022, as well as the dramatic changes caused by the Russian invasion of Ukraine (see for example 'Ukraine – spaceflight implications' by Pat Norris, *AEROSPACE* May 2022, pp 18-20). Luckily, the background and conclusions in the book are largely independent of these two events, making it still a useful summary of NASA's human spaceflight aspirations.

Pat Norris
FRAeS
Author of *Returning People to the Moon after Apollo*, Springer Verlag, 2019

Book Reviews

AIRCRAFT RELIABILITY AND RELIABILITY CENTRED MAINTENANCE

A Practical Guide for Aircraft Reliability Engineers

By Daniel Olufisan

Wing Engineering Ltd, 2021, 226pp, £99.99.

British Airways Hangar 2-HI. CAA.

This textbook is a welcome addition to the technical publications dealing with practical reliability engineering for airworthiness and aircraft maintenance professionals. One may find in the literature an abundance of reliability engineering textbooks but very few are focused or tailored to address the needs of busy aviation professionals or new entrants, as they tend to be more theoretical or aimed at other industries. This new textbook presents practical information and analyses techniques that can be applied in day-to-day technical operations and in decision-making processes in relation to aircraft fleet management. This practical approach to learning is this textbook's key strength.

The theory is discussed in a simple yet concise way, establishing the necessary foundation for continuing airworthiness, aircraft maintenance and engineering practitioners having little or no prior knowledge on the subject. Key statistical concepts and the associated mathematical formulation are described clearly, with worked examples used throughout the textbook to illustrate their use. This also allows the reader to learn by applying the theory and reflecting on the knowledge gained as they move from section to section, and from chapter to chapter. Similarly, basic reliability analysis and statistical evaluation techniques (such as the fault tree analysis technique) are covered with detailed worked examples. All examples are representative of actual technical problems typically faced in the aviation industry. The Reliability Centred Maintenance (RCM) and aircraft maintenance programme chapters offer an overview of the principles and processes used in the industry. This allows the reader to transition smoothly to the aircraft reliability programme chapter, which offers important insights on this topic.

The main text is accompanied by a few appendices, complementing nicely the various chapters. There is a wealth of information one can find there, including forms and other resources with practical value.

From an educational point of view, the key points summarised at the end of each chapter is an excellent feature fostering learning. This summary, in conjunction with the overall structured approach followed in the book, makes the material transferable to the classroom (either in higher education or for initial/continuation training within companies and other aviation organisations). Overall, the book is written in an instructive way, making it a valuable resource for various audiences, such as professionals and students, including self-learners who wish to learn more about the subjects.

> Overall, the book is written in an instructive way, making it a valuable resource for various audiences, such as professionals and students

Dr Kyriakos I Kourousis
CEng FRAeS
Senior Lecturer, University of Limerick
Chair, RAeS Airworthiness & Maintenance Group

Library Additions

BOOKS

AIRCRAFT – LANDPLANES

Savoia-Marchetti S.79 Sparviero: From airliner and record-breaker to bomber and torpedo-bomber 1934-1947 by Luigino Caliaro, Crecy Publishing Limited, 2022, 276pp.

A beautifully illustrated guide to the Alessandro Marchetti-designed aircraft. As well as exploring its evolution, production and variants, it looks at its military service by the Italian Air Force and others, including during the Spanish Civil War and WW2. It also explores its civil variant, the SIAI SM.83. The volume finishes with a photographic survey of the aircraft, both inside and out, and colour diagrams and artwork which would be of great use to aero modellers.

Hawker Hunter by Tony Buttler, Key Publishing, 2022, 95pp.

A nicely illustrated general history of the aircraft, covering the design, development, testing, variants and the use of the aircraft, both by the Royal Air Forces and forces overseas. It also contains details of where surviving aircraft can be found.

Super VC10 development, British Aircraft Corporation – Weybridge Division, 5 July 1965, 1 item.

A press release dating from three days after BAC announced the development of the Super VC10. The release includes an artist's impression of the aircraft in BOAC livery.

The de Havilland Comet passenger liner, Series II (four Rolls-Royce Avon Jet Engines), capabilities, de Havilland Aircraft Company Ltd, January 1951, 36pp.

Information and data about a proposed development of the de Havilland Comet, including a general arrangement diagram, proposed cabin layouts, performance graphs and leading particulars.

AIRCRAFT – GLIDERS

Flying pantechnicons, the story of the Assault Glider Trust, Helion & Company, 2021, 142pp.

