



*JetZero's Blended Wing Concept: the Z-5*

# **The Schools' Aerospace Careers Programme Newsletter**

**Winter 2023/24**

*Edited by: Dr Michael Smith FRAeS*

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## COVER PICTURE

JetZero, a California-based startup, has won a \$235 million contract from the U.S. Air Force to partially fund the development and production of the first full-scale blended wing body (BWB) demonstrator. The BWB configuration is a possible new standard for future military and commercial transport aircraft. The demonstrator is expected to achieve its first flight in 2027. Northrop Grumman's Scaled Composites will build the Boeing 767-sized demonstrator for JetZero. The BWB configuration can achieve 50% fuel savings compared to a traditional "tube-and-wing" commercial aircraft.

The Air Force is rethinking how to perform air refuelling and airlift missions in future scenarios that expose traditional refuelers and airlifters to dangerous threats, even as they are required to operate on longer missions and smaller airfields across the Indo-Pacific military theatre. The Z-5, a medium-sized aircraft, is JetZero's BWB concept that can carry up to twice the fuel of the KC-46 on a maximum-range mission when configured as a tanker.

A blended wing body, also known as blended body, hybrid wing body or a lifting aerofoil fuselage, is a fixed-wing aircraft having no clear dividing line between the wings and the main body of the craft. The aircraft has distinct wing and body structures which are smoothly blended together with no clear dividing line. This contrasts with a flying wing, which has no distinct fuselage, and a lifting body, which has no distinct wings. A BWB design may or may not be tailless. The main advantage of the BWB is to reduce wetted area and the accompanying form drag associated with a conventional wing-body junction. It may also be given a wide aerofoil-shaped body, allowing the entire craft to generate lift and thus reduce the size and drag of the wings.

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# INTRODUCTION

As we publish this edition of our quarterly Newsletter, the Schools' ACP is poised to undertake the second half of the 2023/24 academic year Roadshow of Presentations to Groups of Schools around the UK which, when completed, will take us to face-to-face meetings with over 5,000 young people so far. Our next such milestone – and therefore aim – is to have reached 10,000 by the end of the Charity's current three-year business plan in July 2026. Such ambitious in-person outreach is, of course, only possible with the incredible and increasing support of Industry, schools and many very generous individuals. You know who you are, and my fellow trustees and our supporting team can only say, on behalf of those young people: "Thank you so much!"

Furthermore, as you are aware, the ACP is much more than just a roadshow. Our Digital Support service continues to grow with the further development of our website ([www.aerospacecareersprogramme.co.uk](http://www.aerospacecareersprogramme.co.uk)) and we strongly encourage all readers to explore the site to learn more about our activities, useful contacts, articles and news. Additionally, the site also contains links to our embryonic social media platforms, the latest one being YouTube on which we have recently released our first video.

Then there is our ACP Network which, as you will read in this Newsletter, will develop substantially in academic year 2024/25 once we have analysed and incorporated the results of a two-phase survey involving schools and industry that commences on 1 March 2024.

As you would expect, this Newsletter contains not only comment on the ACP itself but also the regular features listed on the Contents sheet. Included amongst these is an article on robotics, another on private equity, a further one on current engineering trends in aerospace, a glimpse of DARPA'S X-65 and a possible design for the US military's DGADA. Additionally, under commercial aviation operation we look at MRO, and how airlines are meeting the needs of more demanding customers.

Furthermore, we include an article on SaxaVord Space Port, the UK's first licenced space port, and one on the potential use of nuclear power for space propulsion. Staying with space we say goodbye to Ingenuity who has made its last flight in the Martian atmosphere, and discuss the growing concern about space debris. On a sobering note we include a comment by Tobias Ellwood MP on UK defence, but also heartening ones on GCAP and DragonFire.

Continuing we include an explanation of EW, and a caution about social media and cyber security. Then under careers we introduce two of our supporting companies – Babcock International and QinetiQ. Finally, as usual we refer the reader to the useful contacts on our website and, of course, introduce our new logo.

All the above are supported by related news items including a most positive one concerning the UK economy that was released as the Newsletter was about to go to press: [Brexite hasn't crushed the City – it's thriving \(telegraph.co.uk\)](https://www.telegraph.co.uk) which advises that despite all the gloom that some people promote, the City of London has overtaken New York City to be the World's leading global financial centre.

As always we hope you find this edition an enjoyable and informative read, and invite you to send any comments and questions you may have to myself – Michael Smith – at: [chairman@aerospacecareersprogramme.co.uk](mailto:chairman@aerospacecareersprogramme.co.uk)

# THE SCHOOLS’ AEROSPACE CAREERS PROGRAMME



*Spot makes his usual nonchalant entrance, this time at Sheffield High School for Girls during the last ACP Presentation of 2023.*

As we commence 2024 and look back over 2023 the strong theme that emerges is one of steady growth and substantial advancement. For example, we have nearly doubled the number of schools we send information to (now approaching 600) and that number continues to grow; furthermore, we continue to increase both the number of Host Schools and companies supporting the ACP, with more of both to be announced as 2024 progresses.

In addition, we have doubled the number of students and teachers that have attended our presentations, and there are still eight more roadshows this academic year. We have also conducted our second trial Network event, and the Board of Trustees has welcomed its first new member – Elaine Whyte. The recruitment programme continues as we seek two to three more Board members over the next three years. Additionally, the Support Team has grown from effectively zero to four with the arrival of Emma Versen, Chris Marshall, Mike Stokes and Lee Mason.

This is not all, our Digital Support under the guiding hand of Mike Stokes continues to build apace with the number of active social media platforms now increased to four following the introduction of our own YouTube channel last December which features our first video – the Network day at GKN Aerospace’s Global Technology Centre on 9 November. To start with it is planned to produce at least one ACP video per school term, and broadcast several more jointly with supporting companies.

Likewise, social media link-ups with schools continue to increase, as does our knowledge of the schools we support due to the hard work of Emma Versen; and the technology that we will now be



taking with us on the Roadshow is quite simply stunning in capability and impact. For example: a 120” automated floor rising screen + short throw projector + complete sound system including mixer board, speakers and microphones; two desk-top VR based flight simulators; ten AR/VR headsets (with supporting software from VRPilot) + three travel case automatic rising 95” flat TV screens + associated computers; a 3D printer; a camera equipped drone; a 5G Wi-Fi systems which enables us to link our equipment and that of the visiting companies without having to use the schools’ Wi-Fi access, a replica NASA EMU space suit, and of course Spot. All protected in custom built and wheeled travel cases and transported in an extra-long wheelbase, high roof, Ford Transit Van.

Much of this equipment demonstrates some of the technologies of the Fourth Industrial Revolution (4IR) which we base the Roadshow Presentation around, emphasising that two of the most significant industries adopting 4IR are aerospace and space. Chris Marshall is the man that makes it all work, supported now by Mike Stokes. And with technology in mind, Lee Mason’s demonstration of AR/VR design totally engages the students. Moreover, we are now completely independent of schools’ audio-visual and Wi-Fi provision; all we require is space, furniture, power, lighting – and students!

Spot, as you might expect, steals the show, especially as we have equipped him with ChatGPT and a voice so he can now answer questions – *himself!* And then there is the replica space suit we have introduced. That makes a serious impact when the audience see one of their own, dressed as an astronaut with helmet lights blazing, entering to the sound of Sprach Zarathustra from the film 2001.

During the year a great deal of work was undertaken behind the scenes to prepare for our academic year 2023/24 Roadshow Presentations around the UK which commenced on 13 September hosted by Bromley High School and attended by seven visiting schools and, in all, 161 students. See the News Page on: [www.aerospacecareersprogramme.co.uk](http://www.aerospacecareersprogramme.co.uk)

The 2023/24 Roadshow has now undertaken nine presentations with eight more scheduled in the current academic year. So far that has involved 44 schools and 1,394 students and teachers. The next event will take place in York on 27 February, and the final one in Silverstone UTC at the world famous motor racing circuit on 16 July 2024. Preparation for the 20-event 2024/25 Roadshow is well underway.

Naturally, much other activity has taken place in addition to the Presentations Roadshow. For example, the development of the Digital Support service embracing our website and increasing social media continues apace and, as indicated above, our first YouTube video has recently been released featuring a most successful Network event hosted by GKN Aerospace which was ‘sold out’ and attended by 70 students and teachers – see the YouTube link on [www.aerospacecareersprogramme.co.uk](http://www.aerospacecareersprogramme.co.uk)

Concerning the website itself, development is continually ongoing. We are currently preparing an inter-active careers portal which will be launched this Spring, our list of useful contacts continues to grow as do our links to supporting companies’ websites, and our Articles of Interest have now reached 28 with the latest one discussing inter-generation communication. The next article – Materials Challenges in Hypersonic Flight - is already in draft form.

Turning to the Network, the ACP is about to commence a survey of those schools supporting the ACP to establish exactly what they would like the Network to provide and how, and then once that is known we will survey the companies supporting the ACP to establish how they can assist and what they would like in return. A particular potential element we have in mind is a Work Experience facilitation service. Additionally, the survey will include the establishment and involvement of an ACP Alumni for those who have reached the age of 18. Furthermore, in addition to the feedback gained via our

website, the Alumni will enable us to develop an evaluation process to ascertain over the coming years the performance and, therefore, success of the ACP.

By the time we have conducted our first 2024 presentation, our in-person meetings with students and teachers will have reached 4,000; and by the end of this academic year should have reached 5,000. Digital outreach is increasing accordingly and we will report on that once we have reviewed the 2023/24 academic year.

One new service we will introduce as a trial in 2024 - in conjunction with UK Platforms UK - will be the development of ACP School Aviation Clubs based on training for, and certification of, drone piloting. Our view is that such a service will not only provide students with knowledge, and hands-on experience, of aviation, it will do so with aircraft they can immediately relate to because they see drones increasingly utilised for all manner of purposes, including recreation. It will also enable safe operation of these craft, and have the potential to spread to hundreds of schools, thousands of students and, consequently, further publicise and promote the ACP. We will report on this in due course.

To summarise, the Schools' ACP is now established and developing most healthily in accordance with sound planning, operational and financial management, and we look forward to continuing this progression over the years to come always, at the same time, ensuring we meet the needs of the young people we serve – and the schools and companies/other organisations who support us.



*Lost in the virtual world!*

And to finish, here's a preview of our opening video for the second half of the 2023/24 Roadshow programme:



Why The Moon.mp4

# TECHNOLOGIES OF THE FOURTH INDUSTRIAL REVOLUTION



*Spot and Atlas, two Boston Dynamics robots.*

Recognising that robotics is one of the principal 4IR technologies that the ACP includes in its roadshow presentations and that we include our own quadruped robot – Spot – we start this section of our Winter 2023/24 edition with an excerpt from Wikipedia on this increasingly significant subject.

There are many types of robots; they are used in many different environments and for many different uses. Although diverse in application and form, they all share three basic aspects when it comes to their design and construction:

**Mechanical construction.** A frame, form or shape designed to achieve a particular task. For example, a robot designed to travel across heavy dirt or mud might use caterpillar tracks. Origami inspired robots can sense and analyze in extreme environments. The mechanical aspect of the robot is mostly the creator's solution to completing the assigned task and dealing with the physics of the environment around it. Form follows function.

**Electrical components that power and control the machinery.** For example, the robot with caterpillar tracks would need some kind of power to move the tracker treads. That power comes in the form of electricity, which will have to travel through a wire and originate from a battery, a basic electrical circuit. Even petrol-powered machines that get their power mainly from petrol still require an electric current to start the combustion process which is why most petrol-powered machines like cars, have batteries. The electrical aspect of robots is used for movement (through motors), sensing (where electrical signals are used to measure things like heat, sound, position, and energy status) and operation (robots need some level of electrical energy supplied to their motors and sensors in order to activate and perform basic operations).



**Software.** A program is how a robot decides when or how to do something. In the caterpillar track example a robot that needs to move across a muddy road may have the correct mechanical construction and receive the correct amount of power from its battery, but would not be able to go anywhere without a program telling it to move. Programs are the core essence of a robot, it could have excellent mechanical and electrical construction, but if its program is poorly structured, its performance will be very poor (or it may not perform at all). There are three different types of robotic programs: remote control; artificial intelligence; and hybrid. A robot with remote control programming has a pre-existing set of commands that it will only perform if and when it receives a signal from a control source, typically a human being with remote control. It is perhaps more appropriate to view devices controlled primarily by human commands as falling in the discipline of automation rather than robotics. Robots that use artificial intelligence interact with their environment on their own without a control source, and can determine reactions to objects and problems they encounter using their pre-existing programming. A hybrid is a form of programming that incorporates both AI and RC functions.

## **Application**

The goal of most robotics is to design machines that can help and assist humans. Many robots are built to do jobs that are hazardous to people, such as finding survivors in unstable ruins, and exploring space, mines and shipwrecks. Others replace people in jobs that are boring, repetitive or unpleasant, such as cleaning, monitoring, transporting and assembling. Today, robotics is a rapidly growing field as technological advances continue in researching, designing, and building new robots to serve various practical purposes. Current and potential applications include, for example: manufacturing; transport; domestic; construction; agricultural; medical; food processing; mining; space exploration; clean-up; entertainment; education; military.