The story of the Assault Glider Trust's quest to preserve and make publicly available an Airspeed Horsa assault glider.

SERVICE AVIATION

Cold War Boys, previously unpublished tales of derring-do from pilots and crew of the Lightning, Phantom, Hunter, Tornado and other aircraft by Richard Pike, Grub Street, 2022, 199pp.

A further collection of memories of flying and crewing some of the most iconic military aircraft in post-war service.

Fleet Air Arm boys, volume three: helicopters, true tales from Royal Navy men and women air and ground crew by Steve and Heather Bond, Grub Street, 2022, 287pp.

A compilation of first-hand recollections from helicopter air and ground crew, includes reminiscences of working with Westland's Dragonfly, Whirlwind, Wessex, Sea King, Wasp, Lynx, Merlin and Wildcat rotorcraft. The book also recounts stories of pilot training and Junglies.

Gnat Boys, True Tales from RAF, Indian and Finnish Pilots Who Flew the Single-Seat Fighter and Two-Seat Trainer by Rick Peacock-Edwards and Tom Eeles, Grub Street, 2022, 253pp.

A collection of memories from those who flew the Folland Gnat, including civilians and members of the Red Arrows.

AIRCRAFT DESIGN AND CONSTRUCTION

General Aviation Aircraft Design: Applied methods and procedures by Snorri Gudmundsson, Second edition, Butterworth-Heinemann, 2022.

An up-to-date edition of the classic source for answers to realistic aircraft design questions. The book has been expanded to provide design guidance for additional classes of aircraft, including seaplanes, biplanes, UAS, high-speed business jets and electric aircraft. In addition to conventional powerplants, design guidance for battery systems, electric motors and complete electric powertrains is offered.

How to Build an Aeroplane by Robert Petit, 2nd edition, Williams and Norgate, 1911, 118pp. Translated from the French by T O'B Hubbard and J H Ledeboer who contributed the Preface.

AIRSHIPS

British Naval Airships 1909-1921 by Brian J Turpin, Airship Heritage Trust, 4 volumes, 2022.

Containing over 1,200 photographs and 230 line drawings over more than two thousand pages, it chronicles the development of the Navy's use of rigid and non-rigid airships before and after WW1. Each type is explored, including technical details and service histories. The volumes conclude with an exploration of the civil airship programme, including the Imperial Airship Scheme.

A Royal Air Force McDonnell Douglas Phantom FG.1 (F-4K) aircraft of No43 Squadron in 1980. US National Archives.

SPACE ENGINEERING

Saturn I/IB Rocket: NASA's First Apollo Launch Vehicle by David Baker, Crecy Publishing, 2022, 384pp.

The Saturn I and IB rockets were a key to success in the Apollo Moon programme, developing many of the technologies used in that endeavour and flying the first and the last manned Apollo spacecraft. Containing a good selection of photographs and diagrams, it tells the story of that evolution with detailed technical, engineering, industrial and political input plus a highly detailed account of each flight.

European-Russian Space Cooperation, From de Gaulle to ExoMars by Brian Harvey, 1st edition, 2021. Springer, 2021, 406pp.

RAeS book reviewers say: [This] book examines the history of collaboration between Western Europe and Russia (the Soviet Union prior to 1991) from the dawn of the space age until now. …[it] has chapters on the different types of space projects (scientific, human spaceflight and commercial) which works well due to the different political context of each. The wealth of detail is made accessible by use of summary tables and by the lavish illustrations, making it a joy to read.

BIOGRAPHIES

First out in earnest, the remarkable life of Jo Lancaster DFC by David Gunby, Fighting High Ltd, 2016.

The biography of a WW2 pilot, who then became a test pilot and, in late life, an aerial surveyor. After exploring his early life and time in service during WW2, the book explores his time at the Aeroplane and Armament Experimental School, the Empire Test Pilots' School Aerospracy (Cyprus) Ltd and Meridian Maps. The book also explores his time at Armstrong Whitworth, where he test flew the Apollo, AW.52, Meteors, Sea Hawks, Hunters, Javelins and Argosies.

HOVERCRAFT

Jane's surface skimmers 1976-1977 edited by Roy McLeavy, 10th edition, Macdonald & Jane's Ltd.

To borrow these and thousands of other titles contact the National Aerospace Library. E nal@aerosociety.com W www.aerosociety.com/catalogue

Diary

EVENTS www.aerosociety/**events-calendar**/

2 November
Careers in Aerospace & Aviation LIVE 2022
No.4 Hamilton Place, London W1J 7BQ, UK

3 November
The RAF Museum Lecture: A Case Study in Military Effectiveness
Cliff Lloyd, University of Wolverhampton
No.4 Hamilton Place, London W1J 7BQ, UK

8 November
The 21st Century Renaissance of the Transonic Wind Tunnel
Dr Doug Greenwell
Farnborough Branch lecture online and at: Farnborough College of Technology, Boundary Road Farnborough GU14 6SB, UK

8 November
Managing an Airport in Difficult Times
Ioan Reed-Aspley, Head of Media and Engagement, East Midlands Airport
Loughborough Branch lecture at: Room U020 (Brockington Building), Loughborough University, Epinal Way, Loughborough LE11 3TU, UK

9 November
Saudi – UK Road Trip '10,000 miles, 13 countries – Are we nearly there yet?'
Peter W Naylor, Award Winning Sculptor
Brough Branch lecture online and at: Cottingham Parks Golf Club, Woodhill Way, Cottingham, Hull, East Yorkshire HU16 5SW, UK

9 November
Young Persons Network Mini Lectures
Preston Branch online lectures

10 November
Handley Page Lecture 2022: Flight Testing an Integrated 1MW Hydrogen Fuel Cell Powertrain
Mark Cousin, Chief Technology Officer, Universal Hydrogen
RAeS Named Lecture at: No.4 Hamilton Place, London W1J 7BQ, UK

10 November
Strawford Lecture: The Development of the F-86 Sabre
Rod Dean
Birmingham, Wolverhampton and Cosford Branch Named Lecture at: RAF Museum Cosford, Shifnal TF11 8UP, UK

10 November
E-7 Wedgetail
Group Captain Simon Young
Cambridge Branch Lecture online and at: Lecture Theatre '0', Cambridge University Engineering Department, Trumpington Street, Cambridge CB2 1PZ, UK

11 November
Sir Ross and Sir Keith Smith Annual Dinner
Adelaide Branch Named Event at: Naval Military & Air Force Club 111 Hutt Street, Adelaide, 5000, Australia

14 November
Annual Light Aircraft Design Conference
RAeS General Aviation Group conference online and at: No.4 Hamilton Place, London W1J 7BQ, UK

North American F-86E Sabre during the Heritage Flight Training Course at Davis-Monthan AFB, Tucson, Arizona, 5 March 2016. The F-86 Sabre is the subject of the Strawford Lecture at the Birmingham, Wolverhampton and Cosford Branch on 10 November.
USAF/J M Eddins Jr.

14 November
Crowded Skies: Cold War Reconnaissance Over the Baltic
Robert S Hopkins, III, Editor, *The Journal of Aeronautical History*
Manchester Branch Lecture at: Theatre B, Roscoe Building, University of Manchester, Oxford Road, Manchester M13 9PL, UK

15 November
Sir Henry Tizard Lecture
Boscombe Down Branch Named Lecture at: MoD Boscombe Down, UK

17 November
Generation After Next Air Weapons
RAeS Weapon Systems and Technology Group conference online and at: No.4 Hamilton Place, London W1J 7BQ, UK

18 November
Pride in Aviation and Aerospace
RAeS Seminar and Networking Social at: No.4 Hamilton Place, London W1J 7BQ, UK

23 November
The First Satellite Launch from UK Soil
Melissa Thorpe, Spaceport Cornwall
RAeS Lecture at: No.4 Hamilton Place, London W1J 7BQ, UK

24 November
Sleeping and Living in Space
Prof Siobhan Banks, Professor of Psychology and Director of the Behaviour-Brain-Body Research Centre, University of South Australia
Adelaide Branch Lecture at: UniSA, Building MM1-05, University Boulevard, Mawson Lakes, SA 5095, Australia

24 November
An Overview of Airbus in the UK
Jeremy Greaves, Vice President, UK Corporate Affairs & Strategy
Solent Branch Lecture at: TBC

29-30 November
A Bright Future or Fighting for Survival – Where will Aerospace be in 2035 and Beyond?
RAeS conference online and at: No.4 Hamilton Place, London W1J 7BQ, UK

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

RAeS GENERAL AVIATION GROUP

Join the RAeS Aircraft Design Conference

Chris Wright

The Royal Aeronautical Society General Aviation Group (GAG) holds a Light Aircraft Design Conference and a Light Aircraft Design Competition each year. The GAG aims to encourage individuals and UK – and worldwide – industry to address current concerns and opportunities by imaginative application of what is possible. This year the conference on Monday, 14 November will return to No.4 Hamilton Place in London for live talks and it will also be possible to view the conference online.