For more information, read the article at: [https://en.wikipedia.org/wiki/Robotics#Robotics\\_aspects](https://en.wikipedia.org/wiki/Robotics#Robotics_aspects)

### ➤ **3 November 2023**

Keeping robotics in mind a little longer we now commence our usual chronology of relevant news items with an article by James Titcomb in The Telegraph.

China has unveiled plans to build humanoid robots that can work in farms, factories and houses within two years. Beijing's ministry of industry and information technology has laid out plans to support bipedal robots by funding a series of breakthroughs. The ambition represents a new technological challenge to the US, where companies like Boston Dynamics and Amazon are testing humanoids [Atlas and Digit respectively].

A document from the Chinese ministry says robots will be as “disruptive as computers, smartphones and new energy vehicles” and will require advances in both artificial intelligence and artificial limbs. The machines will “profoundly change human production and lifestyle, and reshape the global industrial development pattern”, officials said. The document, which did not outline plans for military uses, said humanoid robots could be used in special environments facing harsh conditions, such as rescuing humans. China also wants to use the machines in medical settings and to clean houses. Beijing wants the first robots to arrive in 2025 but said they would be “significantly improved” by 2027. Read on at: [China to build humanoid robots by 2025 \(telegraph.co.uk\)](https://www.telegraph.co.uk/news/technology/2023/11/03/china-to-build-humanoid-robots-by-2025/)

### ➤ 14 November 2023

Matthew Field writes in The Telegraph that “Every once in a while, a revolutionary product comes along that changes everything, said Steve Job, the Apply Founder as he walked on stage to launch the iPhone in 2007.”

Mr Field goes on to say that those words might now sound prescient, but initially the iPhone was met with plenty of scepticism. Could Apple really replace the Blackberry’s keyboard or the wildly popular Nokia? Yet it proved arguably the most successful consumer gadget in history. The design has been the template for billions of smartphones sold around the world – 2.3 billion of them Apple iPhones. The modern smartphone – a 6-inch slab of glass and metal with a high-powered camera – has become ubiquitous, even mundane. Billions of us are glued to a handset, thumbs sore from endless scrolling. Genuine concerns around phone or social media addiction have failed to prise us away from the gadget in our pocket – or more typically under our nose.

For the last few years, Silicon Valley has been imagining what might come next. Ben Wood, a technology analyst at CCS Insight who curates the Mobile Phone Museum, says: “We had this huge period of innovation when Steve Jobs walked on stage in January 2007. He came up with what has become the dominant design.” Now, he says, “everyone is chasing this concept of what comes after the smartphone, which has become boring and formulaic”. Many billions of dollars have been spent researching virtual reality, smart glasses and foldable smartphones – although with few real breakthroughs.

But a surge of interest in artificial intelligence (AI) – driven by the launch of chatbots such as OpenAI’s ChatGPT – has some in the tech sector believing that a post-smartphone age is on the brink of becoming reality. Last week, one secretive start-up, California-based Humane, unveiled its “AI Pin”, a kind of cross between a pager, a chatbot and a lapel pin. Now continue at: [This tiny gadget could liberate you from your smartphone \(telegraph.co.uk\)](#)

### ➤ 1 December 2023

Sarah Knapton, the Science Editor of The Telegraph, advises that tiny bio-robots that could crawl inside the body to mend a broken spine, clear the arteries or rewire lost neurons in Alzheimer’s patients have been developed by scientists. The ‘anthrobots’ have been made from human windpipe cells which contain tiny hair-like projections called cilia, the role of which is to bat away inhaled particles before they can damage the lungs. Scientists discovered that when these windpipe cells are grown in the lab, they naturally self-assemble into large round structures – dubbed superbots – and use their cilia like oars to move around.

In a major breakthrough, the team found that the unique wiggling action of the superbots stimulated damaged nerve cells and triggered them to heal. When scientists made a “wound” through a mat of neurons and sent the anthrobots through the gap, the neurons began knitting together again creating a bridge as thick as the healthy cells. Neurons did not grow in the wound where anthrobots were absent.

Michael Levin, professor of biology at Tufts University and a member of Harvard’s Wyss Institute, said: “The cellular assemblies we construct in the lab can have capabilities that go beyond what they do in the body. It is fascinating and completely unexpected that normal patient tracheal cells, without modifying their DNA, can move on their own and encourage neuron growth across a region of damage.

We're now looking at how the healing mechanism works, and asking what else these constructs can do.”

Each anthrobot starts out as a single cell, derived from an adult donor. Earlier studies by others had shown that when such cells are grown in the lab they spontaneously form tiny multicellular spheres called organoids. The researchers developed growth conditions that encouraged the cilia to face outward on organoids. Within a few days they had self-assembled into multicellular superbots, ranging in size from the width of a human hair to the point of a sharpened pencil, and had started moving around, driven by the cilia acting like oars or fins. Their motion was also found to stimulate repair mechanisms in nerve cells. Read on at: [Watch: ‘Anthrobots’ could mend broken spines and rewire lost neurons in Alzheimer's patients \(telegraph.co.uk\)](https://www.telegraph.co.uk/health/health-news/anthrobots-could-mend-broken-spines-and-rewire-lost-neurons-in-alzheimer-s-patients/)

#### ➤ 12 December 2023

Matthew Field reports that Britain’s £800m innovation agency is ramping up plans to create brain implant technology to rival Elon Musk’s Neuralink. The UK’s Advanced Research and Invention Agency (ARIA), which launched last year, has called for research ideas in a bid to build microchips that can be inserted into human brains. Its proposal mirrors similar efforts by Mr Musk’s Neuralink, which has developed a brain-scanning chip designed to be implanted under the human skull. Neuralink has already been cleared to start recruiting patients for its first human trials.

Research has shown brain implants could help people with paralysis control devices through their thoughts. ARIA programme director Jacques Carolan said: “Neurological and neuropsychiatric disorders are the cause of an overwhelming societal and economic burden. We need a new suite of tools that enable us to interface, at scale, with the human brain.”

ARIA’s call for “breakthrough ideas” in the brain implant space comes after it said current efforts to build such technology were invasive, complicated and expensive. It said it wants to “dramatically” increase the number of brain implant operations while making them “minimally invasive”. Read on at: [UK innovation agency plots brain implants to rival Elon Musk's Neuralink \(telegraph.co.uk\)](https://www.telegraph.co.uk/health/health-news/uk-innovation-agency-plots-brain-implants-to-rival-elon-musk-s-neuralink/)

#### ➤ 13 December 2023

Matthew Field also reports that Tesla has debuted a new version of its humanoid robot that can squat without falling over and pick up an egg without breaking it. Elon Musk’s electric car company has teased updates to the company’s Optimus automaton in a video posted on Twitter. In a demonstration video, Tesla’s robotics division showed off what it called Optimus “Gen 2”.

The company said the robot could walk 30pc faster, was 10kg lighter and had improved balance and hand movements compared to its previous model. The clip showed the robot doing squats and flexing its fingers, as well as showing Optimus boiling an egg to demonstrate advances with “delicate object manipulation”. The video ended with two robots dancing to electronic music. See: [Tesla unveils humanoid robot that can pick up an egg without breaking it \(telegraph.co.uk\)](https://www.telegraph.co.uk/technology/tesla-unveils-humanoid-robot-that-can-pick-up-an-egg-without-breaking-it/)



➤ **23 December 2023**

Howard Mustoe advises that making computer chips from materials forged in space may sound like an idea from a science fiction novel, but a British company is hoping to make it a reality. Space Forge plans to send small, washing machine-sized modules into low earth orbit, about 500-800 km above the surface of the earth, where gravity is low but retrieval is within reach. Low gravity means the raw materials for semiconductor computer chips can be made more easily. Crystals key to making semiconductor chips can be synthesised with higher purity in orbit. Josh Western, Space Forge’s founder, says: “A combination of the microgravity and the vacuum you find in space allows you to create incredibly pure crystal structures. Space effectively allows crystals to bond better with less contaminants.”

While most chips are made of silicon, Space Forge is exploring the use of alternative materials such as gallium nitride. The full chip won’t be made in space, just the raw material. Higher crystal purity means chips will produce less waste heat, which could save millions of pounds when operated. The amount of energy use could be slashed by up to 60pc.

As more of the economy turns to electric power in an effort to lower carbon emissions, making high-quality chips can deliver significant benefits. Western hopes the technology will lead to significant savings for applications such as 5G phone masts, radar and electric car charging. “Some of the chips in a 5G tower only run at about 8pc efficiency,” he says. “Replacing those chips with space-made ones you can treble the efficiency in those applications.” See: [The British start-up plotting to make computer chips in space \(yahoo.com\)](https://www.yahoo.com/news/the-british-start-up-plotting-to-make-computer-chips-in-space-120000711.html)

## ➤ 28 December 2023

In *The Telegraph*, James Titcomb reports that employees at OpenAI did not expect much on November 30, 2022, when the company unveiled a “low-key research preview” called ChatGPT. Greg Brockman, OpenAI’s president, told staff that it wouldn’t have much of an impact on day-to-day business, confidently forecasting that it would only get noticed in a few nerdy corners of Twitter. It quickly became obvious that this was a wild underestimate. Millions of users signed up within days and ChatGPT was dubbed the most important technology in a decade, leading to a worldwide fervour about artificial intelligence.

Employees could be forgiven for failing to predict its popularity though. ChatGPT, with its ability to conjure up essays and arguments, may have astonished its early users, but to its developers it was positively medieval. The underlying AI system it was based on, known as GPT-3.5, was almost a year old. The company had already developed its supercharged successor, GPT-4, and was preparing to release it to the public. GPT-4 was a Mercedes in comparison to the Fiat Punto of its predecessor. OpenAI described it as being 10 times more advanced, saying it could understand not only text but images; and could pass legal exams.

Now, just over a year later, the company is taking its first steps toward a vastly more powerful system. Excitable techies gossip about GPT-5 with the awe that was once reserved for a new iPhone, speculating about how close to human intelligence it will come. Read on at: [The ‘super’ AI models that could soon upend the economy \(telegraph.co.uk\)](https://www.telegraph.co.uk/technology/2023/12/28/the-super-ai-models-that-could-soon-upend-the-economy/)

## ➤ 7 January 2024

The maker of ChatGPT has warned that a ban on using news and books to train chatbots would doom the development of artificial intelligence, writes James Titcomb and James Warrington. OpenAI has told peers that it would be “impossible” to create services such as ChatGPT if it were prevented from relying on copyrighted works as it seeks to influence potential laws on the topic. It comes as the company, which is reportedly in investment talks that could value it at \$100bn (£79bn), prepares to fight lawsuits from book publishers and the New York Times over claims that it has illegally used their content to “train” ChatGPT.

In evidence submitted to the House of Lords communications and digital committee, OpenAI said: “Because copyright today covers virtually every sort of human expression – including blog posts, photographs, forum posts, scraps of software code, and government documents – it would be impossible to train today’s leading AI models without using copyrighted materials. “Limiting training data to public domain books and drawings created more than a century ago might yield an interesting experiment, but would not provide AI systems that meet the needs of today’s citizens.”

OpenAI said it complies with all copyright laws when training its models and that “we believe that legally copyright law does not forbid training”. However, OpenAI and other rival companies have been accused of illegally free-riding on authors’ and artists’ work. Last month, the New York Times sued the company claiming it is “profit[ing] from the massive copyright infringement, commercial exploitation and misappropriation of The Times’s intellectual property”. Read further at: [OpenAI warns copyright crackdown could doom ChatGPT \(telegraph.co.uk\)](https://www.telegraph.co.uk/technology/2024/01/07/openai-warns-copyright-crackdown-could-doom-chatgpt/)



# THE UK ECONOMY



*Source: CAPYG*

We start this edition with an explanation of Private Equity which, according to Wikipedia is, in the field of finance, stock in a private company that does not offer stock to the general public. Private equity is offered instead to specialized investment funds and limited partnerships that take an active role in the management and structuring of companies. In casual usage, "private equity" can refer to these investment firms rather than the companies that they invest in.

Private equity capital is invested into a target company by an investment management company (private equity firm), a venture capital fund, or an angel investor; each category of investor has specific financial goals, management preferences, and investment strategies for profiting from their investments. Each category of investor provides working capital to the target company to finance the expansion of the company with the development of new products and services, the restructuring of operations and/or management, and formal control and ownership of the company.

*The typical structure / features of private equity investment are as follows:*

An investment manager (the private equity investor) raises money from institutional investors (e.g., hedge funds, pension funds, university endowments, and ultra-high-net-worth individuals) to pursue a particular investment strategy. The fundraise proceeds are placed into an investment fund in which the investment manager acts as a General Partner and the institutional investors act as Limited Partners.

The investment manager then purchases equity ownership stakes in companies using a combination of equity and debt financing with the goal of generating returns on the equity invested, including any subsequent equity investments into the target companies, over a target horizon based on the particular investment fund and strategy (typically 4–7 years).

From a financial modelling perspective, the primary levers available to private equity investors to drive returns are: revenue growth; margin expansion; free cash flow generation / debt paydown; valuation multiple expansion.

Value creation strategies can vary widely by private equity fund. For example, some investors may target increasing sales in new or existing markets (driving revenue growth), while others may look to reduce costs through headcount reduction (expanding margins). Many strategies incorporate some amount of corporate governance restructuring, for example, setting up a Board of Directors or updating the target's managerial reporting structure.