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 and the latest aerodynamics – these and more can contribute to remaining airborne.

This year's Design Conference includes much to whet light aircraft designers' appetites: lightweight structural lessons from human-powered aircraft structures, design tools on a budget, aircraft developed using e-conditions, design reflections and experiences on rebuilding the *Black Magic* Comet Racer, a highly efficient turboprop, and lastly, design and development of the Shark microlight. Zara Rutherford (and now remarkably, her brother Mack also) has circumnavigated the world in the Shark aircraft (above) and Zara will be introducing the Shark presentation with a talk on her experiences on her world trip.

In addition, the results for our International Light Aircraft Design Competition 2021/2 will be announced and the winner and runner-up entries described. The competition was for an electric STOL microlight able to operate from remote airstrips in developing countries.

Join us for the only national conference on emerging light aircraft design technology; view the GA section or the events calendar on the RAeS website for more information.

COUNCIL ELECTIONS 2023

Would you like to help guide the Society?

NOMINATIONS FOR THE 2023 RAeS COUNCIL ELECTIONS ARE NOW OPEN

The Society would like to hear from members who are interested in standing for Council in the 2023 elections. The Council represents the aerospace, aviation and space sectors and provides critical input to the Board of Trustees. To fully represent these sectors we need candidates from across the industry: newly-qualified apprentices, senior engineers, pilots, leaders of industry, consultants and other professionals who support us. We need your skills to enhance our Council.

If you are able to donate your time and expertise you will gain the opportunity to take part in interesting debates on issues affecting the sector and the Society. You will work with other enthusiastic and committed professionals to help shape the direction of the Society. It can be an opportunity for professional development and to enhance your CV. If you wish to, you will also have the opportunity to get further involved in other roles at the Society.

If you are interested, require further information, or to apply please visit: **www.mi-nomination.com/RAeS2023**

Please note that all nominations must be submitted no later than **31 January 2023 at 23.59 GMT**.

THE RAeS AT ICAO's 41st ASSEMBLY

DAVID EDWARDS FRAeS, Chief Executive of the Royal Aeronautical Society reflects on the first few days of the the International Civil Aviation Organization's 41st Assembly, the first since the pandemic, and at a very different time in our world order. This Assembly took place between 7 September and 7 October in Montreal, Canada.

Firstly, why are we here? Well, as an independent learned Society, we're one of only a handful of organisations officially invited as 'observers' to the Assembly. We're here to represent the Society's members at the heart of global civil aviation, we're here to reconnect our Society with the international delegations and organisations around the globe and, perhaps as importantly, we're here to support our Working Paper (**https://www.icao.int/Meetings/a41/Documents/WP/wp_361_en.pdf**) on closing the Skills Gap that's emerged across aviation and aerospace, and looking for best practice from around the world on ways we can encourage the next generation to look towards our sectors for their careers – as well as highlighting the challenges we face to member states.

I've been delighted to meet a huge number of our Fellows at the Assembly, from a wide cross sector of countries and to hear the Society's name mentioned a number of times as delegates' CVs were read out during the varied nominations processes. It was also great to see the Assembly's first-ever female chair appointed, Poppy Khoza, Director of Civil Aviation in the South African CAA. As I've said before, I tend to start most meetings in these types of events by asking why attendees aren't members of the Society when it's clear they should be – on this occasion it's been great not having to ask as many times! As the only global professional and learned society for aviation, aerospace and space professionals, it's absolutely imperative that national representatives at ICAO are part of our Society, building our Learned output, challenging the status quo, leading the debate and ensuring that we remain as relevant in the future as we have done over the past 156 years of our existence.

The ICAO initiative 'No Country Left Behind' sums up the aims of the next two weeks here in Montreal, ensuring that as the world learns to live with Covid, we're aligned on a global scale on safety, security and developing that best practice to allow it to rebuild in the most sustainable way.

As many will know, one of the main focuses of ICAO41 is on a sustainable future for civil aviation and potentially setting the Long-Term Aspirational Goal (LTAG) that the world will commit to, with the aim of being carbon neutral by 2050. Should it be faster? Yes. Can it be faster? Yes. Will it be faster? – well, that depends on the commitments from the nations gathered here. I certainly hope so. Aviation and aerospace have been the most forward-looking, transformational and exciting industries of the past and present and we have the opportunity to be one of the leading technological change makers of the future provided that governments, together with industry, are aligned and committed. That was certainly the view of the UK Department for Transport (DfT), United Kingdom's Dr Rannia Leontaridi OBE FRSA when she delivered a Working Paper on behalf of the UK and European Union.