The use of debt financing in acquiring companies increases an investment's return on equity by reducing the amount of initial equity required to purchase the target. Moreover, the interest payments are tax-deductible, so the debt financing reduces corporate taxes and thus increases total after-tax cash flows generated by the business.

Over time, "private equity" has come to refer to many different investment strategies, including leveraged buyout, distressed securities, venture capital, growth capital, and mezzanine capital. One of the most noteworthy differences between leveraged buyouts and the other strategies is that buyouts are generally "control equity positions", as buyout funds usually purchase majority ownership stakes in their target companies, while other investment strategies typically purchase minority ("non-control") ownership stakes, reducing their ability to effect transformational changes across target companies.

For large deals, private equity investors often invest together in a syndicate in order to jointly benefit from exposure diversification, complementary investor information and skills, and heightened connectivity for future investments.

*Investopedia goes on to advise that:*

Private equity is sometimes confused with venture capital (VC) because both refer to firms that invest in companies and exit by selling their investments in equity financing, for example, by holding initial public offerings (IPOs). However, there are significant differences in the way firms involved in the two types of funding conduct business.

Private equity and venture capital invest in different types and sizes of companies, commit different amounts of money, and claim different percentages of equity in the companies in which they invest. Private equity is capital invested in a company or other entity that is not publicly listed or traded. Venture capital is funding given to startups or other young businesses that show potential for long-term growth.

Private equity, at its most basic, is equity - shares representing ownership of, or an interest in, an entity - that is not publicly listed or traded. Private equity is a source of investment capital from high-net-worth individuals and firms. These investors buy shares of private companies, or gain control of public companies with the intention of taking them private and ultimately delisting them from public stock exchanges.

Large institutional investors dominate the private equity world, including pension funds and large private equity firms funded by a group of accredited investors.

Because the goal is a direct investment in a company, substantial capital is needed, which is why high net worth individuals and firms with deep pockets are involved.

Venture capital is financing given to startup companies and small businesses that are seen as having the potential to generate high rates of growth and above-average returns, often fuelled by innovation or by carving out a new industry niche. The funding for this type of financing usually comes from wealthy investors, investment banks, and specialized VC funds. The investment does not have to be financial, but can also be offered via technical or managerial expertise.

Investors providing funds are gambling that the newer company will deliver and will not deteriorate. However, the trade-off is potentially above-average returns if the company delivers on its potential. For newer companies or those with a short operating history - two years or less - venture capital funding is both popular and sometimes necessary for raising capital. This is particularly the case if the company does not have access to capital markets, bank loans, or other debt instruments. A downside for the fledgling company is that the investors often obtain equity in the company and, therefore, a voice in company decisions.

A private equity firm's strategy is to buy mostly mature companies that are already established. The companies may be deteriorating or failing to make the profits they should due to inefficiency. Private equity firms buy these companies and streamline operations to increase revenues. Venture capital firms, on the other hand, mostly invest in startups with high growth potential.

Private equity firms mostly buy 100% ownership of the companies in which they invest. As a result, the firm is in total control of the companies after the buyout. Venture capital firms invest in 50% or less of the equity of the companies. Most venture capital firms prefer to spread their risk and invest in many different companies. If one startup fails, the entire fund in the venture capital firm is not affected substantially.

Private equity firms usually invest \$100 million and up in a single company. These firms prefer to concentrate all their efforts on a single company since they invest in already established and mature companies. The chances of absolute losses from such an investment are minimal. Venture capitalists typically spend \$10 million or less on each company since they mostly deal with startups with unpredictable chances of failure or success.

Private equity firms can buy companies from any industry, while venture capital firms tend to focus on startups in technology, biotechnology, and clean technology, although not necessarily. Private equity firms also use both cash and debt in their investment, whereas venture capital firms deal with equity only. These observations are common cases. However, there are exceptions to every rule; a firm may act out of the norm compared to its competitors.

We turn now to our chronological news reporting:

### ➤ **6 November 2023**

Gareth Corfield reports that forecasts by the Government's financial watchdog that Brexit would cause significant damage to UK-EU trade have failed to materialise and created "a false narrative" in the minds of the public, a think tank has said. Predictions made by the Office for Budget Responsibility (OBR) before Britain's exit from the single bloc suggested that the UK economy would shrink by about 4pc in the long run as a result of Brexit.

But the Institute for Economic Affairs (IEA) said the UK's trade patterns with the EU failed to show any impact from Brexit, either since the referendum or the end of the transition period. UK exports to EU countries climbed by 13.5pc between 2019 and 2022, before and after Brexit, with exports to non-

EU countries growing by 14.3pc, the IEA said. Meanwhile, UK services exports rose by 14.8pc to EU nations and 22.1pc to non-EU countries over the same period. Continued at: [OBR forecasts that Brexit would damage UK-EU trade are unfounded, says IEA \(telegraph.co.uk\)](#)

### ➤ 13 November 2023

And as Andrew Orłowski writes in The Telegraph, “Look outside London and British enterprise is flourishing.” He goes on to say: Britain at the fag end of 2023 is a nation where nothing works, and where we can’t even seem to manage our own decline. Or so we’re told.

But this pessimistic view is false: the seeds of a vibrant British economy are already here, you just need to know where to look. And the places to find British enterprise are anonymous industrial estates, in market towns and even villages. “What has happened to our industrial workforce over 20 years is like the industrial revolution in reverse,” says Marcus Gibson, founder of the eponymous research agency which monitors Britain’s SMEs, and tells Whitehall where to find them. Engineering and manufacturing never went away, he explains, but in recent years have fled the peripheries of cities for cheaper premises. As a result, he says, “our industrial estates are now the true cathedrals of wealth creation”.

This wasn’t in the script, but in a sense nothing has really changed. The vibrancy and innovation of our engineering supply chains helped Britain escape the worst ravages of the Depression of the 1930s, and these smaller suppliers were widely distributed across Britain – in smaller towns and communities. Today they’re found in Royston or St. Ives, or in even more remote and improbably locations. Just off the B1135 in Norfolk, some 20 minutes’ drive from the suburbs of Norwich, you’ll find the Hethel Engineering Centre, home to a couple of dozen highly advanced engineering companies. These are not places a think-tank wonk could find, even with Google Maps. Read on at: [Look outside London, and British enterprise is flourishing \(telegraph.co.uk\)](#)

### ➤ 17 November 2023

Business Live reports that car makers, aerospace companies and clean energy firms will benefit from a £4.5 billion Government fund earmarked for “strategic” manufacturing sectors. Funding will cover a five-year period and become available in 2025, after the next general election. The Treasury said that the move would provide industry with long-term certainty about investments. Over £2 billion of the fund has been earmarked for the automotive industry, with £975 million for aerospace manufacturers.

*“Britain is now the eighth largest manufacturer in the world, recently overtaking France. To build on this success, we are targeting funding to support the sectors where the UK is or could be world-leading.”* Chancellor Jeremy Hunt

The money is intended to support the development of zero emission vehicles, as well as more energy efficient aircraft equipment, the Treasury said. Over half a billion pounds has been given to the life sciences sector, with another £960 million also committed to a green industries growth accelerator plan. The Treasury said that projects covering carbon capture, hydrogen, nuclear energy and offshore wind would all be able to apply for funding as part of the plan to support clean energy. See: [‘Strategic’ manufacturers to get billions of pounds in Treasury backing | Great British Life](#)

➤ **20 November 2023**

James Titcomb and Matthew Field write that Jeremy Hunt will use this week's Autumn Statement to unveil quantum computing "moonshots" in a bid to ensure leadership of what is seen as a nationally critical technology. The Chancellor is expected to outline a series of projects worth hundreds of millions of pounds, including proposals to build a national quantum supercomputer within a decade.

Quantum computers, which exploit the peculiar properties of quantum physics, promise tremendous breakthroughs in engineering and science. The technology is nascent but evolving quickly: Google has already developed a machine that can instantly make calculations that would take existing supercomputers 47 years.

The technology creates major security risks because of its potential to break encryption systems used by armed forces and banks. Developing quantum capabilities is seen as a national security priority. Other potential projects Mr Hunt is expected to announce include investment in areas such as quantum clocks, sensors, imaging and financial trading systems. Read further at: [Hunt to launch 'moonshot' quantum supercomputing programme in Autumn Statement \(telegraph.co.uk\)](https://www.telegraph.co.uk/news/technology/2023/11/20/hunt-to-launch-moonshot-quantum-supercomputing-programme-in-autumn-statement/)

➤ **30 November 2023**

Christian Calgie advises that [Kemi Badenoch] the UK Trade Secretary has suggested a big US state could sign a Free Trade Agreement [FTA] soon with Britain, after securing a deal with Florida earlier this month. Speaking in the Commons, Ms Badenoch told MPs that Britain is on course to sign a huge agreement with California, a state with an economy larger than India and Britain. If California were an independent country, it would have the fifth largest economy in the world after the US, China, Japan and Germany, meaning a potentially huge boost for Britain's exporters.

[Since Ms Badenoch became Trade Secretary, despite the Biden Administration's obvious aversion to an FTA with the UK, she has signed FTAs with 12 US states.]

➤ **15 December 2023**

Jessica Clark reports that Britain's economy beat European rivals as business activity hit a six-month high at the end of the year. A closely watched measure published yesterday showed output rose for the second month in a row in December as the UK continued to dodge a recession.

Meanwhile business activity in the eurozone fell at a steeper rate this month. Output in the bloc has fallen at its fastest rate for 11 years, barring the early-2020 Covid months, with downturns recorded across both manufacturing and service sectors. Research showed that the private sector output expanded for the second month in a row in December as the [UK] economy showed signs of recovery.

➤ **20 December 2023**

Szu Ping Chan, Fran Ivens and Jonathan Leake write that the Bank of England is expected to start lowering interest rates within months after a surprise drop in inflation sparked a wave of bets on lower borrowing costs. The Consumer Prices Index fell to a two-year low of 3.9pc in November, the Office for National Statistics said, down from 4.6pc in October, and well below analysts' expectations of a fall to 4.3pc. It marked the first time inflation has been below 4pc since September 2021.



The surprise good news prompted traders to ramp up bets on interest rate cuts with markets now predicting a 50pc chance that the Bank could start lowering borrowing costs from March. Markets are also betting rates will fall to 4pc by the end of 2024, compared to expectations of 4.25pc before Wednesday's data. The market moves ramp up pressure on Bank Governor Andrew Bailey and his colleagues who have repeatedly sought to downplay hopes of imminent rate cuts in recent weeks. Read: [Investors bet rates could start falling by March after surprise drop in inflation \(telegraph.co.uk\)](https://www.telegraph.co.uk/economy-and-finance/interest-rates/2023/12/21/investors-bet-rates-could-start-falling-by-march-after-surprise-drop-in-inflation/)

### ➤ 24 December 2023

Liam Halligan reports in The Telegraph that the UK economy has been lacklustre over the last 12 months – but it has actually performed better than expected. At the start of this year GDP was widely forecast to shrink around 1pc during 2023 – not least due to high inflation and the Bank of England's resulting interest rate rises. While rates were 3.5pc last Christmas, the base borrowing cost has been held at 5.25 since August. The Monetary Policy Committee has raised rates 14 times since December 2021 – from a pandemic-era emergency low of 0.1pc. All that monetary tightening has restricted bank lending and credit markets more generally. Thousands of businesses and millions of households have had to pay more in debt interest, curtailing investment and consumer spending.

Eighteen months ago Bank of England economists warned Britain would enter recession – two consecutive quarters of economic contraction – by the end of 2022. GDP would keep falling throughout this year too, the Bank forecast, the longest decline since the 2008 crisis. Yet the UK economy has been a lot more resilient, so far avoiding the post-lockdown recession that has hit Germany and the broader eurozone.

Yes, our economy has flatlined during the second half of this year – with the latest official revisions indicating GDP shrank 0.1pc during the three months to September. But more up-to-date survey data, as we enter 2024, point to a tentative economic recovery. Inflation has dropped from 10.5pc last December to 3.9pc now – with much of that fall over the last two months. That has strengthened real wages and eased companies' input costs, boosting both household and business confidence as the prospect of the MPC lowering rates comes closer into view. See: [Britain's main economic risks in 2024 come from uncertain geopolitics \(telegraph.co.uk\)](https://www.telegraph.co.uk/economy-and-finance/interest-rates/2023/12/21/britains-main-economic-risks-in-2024-come-from-uncertain-geopolitics/)

### ➤ 28 December 2023

Szu Ping Chan writes that the pound will hit \$1.30 next year and keep climbing against the dollar as traders who bet against Britain are proven wrong again, according to analysts. Kit Juckes, chief foreign exchange strategist at Societe Generale, the bank, said there was an “enormous amount of negativity” about the British economy that was unwarranted.

Kamakshya Trivedi, head of global foreign exchange at Goldman Sachs, said he too was sticking with his prediction that the pound would rise from \$1.28 today to \$1.35 within the next 12 months. Mr Trivedi said he was confident that sterling would keep rising despite last month's big drop in inflation as the pound tended to track rising share prices and as fears eased about high interest rates plunging the world into a prolonged recession.

The Bank of England has said it believes the economy will flatline next year, while most analysts believe it will expand by just 0.4pc in 2024. Mr Juckes noted that most forecasts for a flatlining UK economy next year were much more pessimistic than for other economies, including Sweden and the

eurozone, suggesting that there was a lot more room for Britain to outperform. Read on at: [Pound expected to hit \\$1.35 as analysts tear up pessimistic forecasts \(telegraph.co.uk\)](#)

#### ➤ 8 January 2024

Tim Wallace reports that Britain is more attractive than Europe for manufacturing firms, factory bosses have said, as “a newfound sense of optimism” sweeps the industry. Most manufacturing chiefs believe the UK is now a competitive location for their business, according to a new report from industry group Make UK and PwC, and is set to pull further ahead of European rivals.

The majority of bosses also believe Britain’s competitive edge over Germany, France, Italy and Spain will grow rather than shrink this year, the report found. Britain has proven relatively resilient in the past year compared to the industrial heartlands of the Continent. German factories in particular have been hammered by the war in Ukraine, largely due to their reliance on cheap Russian energy.

#### ➤ 17 January 2024

The Telegraph reports that inflation will fall below 2pc by April or May this year, economists have said, in a boost to mortgage holders hoping for interest rates to fall. Economists at Deutsche Bank said that price rises could slow down sharply from the 3.9pc recorded for November. In a research note this morning, Deutsche Bank predicts that inflation will average 2.5pc in 2024, down from a previous forecast of 2.7pc. The bank said inflation will drop “a little below 2pc in April and May” before hovering around 2pc to 2.5pc for the remainder of the year.

The Bank of England has raised interest rates to 16-year highs of 5.25pc in an effort to reduce inflation back down to its target of 2pc. Prices were rising at a pace of 11.1pc a year in October 2022, which was a 41-year high. Governor Andrew Bailey told MPs today that Britain has not seen a jump in unemployment as a result, while household incomes have risen in recent months, limiting the blow from higher borrowing costs.

#### ➤ 28 January 2024

Roger Bootle writes in The Telegraph that [although] we may not have fully seized the economic opportunities offered by our exit [from the EU] claiming it a disaster is a nonsense. He goes on to say that this week we will mark the fourth anniversary of the UK’s departure from the European Union on 31 January, 2020. All the usual suspects are again pouring scorn on that momentous event and attributing many of our current ills to it. But does a sober assessment support this conclusion? Read: [No, Brexit was not a terrible mistake \(telegraph.co.uk\)](#)



# AEROSPACE MANUFACTURING



We started this section in our Autumn 2023 edition with the following paragraph: “It may be a cliché, but it is a time of unprecedented change in the global aviation, aerospace and space industries. No sooner had the Covid pandemic ended, temporarily grounding air travel, than a high-intensity peer-on-peer war erupted in Eastern Europe with Russia’s invasion of Ukraine. Climate action, meanwhile, is now top of the agenda in many places, and the aerospace industry is racing to decarbonise itself – even as it struggles with supply chain shortages and a skills crisis. Meanwhile, sci-fi dreams of flying taxis, rockets that land vertically, hotels in space and now AI that can hold lengthy conversations with humans, are almost here. All of these external factors make for a challenging landscape for today’s firms to navigate when deciding on technology and investment priorities.

Well that hasn’t changed, and with those technologies and investment priorities in mind as we enter 2024 we now refer to an earlier article from CMTA (California’s Manufacturing Network) entitled ‘*Here are ten engineering technology trends to watch*’ starting with:

## **Smart Automation & Blockchain**

Smart automation and blockchain are two distinct technologies that can be used together to create new opportunities for businesses. Blockchain is a shared, immutable ledger that provides an immediate, shared and transparent exchange of encrypted data simultaneously to multiple parties as they initiate and complete transactions. It can track orders, payments, accounts, production, and much more. Smart automation, on the other hand, is the use of technology to automate business processes that span multiple parties, removing friction, adding speed, and increasing efficiency.

The convergence of blockchain and smart automation can bring new value to business processes. For example, AI models embedded in smart contracts executed on a blockchain can recommend expired products to recall, execute transactions such as re-orders, payments, or stock purchases based on set thresholds and events, resolve disputes, and select the most sustainable shipping method. Blockchain technology and smart contracts eliminate the need for middlemen to enforce contracts, verify transactions, or perform background checks. This means that BPM [Business Process Management] software can more fully automate business processes and manage new technology embedded in the process. In summary, blockchain and smart automation can work together to provide new efficiencies and opportunities for businesses.

## **Zero-Fuel Aircraft**

Airbus recently revealed three concepts for the world's first zero-emission hydrogen commercial aircraft, which could enter service by 2035. These concepts each represent a different approach to achieving zero-emission flight by exploring various technology pathways and aerodynamic configurations in order to support their ambition of pioneering the decarbonization of the entire aviation industry. All of the concepts presented by Airbus rely on hydrogen as a primary power source – an option which they believe holds exceptional promise as a clean aviation fuel and is likely to be a solution for aerospace - and many other industries - to meet their climate-neutral targets.

## **Structural Health Monitoring (SHM)**

Structural health monitoring involves the observation and analysis of a system over time using periodically sampled response measurements to monitor changes to the material and geometric properties of engineering structures such as bridges, airplanes and buildings. Aircraft accidents involving catastrophic fatigue failure have the potential for significant loss of life, which makes innovation in this branch of the aerospace industry so important.

The foundation of structural health monitoring is the ability to monitor structures using embedded or attached non-destructive evaluation (NDE) sensors and to utilize the data to assess the state of the structure. Over the last ten years researchers have made significant advances in developing NDE sensors for SHM, and they have developed the hardware and software needed for analysis and communication of the SHM results. The NDE SHM sensors that have reached some modest degree of maturing and are able to monitor significantly large areas of structures include fibre optics, active ultrasonics, and passive acoustic emission.

Furthermore, low-cost emerging computational hardware, such as graphics processing units, is enabling the growing use of advanced physics-based models for improved NDE inspection and for advanced data analysis methods such as machine learning. This is particularly relevant for NASA, for example, as new tools need to be developed in order to support long-duration spaceflight.

## **Advanced Materials**

Innovative materials can be used in a wide variety of areas - from lighter, more agile aircraft and emerging hypersonic systems, to personal protection equipment and anywhere risks or damage can be reduced. Progress in developing advanced materials is expected to address the integration of functions such as energy harvesting, camouflage, structural and personal health monitoring. For example, graphene is a carbon-based material which is merely one atom thick and can be used to make batteries that are lightweight, durable and applicable in high capacity energy storage - plus, they charge more rapidly than a typical battery.

## **Additive Manufacturing (3D Printing)**

3D printing, also known as additive manufacturing, has been proven to be an excellent manufacturing solution for producing components and parts that utilize significantly less material than other comparable, traditionally manufactured, parts. Since the material can be used to create an item through additive manufacturing, extremely complex geometric shapes can be built that have great strength despite the reduced density in the material used. Reducing weight is paramount to the aerospace

technology industry due to increasing performance in areas of speed, capacity, fuel consumption, emissions and more. This realization is leading the aerospace and defense industries to look for applications of 3D printing in their newest products, from seat frameworks to air ducts.

### **Supersonic Flight**

Supersonic flight is when an aircraft travels faster than the speed of sound. US airline United has announced plans to buy 15 new supersonic airliners and "return supersonic speeds to aviation" in the year 2029. Supersonic flights sound familiar? Such passenger flights ended in 2003 when Air France and British Airways retired Concorde. The new Overture aircraft will be produced by a Denver-based company called Boom which has yet to flight-test a supersonic jet. United's deal is conditional on the new aircraft meeting safety standards and noise pollution concerns.

### **More Resilient and Dynamic A&D Supply Chains**

Lower aircraft demand and restrictions on the movement of people and goods due to the pandemic led to a breakdown of many essential aerospace and defense supply chains. This has resulted in an impact on smaller suppliers, especially those with heavy exposure to commercial aerospace and the aftermarket business.

In 2021 the industry's focus is likely to shift toward transforming supply chains into more resilient and dynamic networks, which could be done using strategies such as on-shoring, vertical integration, and increased cyber defenses. To further strengthen supply chains, OEMs and suppliers should leverage digital tools, including automating internal processes and streamlining workflows, implementing smart management systems, and using data analytics. In a recent survey conducted by Deloitte, 72% of industry executives said they are investing in supply chain ecosystems to leverage external alliance partners.

### **Utilizing Internet of Things (IoT) to Anticipate Maintenance Issues**

Aircraft maintenance and repair companies are widely using Internet of Things technology for predictive maintenance of aircraft parts and equipment. An IoT-based predictive maintenance solution can help to predict potential damage for example by collecting data from ultrasonic and vibration sensors attached to the spindle of a CNC machine. Analyzing the collected data helps to identify fragile spindles and tools before they break. IoT technology is used to send critical data from engines, wing flaps, bleed valves, and landing gear to technicians for preventive maintenance. This data aids technicians to create maintenance schedules, procure parts, and schedule relevant workers to fix equipment.

### **Artificial intelligence (AI)**

The aerospace technology industry is also benefiting from artificial intelligence and the use of machine or active learning in research and education. Machine learning offers the ability to gain new insights into materials by employing artificial intelligence to discover new patterns and relationships in the data. AI can handle far more complex problems than humans, and can run the gambit of thousands of outcomes within moments compared to how long the human brain takes to process information. For instance, in order to create the next generation of technology, researchers at the



United States Air Force Research Laboratory are using machine learning, AI and autonomous systems to exponentially increase the speed of materials discovery and lower the cost of technology.

### **Autonomous Flight Systems**

Implementing autonomous technologies has been a growing trend across several industries, and the aerospace industry is no exception. Much of this has been focused on increasing autonomous flights, with the end goal being to launch fully human-free flights. While this may still be several years away, investments and innovation will consistently be geared toward this in the coming years. We might see planes being cut down to just one pilot and subsequently becoming autonomously operated in the coming years. This has already occurred with drones, although this technology will obviously need to be scaled-up before it's ready for passenger planes and longer journeys.

#### **➤ December 2023**

We continue our quarterly news reporting with an article by Bill Sweetman in the December edition of the RAeS' AERO SPACE entitled 'Generational divide' where, with the USAF expected to select a design for its Next Generation Air Dominance Aircraft within the next 12 months, he provides an overview of the project to date.



*Artist's impression of a possible NGADA design*

#### **➤ 11 December 2023**

Via Reuters, David Shepardson reports that the U.S. Commerce Department said on Monday it plans to award \$35 million to BAE Systems to quadruple production in New Hampshire for key semiconductor chips used in F-35 fighter jets and commercial satellites. The announcement is the first from the \$52.7 billion "Chips for America" semiconductor manufacturing and research subsidy program approved by Congress in August 2022 to ramp up U.S. chips production amid concerns about reliance on Asia. The department said it signed a non-binding preliminary memorandum of terms to

provide \$35 million to BAE Systems Electronic Systems to support modernizing the company's Nashua, New Hampshire Microelectronics Center.

The Pentagon plans to spend \$1.7 trillion on the F-35 program including buying 2,500 planes in the coming decades. White House National Security Adviser Jake Sullivan said the chips were critical to F-15s and F-35s. "We do not want to be in a position where another country can cut us off in a moment of crisis," Sullivan told reporters. The Commerce Department in September issued rules to prevent chip subsidies from being used by China and moved in October to halt shipments to China of advanced artificial intelligence chips. Companies like Intel, Micron and GlobalFoundries are among those seeking significant funding from the chip program.

Commerce Secretary Gina Raimondo said the BAE award "is the first of many announcements. We expect the pace of these announcements to accelerate in the first half of next year." The New Hampshire project will reduce the price of future chips by half, more than offsetting the \$35 million cost, an administration official said. The chips are used for electronic warfare systems in battle environments for F-35s built by Lockheed Martin.

The first chip award underscores that the program "is about national security," Raimondo said, adding the aim is create "a thriving long-lasting domestic semiconductor manufacturing industry." BAE Systems CEO Tom Arseneault said in a statement funding would boost its microelectronics which are key to "defense and aerospace customers from next-generation aircraft and satellites to military-grade GPS and secure communications."

### ➤ 15 December 2023

Rupert Hargreaves reports that Airbus and Rolls-Royce have today announced they have been picked by Turkish Airlines to supply the carrier with 220 new aircraft. The planes, a mix of A321 and A350 models, will be manufactured by Airbus for the most part in the UK, with the engines supplied by Rolls-Royce.

The 70 A350 aircraft will be powered by Rolls-Royce Trent XWB engines, which are assembled and tested in Derby, and are 25 per cent more efficient than similar models. Rolls-Royce chief Tufan Erginbilgic said: "Today's announcement marks an exciting and truly historic day for Rolls-Royce. It is proof that the actions we are taking to transform Rolls-Royce into a high-performing and competitive company underpinned by profitable growth are working."

The deal is the latest boost to the UK manufacturing industry, which has shrugged off economic concerns and the disruption of Brexit in 2023. It follows Nissan's £2bn in electric vehicle production in Sunderland and Tata's £4bn new UK gigafactory. Last month the government also announced £4.5bn of funding for British manufactures as part of its efforts to improve the country's growth prospects and productivity. The Treasury has also earmarked £1.4bn in funding for the aerospace industry over the next decade through the Aerospace Technology Institute Programme.