Below: David Edwards, RAeS CEO, left, with Capt Don Van Dyke, the Society's permanent representative to ICAO.

On Thursday, 6 October, our Working Paper was put forward for consideration by the Assembly and I hope it will help bring about a refresh of the Next-Generation Aviation Professional (NGAP) programme, taking into account the impact of the pandemic. While I wasn't there in Montreal in person for it, I attended virtually and the Society's permanent representative to ICAO, Capt Don Van Dyke FRAeS, was in the Chief Observer's seat in the Assembly Chamber to hear the views of the international delegations.

I want and need the Society to remain as relevant tomorrow as it is today and it's work like this that helps our discussions on how we shape ourselves to support that aim. My meeting with the Society's Montreal Branch on 26 September at McGill University helped that discussion, talking with students, current Society members and non-members on what they want our Society to be by 2035.

It's a privilege to be Chief Executive of the Society and representing the membership in ICAO. It's really clear to me the benefit of being able to travel by air again and seeing colleagues and friends in person, meeting teams from ICAO, the Flight Safety Foundation, the Académie de l'air et de l'espace – Air and Space Academy and many of the delegations (including old colleagues from the United Arab Emirates and Qatar).

No.4 Hamilton Place, London
9 December 2022 10:30-16:30GMT

ROYAL AERONAUTICAL SOCIETY

RAeS Young Professionals Conference

Moving on from Kerosene: What needs to happen?

YPC Supporter:

WLFC
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Power to Spare – Worldwide®

The annual Young Professionals Conference is back! This inspiring conference will seek to represent a variety of topics on future aviation propulsion, such as hydrogen, electrification, sustainable aviation fuels and more!

To find out more about attending or sponsoring the event, please visit:
https://bit.ly/3RQkitR
or email YPN@aerosociety.com

Are you thinking about **upgrading** your membership or applying for **Professional Registration?**

ROYAL AERONAUTICAL SOCIETY

The last closing date for applications this year is 22 November

If you are thinking about applying for membership, upgrading or applying for professional registration with the Engineering Council, the last closing date for the year is **22 November.** Applications submitted by this date will be reviewed in early 2023.

To apply, or continue with your application, please login at **aerosociety.com/login** and go to Current Applications.

Not sure what membership grade to apply for? Please email a copy of your CV to **membership@aerosociety.com.**

If you need extra support, we can offer this too. Our webinars can be found online and you can book a 1-to-1 call at **aerosociety.com/support.**

+44 (0)20 76704 384 **membership@aerosociety.com**

NEW MEMBER SPOTLIGHT

Name: Alasdair Gerrard AMRAeS, 27

Location: Bristol, UK.

Job title: Systems design engineer – gas turbine performance.

What inspired you into aviation? When I was younger, I was lucky enough to visit the Kennedy Space Center where I was banned from going to Mars by my Mum. My subsequent rationale was "if I can't go to Mars myself, maybe I can send something there instead." A healthy interest in maths and some introspection led to studying aerospace engineering at university and I haven't left the field since.

What is the best thing about your current role? As I sit at the system level, I get the 'big picture' story without being bogged down in the details of component design. Still being relatively early on in my career, I like this as it allows me to see how requirements cascade down from a top level into a subsystem world through to a component level. Because of this, it also allows me insight into all subsystems I work with – I've learnt a lot since I've been in my role which was one of the main things I wanted from a job. The moment I stop learning will be when I look to move roles.

What made you join the Royal Aeronautical Society? Initially, I joined the Royal Aeronautical Society as we were given free membership on my university course as it lined up with a path for chartership down the line. Since I graduated, chartership has become a much clearer and closer goal. Being part of the RAeS allows me a path to realising this goal.

What do you hope to get out of your membership and registration with RAeS? Chartership is my main goal for the foreseeable future but this is also coupled with being part of a network of like-minded people. I also look forward to joining some of the events and conferences in the future and meeting other members.

What three items would you take with you to the space station?

- Rowing machine – I started rowing in 2021 and it's somewhat taken over my evenings and weekends. Needs some thought on how I'm getting it there though…
- Laptop – most things revolve around technology nowadays and I'd probably be a bit lost without it.
- E-reader – I presume I'd need some sort of entertainment at some point and my e-reader can store hundreds of books, so that would be useful.