Business and Trade Secretary Kemi Badenoch said: "This is a big win for the UK's world-leading aerospace sector and one that will help secure high-skilled jobs across the country and drive economic growth. These successes show our plan for British manufacturing is working, and our recently released Advanced Manufacturing Plan will ensure the wins keep coming." Read on at: [Airbus and Rolls-Royce ink multi-billion pound deal to build planes for Turkish Airlines in the UK \(cityam.com\)](https://www.cityam.com/news/airbus-and-rolls-royce-ink-multi-billion-pound-deal-to-build-planes-for-turkish-airlines-in-the-uk)

### ➤ 2 January 2024

Matt Oliver writes in The Telegraph ‘How aeroplane breakthroughs may have saved 379 lives from the Japan Airlines fireball’. He goes on to say that the evacuation of every passenger from the Japan Airlines aircraft that collided with a smaller plane on Tuesday seemed all the more miraculous as footage of the ensuing inferno emerged.

However, instead of being down to luck, industry insiders believe the incident is proof of how modern materials and tough fire safety rules can protect passengers. The incident at Haneda Airport, Tokyo, marks the first time an Airbus A350 has been destroyed in an accident. The model is the first of the manufacturer’s passenger jets to be built largely from carbon fibre composites.

“It’s a watershed event in aviation safety,” says Andreas Spaeth, an aviation journalist and co-host of a podcast that examines historic plane crashes. “This was an aircraft that was absolutely full. So to see that everyone escaped safely is a miracle. Even then, it was a fairly long time before a big fire emerged. We have never seen a fuselage made of carbon fibre burn. And the structure held up pretty well.” Read more at: [Japan plane crash 2024: How airplane breakthroughs may have saved 379 lives \(telegraph.co.uk\)](https://www.telegraph.co.uk/technology/2024/01/02/japan-airline-crash-2024-how-airplane-breakthroughs-may-have-saved-379-lives/)

### ➤ 3 January 2024

DARPA has selected Aurora Flight Sciences to build a full-scale X-plane (artist’s impression below) to demonstrate the viability of using active flow control (AFC) actuators for primary flight control. The award is Phase 3 of the Control of Revolutionary Aircraft with Novel Effectors (CRANE) program.



In December 1903, the Wright brothers flew the world’s first fully controllable aircraft, which used wing warping to successfully achieve flight. Virtually every aircraft since then has used a system of movable, external control surfaces for flight control. The X-65 breaks this century-old design paradigm for flight control by using jets of air from a pressurized source to shape the flow of air over the aircraft surface, with AFC effectors on several surfaces to control the plane’s roll, pitch, and yaw. Eliminating external moving parts is expected to reduce weight and complexity and to improve performance.

“The X-65 is a technology demonstrator, and it’s distinctive, diamond-like wing shape is designed to help us maximize what we can learn about AFC in full-scale, real-world tests,” said Dr. Richard Wlezien, DARPA’s program manager for CRANE. The X-65 will be built with two sets of control actuators – traditional flaps and rudders as well as AFC effectors embedded across all the lifting surfaces. This will both minimize risk and maximize the program’s insight into control effectiveness. The plane’s performance with traditional control surfaces will serve as a baseline; successive tests will selectively lock down moving surfaces, using AFC effectors instead. Read further at: [DARPA Moves Forward on X-65 Technology Demonstrator](#)

#### ➤ 7 January 2024

Following the ‘blow out’ of a window and associated portion of fuselage of an Alaska Airlines’ Boeing 737-9 MAX, Ruby Hinchliffe writes in The Telegraph that the decision by American regulators on Saturday night to temporarily ground several Boeing 737 jets is a massive blow to the US aircraft giant, as well as to the airlines that use its planes. First launched in 1967, the Boeing 737 is one of the most commercially successful aeroplanes ever produced. The narrow-body airliners make up the majority of the aviation giant’s sales volumes with around 10,000 delivered since their inception. But in 2018 and 2019 two fatal crashes claimed the lives of 346 passengers. This led to a 20-month grounding of the planes while significant changes were made.

Now, after the a portion of fuselage of a brand new 737 Max 9 flown by Alaska Airlines blew out at 16,000 feet and left passengers clinging to their seats, the future of the brand has been called into question once again. Alaska Airlines grounded more than 60 737s in an immediate response to the safety failure on Saturday morning, while civil aviation authorities around the globe held talks on the incident. Read on at: [grounding of Boeing 737s is latest blow to business for aviation giant the telegraph - Search \(bing.com\)](#)

#### ➤ 10 January 2024

Guy Taylor reports in City AM that Reaction Engines, a UK-based space and technology company currently developing a rocket engine for hypersonic flight, has said it is looking to cut costs to avoid asking shareholders to drum up more cash. The Abingdon, Oxfordshire-based, firm had previously raised £150m from its backers but warned in its latest Companies House filing that it would run out. The company, which is backed by a slew of major players in the aerospace sector including Rolls-Royce, Boeing and BAE Systems, said there was a “material uncertainty” over its ability to continue as a going concern.

However, it added it was confident risks could be managed, given its previous success in securing outside investment. The space tech firm obtained equity investments of £23.5m in 2021 and £41m in 2022, although it made a pre-tax loss of nearly £30m that same year. “The directors have a reasonable expectation that the company and the group have adequate resources to continue in operational existence for the foreseeable future, and thus they continue to adopt the going concern basis in preparing the financial statements” the company said in a statement. Read on at: [Rolls-Royce and Boeing-backed rocket maker Reaction Engines looks to cut costs ahead of cash deadline \(msn.com\)](#)

➤ **12 January 2024**

Maya Yang in The Guardian advises that NASA has unveiled a one-of-a-kind quiet supersonic aircraft as part of the US space agency’s mission to make commercial supersonic flight possible. In a joint ceremony with Lockheed Martin Skunk Works in Palmdale, California, on Friday NASA revealed the X-59, an experimental aircraft that is expected to fly at 1.4 times the speed of sound – or 925mph (1,488 km/h).

The aircraft, which stands at 99.7ft (30.4 metres) long and 29.5ft wide, has a thin, tapered nose that comprises nearly a third of the aircraft’s full length – a feature designed to disperse shock waves that would typically surround supersonic aircraft and result in sonic booms. In attempts to further enhance the aircraft’s supersonic capabilities, engineers positioned the cockpit almost halfway down the length and removed the forward-facing windows typically found in other aircraft.

Explaining the configurations at Friday’s launch event, NASA’s deputy administrator, Pam Melroy, said: “We made that decision to make it quieter, but it’s actually an important step forward in advancing aviation technology. [With the] huge challenge [of] limited visibility in the cockpit the team developed the external vision system which really is a marvel of high-resolution cameras feeding an ultra-high-resolution monitor.” Melroy added: “The external vision system has the potential to influence future aircraft designs where the absence of that forward-facing window may prove advantageous for engineering reasons, as it did for us.” The aircraft also features an engine mounted on top as well as a smooth underside to prevent shock waves from forming behind the aircraft and causing sonic booms.

The X-59 is set to take its first flight later this year and then its first quiet supersonic flight, NASA said. The agency added that once test flights are completed the X-59 will fly over several cities across the US that have yet to be selected and will collect public feedback on the sound it generates. For the last 50 years commercial supersonic travel over land has been banned in the US because of public concerns over the explosive sonic booms that could be heard from miles away. Read further at: [Nasa unveils quiet supersonic aircraft in effort to revive commercial flights | Nasa | The Guardian](#)

➤ **13 January 2024**

Against the background of disasters with the Boeing 737 Max – the best selling commercial airliner ever with over 1,000 in the air at any moment - Ben Marlow discusses the possibility of China’s C919 (see photo below) at last becoming a commercial success.

See <https://www.telegraph.co.uk/business/2024/01/13/boeing-tailspin-china-commercial-jet-c919/>





➤ **19 January 2024**

Reuters reports that French engine maker Safran said on Friday it had begun wind-tunnel tests for its "RISE" technology project, a radical jet engine design for the next generation of medium-haul jets. Safran and its partner GE Aerospace are testing the building blocks for an open-bladed jet engine able to reduce fuel use and emissions by 20% from the middle of next decade.

Positioned as a possible successor to the "LEAP" model used on the Boeing 737 MAX and about half of competing Airbus A320neo jets, "RISE" features visible fan blades and would be twice the diameter of today's comparable models in a quest for efficiency. A key part of the future certification is expected to focus on the safe handling of any blade failures, since the front fan that provides most of an engine's thrust would not be housed inside the conventional housing familiar to airline passengers.

A one-fifth mock-up of the "Open Fan" concept revealed to reporters on Friday sits inside a vast tunnel outside Modane in the French Alps and will be subjected to 200 hours of testing. The historic S1MA wind tunnel was originally built from plans and steel parts captured at the end of World War Two from a construction site in the Austrian Tirol where Nazi Germany had been racing to exploit advances in propulsion and aeronautics.

The plans included a system of interchangeable test chambers, each weighing 500 tonnes, which slot into the massive rectangular tunnel on rails, and which are still in use today. France's ONERA research body says it is the biggest wind tunnel of its type, which involves accelerating air towards the sound barrier to duplicate or exceed typical cruise speeds. Drawing solely on hydroelectric power, equivalent to 1,000th of France's total consumption, the snaking set of mountainside tunnels has tested iconic aircraft from Concorde to the Airbus A380 and generations of French fighters.

CFM is the world's largest jet engine maker by the number of units sold. It is the sole engine supplier for the Boeing 737 MAX and competes with Raytheon Technologies' unit, Pratt & Whitney, for airline engine selections on the Airbus A320neo

➤ **22 January 2024**

Phil Oakley writes in The Telegraph that few images can represent the perils of investing in an aircraft manufacturer as viscerally as the sight of a hole blown off a plane in mid-flight. Shares in Boeing have fallen 14pc after a refrigerator-sized hole opened up on the side of one of its 737 Max-9 planes on a flight from Oregon to California earlier this month. He goes on to write that The Telegraph is not, however, recommending readers invest in Boeing. Instead, the investment decisions of some of the best-performing fund managers in the world have led this column to shares in one of the embattled American aircraft giant's rivals. Embraer may not be a household name, but the Brazilian company is the third largest aircraft manufacturer in the world, behind only Airbus and Boeing in the number of commercial planes it delivers to customers each year.

➤ **January 2024**

In the January edition of AERO SPACE Tim Robinson and Bella Richards of the RAeS report on the Dubai Airshow which took place between 13 – 17 November 2023 and attracted over 100,000 visitors and 1,400 exhibitors from 95 countries. The show featured 180 aircraft, 20 national pavilions, and a week-long conference and industry forum with some 300 speakers.

# COMMERCIAL AVIATION OPERATION



*Image source: <https://fsd.servicemax.com/2019/02/12/>*

We commence this section with an extract from a late 2021 article on MRO by Aeroclass, part of the Avia Solutions Group family, the world's largest ACMI (Aircraft, Crew, Maintenance and Insurance) provider, with a fleet of 199 aircraft. The group also provides a range of aviation services including, MRO (Maintenance, Repair and Overhaul), pilot and crew training, ground handling, as well as a variety of associated services.

MRO is a term is commonly used in aviation to label any major maintenance facility, whether as part of an airline, an aircraft maintenance unit, an aircraft maintenance facility, or a military facility. While it is true that the term has been generalized to refer to many different companies in the industry, it is also true that all of them revolve around the maintenance of aircraft. This is the real reason to use MRO aviation to categorize those organizations.

An MRO facility is a building, like a workshop or a hangar, which engages in the professional maintenance of aircraft. Moreover, some MRO facilities provide other engineering services and the inspection of engines, landing gear components, and other aircraft components to guarantee safety. Therefore, MRO technicians and equipment help ensure flying aircraft runs safely and reliably by using their ground support equipment.

MRO services are not limited to the maintenance, repair and overhaul of commercial airplanes. The most comprehensive aircraft MRO services can cover all of the following:

- Commercial aircraft
- Corporate jets
- Helicopters
- Other special aircraft

It is essential to notice that, although the term MRO facilities involve a significant industry area, the business models can be very different from one MRO facility to another. Before we speak about the business models, however, let's take a closer look at the activities performed by aircraft MRO services.

### **Aircraft inspections and maintenance**

Inspection includes verifying the conditions of the airframe structure and mechanical components, which is usually performed by applying Non-Destructive Testing (NDT) techniques. These inspections should also cover engines. The most relevant NDT techniques used include ultrasound, eddy current testing, liquid penetrant testing, bond testing, magnetic particle testing, resonance testing, and infrared thermography.

Maintenance refers to the work done to keep the aircraft in optimal condition. It usually comes in the form of planned or preventive maintenance or when inspections discover any potential issues. It is essential to understand that maintenance does not mean the same as repair, as components requiring maintenance are not necessarily completely broken or not working. Some examples of aircraft maintenance include:

- Lubrication of fittings.
- Lubrication of nose gear retract actuator.
- Verification of emergency lights operation.
- Verification of the pressure of the parking brake accumulation.

### **Aircraft repairs and overhauls**

This is a specific activity that is usually confused with maintenance. Repairs may indeed derive from inspection and maintenance activities that discover broken parts, but they should be set apart from the previous activities. The idea is to perform inspections and maintenance to avoid repairs since the latter are necessary when the components are already broken. Typical components requiring repair are failed instruments or controls that are not responding as expected, structural issues like dents, or broken windows, among others.