Top right: Lockheed SR-71A reconnaissance aircraft over Beale Air Force Base. USAF/Tech Sgt Michael Haggerty.

What is your favourite aircraft? It's got to be the SR-71 – first off it looks really cool, but it can also fly in excess of Mach 3 and it was developed in the 1960s! It's crazy that not a single one was lost due to enemy fire. The innovations which allowed it to reach Mach 3 (compressor bleed reheated engines, use of titanium and special stealthy paint) are exceptional feats of engineering.

Who is your biggest inspiration? Tony Stark – if there was one person I wish was real it's Tony Stark. I remember watching *Ironman* for the first time and thinking "I wish I was this guy" – it's a shame he is only a fictional character. In general though, I meet a lot of inspirational people and I couldn't draw on a specific person – I think who you're surrounded with (both at work and in your free time) is really important in life and as long as you have a good (and diverse) community you don't need to rely on a specific person as a source of inspiration.

Piece of advice for someone looking to enter your field? Take all the opportunities and experience you can get. There is no such thing as bad experience – and you will always learn something (even if the outcome is that you really never want to do X again). There are so many opportunities in life and you never know unless you try. When I was a student I was lucky enough to study abroad on the Erasmus scheme and I think this was one of the best decisions I ever made. Not only did I meet amazing people, but I made myself stand out from the crowd when it came to leaving university!

A Tale of the Unexpected

Over the past six months or so our Consultant Archivist, **PETER ELLIOTT**, has started to explore the darker corners of the National Aerospace Library to find material that chronicles the Society's past. He has had some interesting finds....

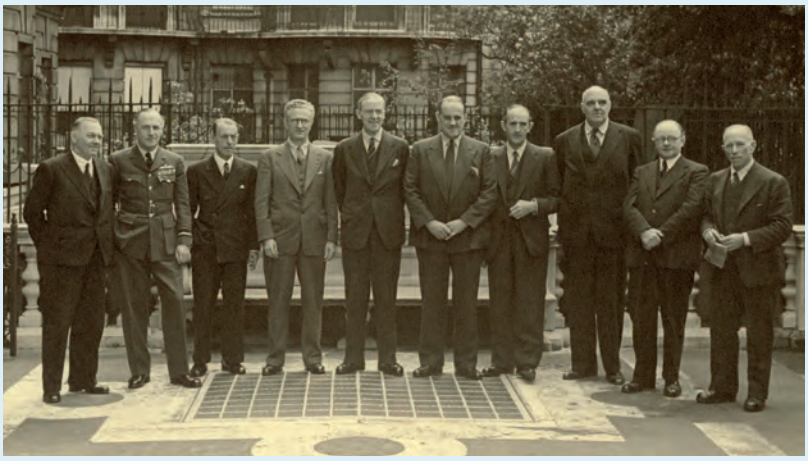
For me, one of the most satisfying aspects of working with archives is coming across documents that I wasn't expecting, or that give glimpses into the way people and organisations operated many years ago. So when I was invited to work on the RAeS archive I approached it with more than an enthusiast's interest.

I soon learned that the archive collection – records created by the Society and its forebears – is very large, varied in content and scattered across several locations within the National Aerospace Library – in cupboards, boxes (of different sizes) envelopes and parcels. Some of the collection is rather mundane – 1903 was a memorable year for aviation but how many copies do we need of that year's list of members? [hint: rather less than ten] – while others throw light on the early days of the Society, such as volumes containing letters sent by the Society from 1866. There were no photocopiers or typewriters (and no carbon paper), so correspondence had to be copied out by hand. Minute books and other committee papers may look at first glance to be rather dull, but they are an important source for historical research and can explain why decisions – that may still have relevance today – were made.

The Society made efforts in the 1950s to preserve historic aircraft, purchasing R J Nash's collection and compiling a list of aircraft of historic importance. The papers of the project committee are in the archive, together with those of the group which was formed to carry out restoration work. Plaques were sent to the owners of such aircraft, to be mounted in the aircraft, and a stock of blank plates has survived together with one plaque which could not be issued before the aircraft was scrapped.

The four organisations that came together to form today's RAeS – the Aeronautical Society of Great Britain, the Institution of Aeronautical Engineers, the Society of Licensed Aeronautical Engineering Technicians, and the Helicopter Association of Great Britain – are all represented in the archive with, in most cases, letters and other papers reflecting the negotiations that took place.

The work of the Brabazon Committee, which tried to determine the types of civil aircraft that the UK should build after WW2, will be known to many members of the Society, but far fewer will be aware that the Society had a committee giving advice to the Minister for Aircraft Production on a wide range of topics, including aero engine policy, metals, such as Beryllium and Magnesium, and low-level attack aircraft.



The Royal Aeronautical Society Advisory Committee to the Ministry of Production, appointed in 1941, on the terrace behind No.4 Hamilton Place. From left: Sir Arthur Gouge, Chief Designer, Short Brothers; AVM Sir Ralph Sorley, CRD Ministry of Supply; Capt J L Pritchard, RAeS Secretary and Secretary of the Committee; T P Wright, USA, Guest of the Committee for one meeting; Sir Stafford Cripps, Minister of Supply; Sir A H Roy Fedden, Chairman; S Camm, Chief Designer, Hawker Aircraft; R K Pierson, Chief Designer, Vickers; Dr L A Aitchison, Professor of Metallurgy, Birmingham University; and C C Walker, Chief Engineer, de Havilland Aircraft. RAeS/NAL.

In addition to such weighty matters, the Society has always maintained social events, such as garden parties and dinners and there is a considerable number of menus and related material, often signed by those present.

In 1953 a reception was held at the Science Museum to mark 50 years of flight: the programme includes films and television and asks: "Members and Guests who have had a previous opportunity of seeing Television" to go straight to the Cinematograph Room, thereby letting others have a chance to see it. We have forgotten that TV was once a new technology!

Work continues to complete the catalogue and rehouse the collection. One of the most unexpected documents that came to light is what seems to be the Librarian's 'To Do' list from around 1913; at the end of the list is 'Catalogue Society's Records etc' – some 109 years later, I'm working on it!

Below right: Historical Group inaugural luncheon menu, 1959, including the signatures of Peter Masefield, Jack Bruce (later RAF Museum), Charles Gibbs-Smith and J M Ramsden. RAeS/NAL.

Below: The surviving RAeS plaque for aircraft of historic importance which was too late for the Armstrong Whitworth AW52G glider. RAeS/NAL.

Elections

FELLOWS

Roger Amaral
Andy Craig-Wood
Helen Heenan
Matthew Knowles
Rick White
Glen Wilson

MEMBERS

Daniel Bonner
Christo Botha
Carl Bryan
Andrew Devereaux
Naleen Ehalape Gamage
Christopher Gilks
Kin Man Benjamin Lee
Jeslin Mathew
Atma Prakash
Dmytro Sabadash
Daniel Shure
Darren Williams
Robert Williams
Siyang Zhong

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ASSOCIATES

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Nicolas Barra
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Ace Pagaddu
Kevin Payne
Ben Skipper
Anton Tolic
Paul Wells

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Zoe Lumley
Isa Phuyuthanon
Jack Proudfoot
Toby Van Der Herik

WITH REGRET

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

AVM Michael Keith Adams CB AFC FRAeS 88
Sqn Ldr Geoffrey Bakewell CEng MRAeS 73
Lord David Chidgey CRAeS 80
Brian Crowther Davis CEng MRAeS 86
Gp Capt Kevan John Dearman FRAeS 82
Timothy Lintott FRAeS 69
Dr Alan Munro Thompson AMRAeS 77

NEWS OF MEMBERS

Kit Mitchell awarded the RAeS Distinguished Service Award

Dr Kit Mitchell FRAeS was awarded the Society's Distinguished Service Award at the National Aerospace Library on 6 October. Dr Mitchell was the founding editor of the Society's *Journal of Aeronautical History*, a post he held for ten years, is a long-standing member of both the Farnborough Branch and Aeronautical History Specialist Group (AHSG) Committees, including a distinguished spell as AHSG Chair. Dr Mitchell's service to the Society goes back to the mid-1960s when he Chaired the Graduates and Students Section and was their representative on Council.

Dr Kit Mitchell, far right, receives his RAeS Distinguished Service Award from Andy Rankine FRAeS at the National Aerospace Library.

ROYAL AERONAUTICAL SOCIETY

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.

Why become a Chartered Manager?

- 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, 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 10 years' management experience, with at least 3 years at a strategic level.

For more information about the application process, email the Membership Team: **registration@aerosociety.com**

The Last Word

COMMENTARY FROM

Professor Keith Hayward
FRAeS

Demonstration saves money

Investing in technology demonstration to de-risk complex programmes is a sensible strategy. The British Aerospace Experimental Aircraft Project (EAP) was exemplary in saving time and money over the long term when it came to the Typhoon. However, demonstration is cheap, requiring a significant early investment by both supplier and customer. The Tempest demonstrator makes a great deal of sense given the leap in technology from the 4th generation Typhoon to something that will still be in service in the mid 21st Century with a high level of systemic complexity.