An aircraft overhaul is a significant endeavour requiring the aircraft to be disassembled part by part. Each part is then inspected to discard any potential issues and to determine whether it is fit to get back into operation. This is essential to keep aircraft airworthiness since mechanics can see what is happening below the surface. They inspect for unusual wear and tear and hidden damage and replace any component that is not fit for its purpose anymore according to standards and specifications. Given their nature, these activities must be planned carefully so the airlines can keep their operations running smoothly.

### **Independent repair stations**

These are the simplest among the business models found in the MRO world. They can be described as small organizations specializing in specific areas of repair like airframes or electrical systems. However, they represent a branch of a larger organization that owns the repair stations which are usually bigger than the standard independent repair stations and are generally found in the most significant airports providing service to the major airlines.

## **Fixed-base operators**

Also known as FBOs, these organizations are always based in one specific airport, hence the name. They usually have close relations with the aviation community of the airport, including local mechanics. They typically add fuelling and parking to the services they provide.

## **Commercial airline hubs**

Some people consider this is not an MRO business model. The reason is that commercial airlines have these MRO facilities within their major hub to service their own fleet only. While there are exceptions, major airlines do not usually offer MRO service to competitors. Since such MRO facilities are usually in the major hub airlines make sure any plane requiring maintenance, repair and overhaul is scheduled to land in the location accordingly to improve efficiency for their operations. Some regional airlines also own MRO facilities, but the main difference is that they can distribute them across their whole area of operations since it is much smaller.

## **The MRO Aviation Industry**

In 2019, IATA forecasted that the average world citizen travelled once every two years. When the value market in the aviation arena grows, supporting operations and aircraft management organizations like MROs are at a higher cost. Also, in 2019 MRO spending was expected to hit more than \$115 billion in just ten years, according to the aviation consultancy Oliver Wyman. Of course, with the pandemic forcing every airline to keep their entire fleet on the ground, this kind of spending was slowed down. However, with the flight demand increasing again the number should move back to what was expected. In fact, North American aftermarket MRO spending is expected to reach \$187.6 billion by 2028.

Given the fact that having in-house MRO capabilities requires an enormous amount of time and capital investment, it is obvious that airlines will continue to choose to work with an external MRO provider. So, MRO organizations can expect a sound future for their businesses. However, it is important for these organizations to consider that MRO and the services they provide to commercial airlines must evolve as the new generation of aircraft and the whole industry grow together with technological developments like IoT, wearables, Augmented Reality (AR), Artificial Intelligence (AI) and many more that seek to take passenger flight to the next level.

With these technologies in place and the power of Big Data, any MRO service provider can use data analytics to apply techniques such as condition-based monitoring and maintenance, which will improve efficiency and effectiveness by making intelligent decisions based on the data obtained. In other words, MRO will keep escalating, and it will continue to be essential for the aviation industry.

We turn now to our quarterly news reporting.

### **➤ November 2023**

Three years after the pandemic Cirium Ascend Consultancy's Lalitya Dhavala and Richard Evans ask in the November edition of AEO SPACE in an article entitled 'The growth cycle recommences?' is it time to finally start looking forwards?

Additionally, in this edition Charlotte Bailey reports on the highlights of the RAeS' Annual President's Summit which, this year, was focused on 'The Future of Flight'.

### ➤ 21 November 2023

John Arlidge writes that Sir Tim Clark, the British-born president of Emirates airlines, has just signed a \$2billion refurb cheque. It's very good news for British travellers because the lion's share will be lavished on the jet that we like more than any other - the Emirates Airbus A380 superjumbo.

Airbus has stopped making the 500-seat double-checker "Clipper of the skies" as it concentrates on smaller single-deck, twin-engine jets to compete with Boeing, which stopped making its four-engine 747 earlier this year. Emirates' Gulf-based rivals, Qatar Airways and Abu Dhabi flag carrier Etihad, say they will ditch their A380s in the next few years. But Emirates is doubling down. In an interview with Telegraph Travel at the Dubai Airshow last week, Clark said: "The A380 will remain Emirates' flagship product and a vital pillar of our network plans. We'll keep all of them going for as long as possible. It's going to be the late 2030s, maybe early 2040s, before we wave goodbye to the last one."

A handful of the carrier's A380s have already been refitted, but "the tsunami of demand for air travel" since the end of the pandemic has convinced Clark to commit to installing thousands of brand new economy and premium economy seats, and hundreds of business and first-class suites across his entire 116-strong A380 fleet. (To put the size of Emirates' fleet in perspective, British Airways, Qantas and Singapore Airlines have the second largest operational fleets in the world with 12 A380s each).

All Emirates' A380s flying to and from UK airports – 103 flights per week – will be refurbished by 2025 in the first stage of the two-year refit programme which will be conducted in specially configured hangars in Dubai. As well as reintroducing A380s on all routes on which it operated before Covid, Emirates is increasing its use. It now flies the jet to 48 cities, including Bali, Bangalore and Istanbul. Read further at: [Emirates unveils futuristic A380 refit \(BA, take note\) \(telegraph.co.uk\)](#)

### ➤ 1 December 2023

Ryanair has found "fake parts" in two of its aircraft engines during scheduled maintenance checks, becoming the latest airline to be impacted by a brewing scandal. The parts were discovered during assessment in Texas and Brazil over the past few months and have since been removed from the engines, the low-cost carrier's chief executive Michael O'Leary told Bloomberg News.

It comes as the global aviation industry is grappling with a fake parts scandal that has left airlines and regulators scrambling to assess engines and trace equipment. Aviation regulators have accused an obscure London company called AOG Technics of supplying thousands of engine parts with faked certification documents for Airbus and Boeing models, including older-generation 737s used by Ryanair.

The Civil Aviation Authority said in August that it has been investigating the supply of a "large number of suspect unapproved parts" through AOG Technics. Mr O'Leary said the Irish airline has never conducted business directly with AOG, receiving the component for two engines instead via third parties. He added the carrier remains "largely unaffected" overall by the scandal. Airlines were told to check their stocks of spare engine parts after reports around AOG started circulating earlier this year, according to Mr O'Leary.



The discovery of so-called fake parts comes after Ryanair was forced to make changes to its winter schedule after Boeing delayed deliveries of aircraft. In October, he said: “It is frustrating because the demand for travel is very strong and we think there are a lot of competitors who are going to be grounding their aircraft.”

The company said to be at the centre of the scandal, AOG Technics, has been accused by US engine giant General Electric and its French business partner Safran of large-scale fraud that they allege has led to fake or old parts being falsely installed into more than a hundred engines. AOG’s founder and owner Jose Zamora Yrala, who founded the business from a rented terraced house in Hove on the South Coast, is fighting the allegations.

Also this month, with the first eVTOL vehicles projected to enter service in 2024, in the RAeS AERO SPACE journal Professor Dame Helen Atkinson and Dr Adrian Cole look at the barriers and enablers facing this new form of transport.



*Vertical Aerospace VX-4*

#### ➤ 18 January 2024

Hazel Plush, travel writer for The Telegraph, advises that “Business class” is fast becoming a misnomer. When airlines first divided their cabins in the 1970s those plush seats and fancy cutlery were the domain of corporate globetrotters. But now, holidaymakers are the ones turning left, and at a pace that far outstrips those flying for work. The reason is simple: our buying power is stronger, and the airlines know it. “Generally speaking, corporations aren’t quite up to the profits they were pre-pandemic,” says Justin Penny, the head of aviation at Flight Centre UK, who is also a frequent business-class flier. “So airlines have shifted to prioritising holidaymakers – and because it’s a global trend, prices are staying competitive too.”

This lust for luxurious leisure travel is driving the industry’s post-Covid recovery. In February [2023] premium passenger traffic reached 86 per cent of 2019 levels, according to the International Air



Transport Association (IATA), whereas the wider industry was only hitting 81 per cent. And despite the cost of living crisis, Britons are prioritising their holiday spending. “Half of people say there will be no change in their holiday spend next year,” says Mark Tanzer, the CEO of Abta, the travel association. “But the numbers planning to spend more (28 per cent) are ahead of those looking to spend less (21 per cent).”

According to Skyscanner, 9 per cent of British travellers intend to upgrade their flight to business or first class in 2024, while British Airways Holidays is currently seeing a 21 per cent year-on-year uplift in searches for holiday packages with premium flights. But which airlines have the best business-class experience – and with more of us prepared to fork out for the privilege, can it retain its exclusivity, something that in recent years has been lost in the airport lounge?

“On one hand, some airlines have top-tier premium cabins, chauffeurs and lounges with food that would bring a tear to King Henry VIII’s eyes,” says Jonathan DeLise, a food consultant based in the US. “On the other hand, even with the most exclusive airlines, there’s a real ‘Ryanairing’ of business class. I’m seeing some airlines charging for lounge access even with a business-class ticket, charging for seating, and devaluing mileage accrual for those with the cheapest business-class fares.”

Upper-tier fares are, generally speaking, airlines’ biggest earners. “Fill up the front of the aircraft and the back takes care of itself,” one industry executive quips. But in order to keep those fares rolling in high-quality business class requires significant investment: in industry parlance, ranging from the “hard product” (the aircraft itself, the seats, the cabin interior), to the “soft product” (the service, food and beverage). And unfortunately they’re far from consistent across airlines. “When it comes to international business class, particularly with airlines like Emirates or Singapore Airlines, there’s an additional level of luxury,” says James Cunningham, a health coach who flies business class at least twice a month. “The seats are more like private suites, and the dining is akin to a high-end restaurant – like a small luxury hotel in the sky.”

Talk to any frequent business-class flier, and the leading Gulf trio come up repeatedly: Emirates, Etihad and Qatar Airways. All have invested in their product to a level that most carriers can only dream of: Emirates invested almost £40 million in its wine collection alone last year, filling a cellar in France with six million bottles, many of which are worth hundreds of pounds, to be served in its premium cabins.

But European airlines are trying to respond. British Airways is currently rolling out new Club Seat cabins in its fleet, featuring flat-bed seats shielded from the aisle by their own private door. Lufthansa is currently giving its long-haul business-class cabins a €2.5 billion (£2.15 billion) refresh, and Air France launched sleek new-look cabins in February 2023, complete with 4K television screens, wireless charging and seats trimmed with French leather.

But while Europe’s carriers invest in their long-haul fleets, their short-haul products are often below par, complains one aviation executive who wishes to remain anonymous: “It’s lagging behind. So often in short-haul the business-class seat configuration just involves an empty seat between two occupied ones. I think some of the European carriers have a long way to go.” Read further at: [Hoi polloi ruined airport lounges – and business class could be next \(telegraph.co.uk\)](https://www.telegraph.co.uk/travel/news/hoi-polloi-ruined-airport-lounges-and-business-class-could-be-next/)

➤ 29 January 2024

Reuters reports that Ryanair has told Boeing that if any U.S. customers refuse to take delivery of 737 MAX 10 aircraft it would buy them "at the right price," executives said on Monday. The Irish airline, Europe's largest by passenger numbers, already has 150 firm orders for the MAX 10, the largest jet in the 737 family, and options for 150 more, with the first deliveries due in 2027. It said it expects the jet to be certified by the end of the year and flying early next year despite the Federal Aviation Administration's now-lifted grounding of MAX 9 jets following the mid-air blowout of a cabin panel on a new Alaska Airlines' plane.

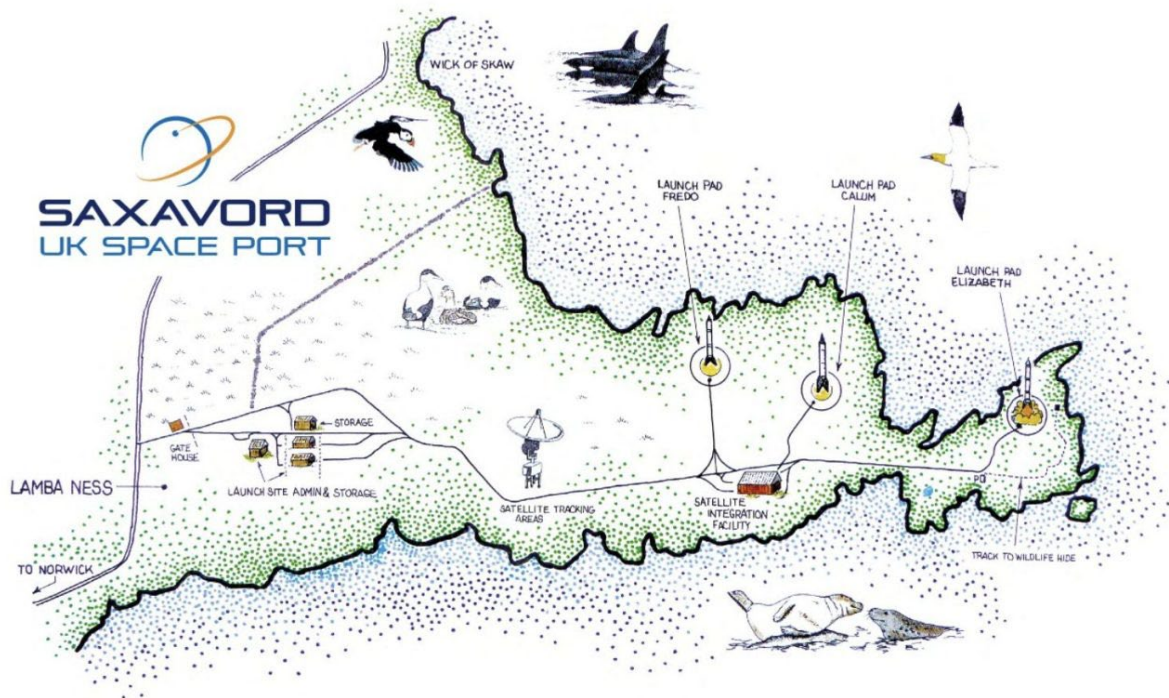
United Airlines CEO Scott Kirby, whose carrier has ordered 277 MAX 10 jets with options for another 200, said last week his airline would build a new fleet plan that does not include the model, which had already been mired in regulatory and delivery delays before the Alaska Airlines incident.

"We have told them if some of these American airlines don't want to take the MAX 10 aircraft, Ryanair will take those aircraft," Ryanair Group Chief Executive Michael O'Leary said in a presentation on the airline's quarterly results. He described the MAX 10 as "transformational" and said Boeing would always make great aircraft "but quality does need to be improved." Continue reading at: [Ryanair tells Boeing it would buy any MAX 10 orders dropped by US airlines \(msn.com\)](#) (Writing by Conor Humphries; Editing by Jamie Freed)



*Boeing 737 MAX-10*

# SPACE



SaxaVord Spaceport, previously known as Shetland Space Centre, is a planned [now licenced] spaceport located on the Lamba Ness peninsula on Unst, the most northerly of the Shetland Islands off mainland Scotland. The site is near the RAF Saxa Vord radar station and the settlement of Skaw, adjacent to the Saxa Vord distillery.

Lockheed Martin's UK Pathfinder satellite launch system will launch from this spaceport. The proposed launch vehicle under this programme is the RS1 from ABL Space Systems, a US-based company developing 27m tall rockets capable of carrying payloads up to 1000 kg into a Sun-synchronous orbit. The UK Pathfinder Launch programme is supported by £23.5 million of UK Space Agency grants.

## Timeline so far

The launch site will also be used by HyImpulse Technologies, a German rocket maker which initially aimed for engine and suborbital testing by the end of 2021, with orbital launches by 2023. In October 2021, Skyrora signed a multi-launch deal over the following decade for this site, hoping to start sending satellites into orbit within 2022.

Plans for the spaceport were submitted to Shetland Islands Council by Farningham Planning in January 2021 to enable up to 30 launches per year. The proposal [was and still is] for three rocket launch pads on Lamba Ness peninsula with additional infrastructure such as a satellite tracking facility, rocket hangars and integration facilities. The plans also documented proposals for a Range Control Centre at the former RAF Saxa Vord complex, fuel storage facilities at Ordale Airport at Baltasound, and improvements to the launch site's approach roads.

On 29 March 2021 Historic Environment Scotland (HES), a statutory body, refused consent for the development on the grounds it would destroy a scheduled monument of national significance – the Chain Home radar station at Skaw. The refusal of consent carried significant legal weight as it is a criminal offence to carry out works to a scheduled monument without such authorisation. Due to the almost one-to-one overlap of the monument location with the proposed spaceport this refusal led to concerns being voiced about the viability of the spaceport project. In January 2022 HES withdrew the objection stating "We recognise the benefits that this development will bring to the community in Unst".

In January 2023 German company Rocket Factory Augsburg (RFA) signed a multi-year launch agreement which gave exclusive access to the northernmost launch pad of the spaceport, Launch Pad Fredo, with testing of the RFA One core stage beginning in mid-2023 and a first launch scheduled in late 2023.

In May 2023, spaceport CEO Frank Strang announced a new \$137 million debt financing package during a UK Parliamentary Science and Technology Committee hearing. The source of the funding was not revealed.

On 28 July 2023, the United Kingdom's UK Civil Aviation Authority (CAA) granted HyImpulse permission to launch its SR75 rocket for the first time from SaxaVord between 1 December 2023 and 30 November 2024. The UK CAA announced on 17 December 2023 that SaxaVord had been granted a spaceport licence "to host up to 30 launches a year", making it "the first fully licensed vertical spaceport in Western Europe."

On 17 December 2023 CEO Frank Strang said: "The award of our spaceport licence is historic for Shetland, Scotland and the UK and places us firmly at the leading edge of the European and global space economy. As importantly for me it is also a fantastic achievement by our Operations and Licencing Team led by Scott Hammond who have been working tirelessly alongside the CAA for almost three years to secure this award. Our team is very proud that the Government has entrusted us with operating a complex, multi-disciplinary and multi-launch spaceport and we all take this responsibility very seriously."

SaxaVord has a roster of clients including Rocket Factory Augsburg, HyImpulse, Lockheed Martin/ABL Systems and Skyrora. The spaceport licence puts Scotland at the forefront of the European launch market, with Scottish satellites already in space, and home-grown rocket companies breaking new ground. There are a number of launch operators from around the world currently developing rockets to launch from SaxaVord who are at various stages of the assessment process with the CAA. Read further, and keep up to date on the latest news about SaxaVord Space Port, at: <https://saxavord.com/https://saxavord.com/>

Turning now to our normal news coverage:

### ➤ **18 November 2023**

Keith Perry reports in The Telegraph that SpaceX has lost contact with its Starship mega rocket following a series of explosions yesterday during its second test flight. The two-stage rocket ship blasted off from a launch site near Boca Chica in Texas and travelled over the Gulf of Mexico. It had

been hoped that the Starship would reach an altitude of 150 miles before plunging into the Pacific near Hawaii 90 minutes after lift-off.

Mr Musk, who owns SpaceX, shared footage of the moment that the rocket took off and in the caption on Twitter, said: “Magnificent Machine with a 1000 ft plume.” It had originally appeared to be successful but it exploded a short time later. SpaceX’s livestream host John Insprucker said: “We have lost the data from the second stage... we think we may have lost the second stage.”

Around eight minutes into the test mission, a camera tracking the rocket revealed an explosion that indicated the vehicle had failed on reaching an altitude of 91 miles. The launch had originally been due to be staged on Friday but it was delayed for a last-minute change of flight-control hardware. SpaceX said in a post on the social media site X, formerly known as Twitter: “With a test like this, success comes from what we learn, and today’s test will help us improve Starship’s reliability as SpaceX seeks to make life multiplanetary.”



*The Starship breaks the sound barrier CREDIT: Eric Gay/AP*

The mission’s objective was to launch Starship into space just shy of reaching orbit, before it plunged through the Earth’s atmosphere for a splashdown off Hawaii’s coast. The launch was the second attempt to fly Starship into space, following an attempt in April that ended in an explosion about four minutes after lift-off.

The Federal Aviation Administration, which licensed the test flight, said: “A mishap occurred during the SpaceX Starship OFT-2 launch from Boca Chica, Texas, on Saturday, Nov 18. The anomaly resulted in a loss of the vehicle. No injuries or public property damage has been reported.” The FAA said it will oversee a SpaceX-led investigation into the testing failure, and will need to approve SpaceX’s plan to prevent it from happening again. Read further at: [SpaceX loses Starship rocket after reaching space for first time \(telegraph.co.uk\)](https://www.telegraph.co.uk/technology/space/2023/11/18/spacex-loses-starship-rocket-after-reaching-space-for-first-time/)



➤ 23 November 2023



*The ExoMars rover, now renamed Rosalind Franklin*

Sarah Knapton, Science Editor of The Telegraph, writes that when Russia invaded Ukraine few could have envisaged that it might prevent life being discovered on Mars. The ExoMars rover mission – a joint venture between the European Space Agency (ESA) and Russia’s Roscosmos – was scheduled to launch in September 2022 with the aim of drilling down into the Red Planet in search of evidence of past habitation. If it had lifted off on time we may already know that life had once thrived on Mars, but the mission was mothballed as relations with Russia soured, leaving Europe struggling to plug critical technical gaps.

Now the UK Space Agency has stepped in to provide £10.7 million to replace a crucial Russian instrument that will pick out the most promising spots for finding life, allowing the mission to launch in 2028. Dr Paul Bate, the chief executive of the UK Space Agency, told The Telegraph: “This is the best opportunity to find if past life once existed on Mars. The really key bit is that once the rover has landed and trundles out and looks around, it needs to find the right spot to drill down. And this instrument can look at the infrared signatures of different rocks and say ‘over there’. It’s like getting to a city and wanting to go out to eat, and instead of walking around every restaurant checking the menu, you look on Google Maps first.”

Dr Bate added: “One of the things that would have been really challenging was if we hadn’t replaced the Russian instrument. This is about finding evidence of past life, but that is not to rule out that you might find extant life, and this is definitely the first and best opportunity we’ve got to find out about life there. This is humanity-defining science and we’re confident in the work that ESA has been doing that this is on track to launch in 2028.”

The ExoMars spacecraft was waiting to be shipped to Baikonur in Kazakhstan for launch on board a Russian Soyuz rocket when war broke out in February 2022. As relations broke down, Russia took



back its landing hardware and instruments, meaning ESA was forced to go back to the drawing board for many of the elements. Last year ESA member states agreed to save the mission, now called the ExoMars Rosalind Franklin mission, with Britain spending £377 million to date to get the project off the ground, and additional support from the US. The ESA is developing a new landing module to get the rover to the surface of Mars, and will need to find a new launcher. The rover, named Rosalind Franklin after the British chemist who helped uncover the double-stranded helix structure of DNA, was built by Airbus in Stevenage.

### ➤ **26 November 2023**

Callum Muirhead reports in *This is Money* that the UK's space sector has been boosted by Jeremy Hunt's announcement of a multi-million pound cash injection to help more rockets blast off from British soil. The Chancellor detailed a package of measures aimed at improving the competitiveness of the UK as a hub for new tech and scientific research. Among these was £121million earmarked for Britain's space industry, with the Treasury saying the cash would support observation of the Earth from orbit as well as creating “new capabilities” for satellite communications tech.

The Government's investment will help to meet the growing demand for satellite manufacturing and launch sites located across the world. Projects backed by the Treasury include the development of the North East Space Skills and Technology Centre in Newcastle, as well as the Cardiff-based Space Forge's National Microgravity Research Centre, which is focused on developing new materials for use in outer space.

While the fledgling industry took a knock in January following the failed launch of a satellite from Cornwall Airport Newquay by Richard Branson's Virgin Orbit, excitement has continued to grow. In August, UK defence giant BAE Systems took a major leap into the space sector by snapping up the aerospace arm of US firm Ball Corporation in a £4.4billion deal. The UK space industry employs almost 50,000 people and added £7billion to the economy last year, according to aerospace trade body ADS Group.

### ➤ **1 December 2023**

In *The Telegraph*, Kathryn Porter suggests that there is one place where the case for nuclear power is indisputable, because otherwise chemical rockets and solar panels will chain humanity to Earth for ever. She goes on to write that unfortunately, neither the US military nor anyone else on Earth, has yet worked out how to harness nuclear fusion – the process that powers the sun and all the other stars. The only human use of fusion is in thermonuclear weapons. This more modest plan involves sending ordinary fission reactors into space.

In many ways, the only real surprise is that it isn't already routine: after all, the US and other militaries already use nuclear reactors to power submarines. They do this because all other means of powering a ship require air, or some other plentiful source of oxygen, to burn chemical fuels with. This means that conventionally powered subs need to come to the surface often (or extend a “snort” air-intake mast above it) so as to run their engines and recharge their batteries. Only a nuclear submarine can move fast and far while fully submerged.

No requirement for air obviously makes nuclear reactors suitable for space however. And reactors have other things in their favour as well. Reactors pack a huge energy density punch, with large

amounts of energy delivered from small units and small volumes of fuel. This makes them ideal for space travel where things which don't weigh a lot or take up a lot of space are always needed.

There are essentially two requirements for energy in spacecraft. One is electrical power, used to run the spacecraft's systems and also for some forms of propulsion. The other is heat energy, used to blast reaction mass out of a rocket to provide thrust. Current propulsion methods mostly use chemical fuel and oxidiser both to generate heat and as the reaction mass. Launch rockets typically consist of large tanks of highly flammable hydrogen or kerosene fuel and other tanks of liquid oxygen. Even the vast amounts of energy stored in such a rocket are not enough to put it into orbit, so the rockets have to be stacked on top of each other, with only the final stage actually achieving orbit. Such rocket stacks are tricky things, as more than a dozen rocket failures in 2022 can attest.

Putting even relatively small payloads into space using this kind of propulsion can become ridiculously expensive. The Saturn V stacks which sent the Apollo spacecraft (around 40 tonnes) to the moon massed almost 3000 tonnes. The forthcoming NASA Space Launch System is essentially the same technology. Elon Musk's Falcon and Starship rockets are at least new designs, and they have the huge virtue that most of the stack comes back to land on Earth for re-use: but they are still bound by the limits of chemical reactions and chemical energy density. And the numbers only get worse for missions beyond Earth orbit.