Linking a production Tempest to a cloud or constellation of 'loyal wingmen' UAS will add another dimension to the task. Developing these vehicles has already seen some false starts and reveals a not altogether convincing overarching national strategy for domestic UAS activity. We don't yet know exactly how these vehicles will interact with the deployed Tempest – relatively autonomous or 'swarmed' – choices here will affect operational concepts and the value of pure stealth. If swarming drones, the idea presumably is to hide the piloted aircraft within a cloud of similar radar cross sections. Either way, this will take a lot of work and some risk of dead ends.

Lessons from history

Putting up a range of alternative solutions is a classic way of dealing with technological and strategic uncertainty. This was the approach adopted after the Second World War when the UK was presented with several novel military technologies. This situation combined with budgetary austerity engendered a degree of caution before launching new military production programmes. Instead, there were lots of R&D and experimental projects – not cheap, but far less expensive than building interim combat aircraft. The best and perhaps the most successful aircraft coming out of this approach were the four nuclear-armed bombers – three 'V' Bombers and the Short Sperrin. The existence of three production types was itself a result of a cautious approach to new technology.

But, in general, the result was a lot of flying testbeds, many of which went nowhere. Worse still, the outbreak of the Korean War in 1950 left the RAF and Fleet Air Arm with obsolete equipment. Rushing more advanced designs that had been slowly evolving proved to be a major error. One, the Hawker Hunter, eventually came good – indeed very good; another, the Supermarine Swift was the first of what would become a series of post-war procurement disasters.

From development to production

I cannot conceive of a future Korean War-style emergency re-armament programme whipping half-developed technology off the shelf and into production. Since the 1950s, conflicts have been, and are likely to remain, 'come as you are' parties. But sooner or later technology has to be integrated into production types. This when life can get very expensive and if the total cost of developing 'wingmen', next-generation fighters and missiles, hypersonic or not, is to be borne by even the promised expansion of the defence budget, the UK will need some solid well-funded friends.

In the event, the EAP was largely funded by the UK – Italy put in some money, but Germany opted out keeping open the option of working with France. The old Tornado team plus Spain eventually came together in Typhoon. Tempest has already a loose coalition of active international partners, with Japan inching towards full membership of a production team. The collaborative structure to my mind currently resembles a boosted EAP with BAE Systems acting as a surrogate prime contractor in the Lockheed-led F-35 mode.

Time enough perhaps to get the technology right and set for commitment to full-scale development and production, but choices will have to be made soon. The absence again of a single European option might be offset to a degree by Tempest's more global team, but this will only be proven by the final development team line-up.

> THE ABSENCE AGAIN OF A SINGLE EUROPEAN OPTION MIGHT BE OFFSET TO A DEGREE BY TEMPEST'S MORE GLOBAL TEAM

ROYAL AERONAUTICAL SOCIETY

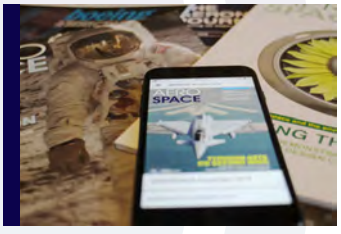
It's time to renew your membership for 2023

We are now inviting all members to renew their membership for 2023. Through renewing your membership at the Society, you will continue to have access to a range of exclusive membership benefits, developed to ensure you have access to the resources, support and tools, whenever you require them.

You will shortly receive an email which provides further information on how to renew your membership with details on how to make payment. As such, if you have not checked recently, please ensure that your email address and personal details are up to date. Log in to your account on the Society's website to check and update them here: **aerosociety.com/login.**

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 / 4384 or subscriptions@aerosociety.com.**

Are you making the most of your membership?



- Use of your RAeS post nominals, as applicable
- Subscription to the monthly AEROSPACE magazine through the post and the app
- Access to Aeroversity, our learning and professional development platform
- Access to the National Aerospace Library resources which includes e-books, e-journals & podcasts
- Discounted rates for conferences
- Access to Society news and blogs online
- Join Specialist Groups
- Engage with your local Branch through events and networking opportunities
- Support gaining Professional Registration
- Recognition of achievement through the Society's Medals and Awards
- Free online access to The Aeronautical Journal and its 123 year old back catalogue
- Exclusive 20% discount on 30+ Cambridge University Press books on the topic of Aerospace Engineering

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