It is possible to build a nuclear powered rocket, in which nuclear power would heat up the reaction mass – probably hydrogen – rather than a chemical reaction. NASA spent a long time working on this in the Nuclear Engine for Rocket Vehicle Application (NERVA) programme, which ran from 1958 to 1973. The NERVA rocket could have been used as an upper stage in a Saturn V, which would have made the stack able to lift a lot more payload, or it could have been used for propulsion out in space: NASA considered that it would have made manned Mars missions possible in the 1970s. The heated hydrogen in a NERVA-type rocket propels the spacecraft with double the propellant efficiency of chemical rockets. NASA engineers estimated that a mission to Mars powered by nuclear thermal propulsion would be 20 per cent shorter than a trip on a chemical-powered rocket. In the event, NERVA was cancelled as part of the massive NASA cuts of the early 1970s.

An alternative approach is to use electrical power to squirt the reaction mass out of the rocket. This is now done routinely using so-called "Hall thrusters" powered by solar panels. Only tiny amounts of reaction mass (usually krypton, xenon or argon) are ejected from a Hall thruster of today, but they are ejected at huge velocities and so deliver a lot more push for a given amount of reaction mass. A Hall thruster could never lift itself off the ground, but it is excellent for modifying the orbit of a satellite. Because only very small amounts of thrust are involved the small amounts of power produced by solar panels are sufficient.

There have been more ambitious plans along these lines. Former space shuttle astronaut and plasma physicist Franklin Chang Díaz has calculated that a ship equipped with his Variable Specific Impulse Magnetoplasma Rocket (VASIMR) propulsion technology – like Hall thrusters, a type of ion engine – powered by a dustbin-sized nuclear reactor of the same kind used in submarines would be able to reach Mars in just 39 days. Chemically powered craft take about seven months. Now read on at: [There's one place where the case for nuclear power is undisputable \(telegraph.co.uk\)](https://www.telegraph.co.uk/news/science/2018/08/29/there-s-one-place-where-the-case-for-nuclear-power-is-undisputable/)

And with the subject of nuclear propulsion in mind Robert Coppinger writes in the November 2023 edition of AERO SPACE on the peaceful uses of atomic propulsion for space exploration that are, once again, gaining momentum.

➤ **December 2023**

Staying with the RAeS' AERO SPACE journal, Bella Richards explores the challenges and opportunities in the Artemis programme and how it has become a symbol of global cooperation amid the ongoing tensions on Earth.

➤ **2 December 2023**

Sky News reports that the UK, US and Australia have announced a plan to track and identify objects in deep space using high-powered radars. Under the AUKUS security pact a network of three radars will be set up in the UK, US and Australia to protect satellites and assist with space traffic. Once the radars are fully operational by 2030, according to the Ministry of Defence (MoD), the system will be able to characterise objects up to 22,000 miles away from Earth. That's about 10% of the distance to the Moon, but far further than the 250 miles between Earth and the International Space Station.

The "unique geographic positioning" of the three nations means the Deep Space Advanced Radar Capability (DARC) programme would provide global coverage, the MoD says, including "detecting potential threats to defence or civilian space systems". The UK's radar, which is planned for construction at Cawdor Barracks in Pembrokeshire, is expected to be up and running by the end of the decade, with Australia's due in 2026.

➤ **10 December 2023**

Lewis Page advises that later today, at 8:14pm Eastern, the US military will once again be sending up its robotic mini space shuttle, the X-37B, once described by the Iranian government as a "secret space warplane". Despite the Iranian excitability, however, the X-37B probably won't be doing anything very aggressive or hostile. Not this time anyway. According to the US Space Force and the Department of the Air Force Rapid Capabilities Office, in charge of the mission: "The X-37B Mission 7 will launch on a SpaceX Falcon Heavy rocket for the first time, designated USSF-52, with a wide range of test and experimentation objectives. These tests include operating the reusable spaceplane in new orbital regimes, experimenting with future space domain awareness technologies, and investigating the radiation effects on materials provided by NASA."



*The X-37B robot mini-shuttle in a hangar at Vandenberg Space Force Base. CREDIT: Reuters*

So there will be some innocuous civilian NASA science business going on. There will also, however, be some experimentation with “space domain awareness”. That sounds suitably anodyne, but in fact it is a military mission. It’s one half of the ability to wage war in space.

#### ➤ **January 2024**

In the January 2024 edition of AERO SPACE Richard Lowe asks what does the year ahead hold for the global space industry? The RAeS Space Group provides some insights.

And in the same edition, Trevor Beattie and Kellie Gerardi talk about their astronaut experiences with Virgin Galactic, Trevor with a piece of aeronautical history in his pocket – a cheque signed by Orville Wright in 1923 - and Kellie who was responsible for several science experiments during her flight.

#### ➤ **8 January 2024**

The first American spacecraft to attempt to land on the Moon in more than half a century blasted off early on Monday, reports the Foreign Staff of The Telegraph. Space robotics firm Astrobotic’s Peregrine lunar lander began its journey toward space at 2:18am eastern standard time (07:18 GMT) after launching off from Cape Canaveral, Florida. It was being carried on the first flight of Vulcan, a powerful new rocket built by United Launch Alliance (ULA), a joint venture of Boeing and Lockheed Martin.

If all goes to plan, Peregrine will mark the first US soft landing on the moon since the final Apollo landing in 1972, and the first-ever lunar landing by a private company - a feat that has proved elusive in recent years. It is set to touch down on a mid-latitude region of the Moon called Sinus Viscositatis, or Bay of Stickiness, on February 23.

Until now, a soft landing on Earth’s nearest celestial neighbour has only been accomplished by a handful of national space agencies: the Soviet Union was first in 1966, followed by the United States which is still the only country to put people on the Moon. China has successfully landed three times over the past decade, while India was the most recent to achieve the feat on its second attempt last year.

Now, the United States is turning to the commercial sector in an effort to stimulate a broader lunar economy and ship its own hardware at a fraction of the cost, under the Commercial Lunar Payload Services (CLPS) program. Read on at: [US launches first Moon landing mission since Apollo as Vulcan takes off \(msn.com\)](#)

#### ➤ **26 January 2024**

Reported in Indy 100, NASA has announced that its Ingenuity helicopter which has been operational on Mars won’t fly again after suffering damage. The groundbreaking technology had been the first robot vehicle to fly on a different planet to our own, but the space agency has now stated that its mission is over.

Despite the fact that Nasa had only planned for Ingenuity to fly for 30 days, it had been operating for nearly three years. [However] rotor blade damage means that it won’t be able to fly again, and NASA Administrator Bill Nelson posted a video on social media discussing the helicopter’s remarkable run.

“It is bittersweet that I must announce that Ingenuity, the ‘little helicopter that could’ - and it kept saying, ‘I think I can, I think I can’ - well, it has now taken its last flight on Mars,” It flew an awful lot in that time – far exceeding the expectations of the engineers who built it. In fact, it flew 14 times farther than originally planned and covered a distance of 10.5 miles (17 km) through all 72 flights.

Things began for Ingenuity when it landed strapped underneath NASA's Perseverance rover, which landed on the Red Planet three years ago. To fly on Mars at all is an incredible technological achievement, especially given that taking off from the surface of the planet is much harder than on Earth given that it's especially hard to gain aerodynamic lift as the atmosphere is only 1 per cent as dense.

It made its last journey on January 18, where it performed a short, vertical flight before beginning its descent and losing contact with the team. A few days later, images showed the shadow of its rotor blades, showing one had broken.

### *Goodbye Ingenuity*



*An artist's impression of the Ingenuity rover (Creative Commons)© Provided by Indy 100*





## UK DEFENCE



*Global Combat Air Programme: a multinational initiative led by the United Kingdom, Japan, and Italy to jointly develop a sixth-generation stealth fighter.*

With the current increasingly unstable geopolitical situation in the world we commence this section with a timely article by Tobias Ellwood MP, former UK Foreign Office & Defence Minister:

Presidents and Prime Ministers do not drop everything for impromptu visits to war zones unless the world is in trouble. Not long after President Biden’s return from Israel, his State Department issued a global threat alert to all Americans – anywhere abroad – “to exercise extreme caution.” It’s a powerful indictment of just how fragile our world has become. The outbreak of war in the Middle East is yet another red light on the ever busy ‘global order dashboard’, underscoring how tested the West’s bandwidth has become in containing an ever-deteriorating threat picture.

Prepare for more. Autocrats will have calculated that there’s been no better time since the fall of the Berlin Wall to seriously advance their belligerent agendas. Indeed, after three decades of relative peace (and growing complacency) we must finally acknowledge how increasingly unstable our world has become. We face serious shifts in geopolitical, economic, and military centres of gravity. Eastwards, growing authoritarianism and the formation of new alliances are actively pursuing a very competing interpretation of global order. Our arrogant assumption that after thousands of years of war we had crafted a utopian structure – one of liberal democratic global governance – led us to believe the concept of state tyranny was finally contained, if not defeated.

But, as we saw on 7th October, Western power can’t prevent humans stooping to grotesque levels to further their agenda. For years now despots and dictators, already abusing their domestic constitutions to retain power, began appreciating the absence of serious pushback (beyond general condemnation) when they expanded their influence beyond their borders. Russia secured chunks of Georgia and China dozens of islands before Ukraine was invaded. More subtly, both Xi and Putin have lured Africa and Asia into their net. Putin with Wagner mercenaries, Xi through debt traps. 20 years of coercive power



resulting in gradual democratic decline across the world. This has already led us into a new Cold War about which many are in denial.

Russia's adventurism in Eastern Europe and Iran's proxy influence over Hamas (and other terrorist operations) could be manageable in isolation, but not with China's wider rejection of Western standards and its support of expansionist powers spurring our world to splinter into two competing spheres: the traditional overture to a world stumbling to war. With precious little visionary leadership, many non-aligned countries, now grouped as the Global South, remain unwilling to take sides – though dozens are effectively silenced by signing up to China's 'One Belt, One Road' programme.

History doesn't repeat itself, but it rhymes. Historically, epoch-based power-shifts have often been spawned by major wars and the peace that follows, hallmarked by major international treaties written by the victors. These rules last a few generations before power shifts away from said victors and alliances change, thereby leading to a new conflict that results in a reset to establish a new set of rules. The 1648 Westphalia Treaty concluded the Thirty Years War and established the principle of the sovereignty of nations that's still recognised today. 1713 saw the Treaty of Utrecht which established the balance of power. The Vienna Congress in 1815, after the tumultuous Napoleonic Wars, established a conference system to try to guarantee that new balance of power across Europe. The Treaty of Versailles in 1919 after the Great War reinforced this by creating the League of Nations. Yalta and Bretton Woods finished the job by birthing institutions like the United Nations and International Monetary Fund.

Once again the great cogs that turn the mighty geopolitical kaleidoscope are beginning to rotate with no clear indication where they will stop. Today's world is volatile, further complicated by a general retreat from globalisation, military proliferation, the growing challenges of climate change, and the distraction of domestic politics. It is imperative to recognise the gravity of the situation. The number of people living in democracies has plummeted from 3.9 billion in 2017 to around 2 billion today. Around 70 percent of the world's population now live under autocratic rule.

Without swift, collective action, we risk descending into chaos and wider conflict – echoing the failures of the 1930s. Just as then our enemies challenged us one by one – Japan invaded Manchuria, Italy Abyssinia, and Germany Austria – but we turned a blind eye. With Russia in Ukraine, Iran in Gaza, China must be calculating there's no better time than now to make a move on Taiwan.

The penny must now drop; our rules-based order requires urgent repair, and we are overdue a significant upgrade to our defence posture. Not just for our own security, but to add authority to our statecraft. As a nation that offers leadership and convening power, it's time for Britain to wake up and step forward with collective solutions to put these red lights on the global order dashboard out.

Now with those sobering comments in mind we continue our chronological news reporting with a report from Germany:

### ➤ **2 November 2023**

James Callery writes in the Daily Mail that Germany is considering ditching a £90billion fighter jet project with France and joining a rival programme with Britain. Ahead of a potential deal, German Chancellor Olaf Scholz is also in discussions about removing Germany's veto on a delivery of Eurofighter Typhoon jets to Saudi Arabia, which the UK considers strategically important. A pact of this

nature would amount to a coup for the UK and reflect a progressively intensifying rift between Germany and France, with the two nations holding contrasting views on issues including diplomatic protocol, air defence and energy.

The fighter jet issue has left Scholz with tough choices that will factor in his nation's alignment in Europe and worldwide. He must decide whether to keep the Future Combat Air System (FCAS), a leading Franco-German-Spanish programme to construct the next generation of air power, which some analysts have hailed as Europe's most significant defence project.

The central focus of the project is to use a single platform to digitally interweave a new brand of stealth fighter with drones, automated mini-fighter jets, older combat aircraft and naval or ground-based assets. Sources familiar with Scholz's thinking say he is worried that the project could turn into a white elephant and fall behind competitors, The Times reports.

The US navy and air force each plan to field their own new types of sixth-generation jet by 2030. Rolls-Royce and BAE Systems are taking the leading role in developing a stealth fighter known as the Tempest, scheduled to be ready by 2035. It will form the foundation of a wider British-Italian-Japanese aerospace alliance. One senior German official told the newspaper that Scholz did not see any point in FCAS competing with Tempest and wanted either to merge the two or jettison FCAS and join Tempest if that wasn't a possibility. Scholz is also said to be frustrated by the preferential treatment France has handed to its own aerospace firms in the early stages of the FCAS project.

The source [also] said that Scholz was annoyed that Prime Minister Rishi Sunak has yet to visit him in Berlin and wanted to see much more direct engagement from figures at the top of the UK government over strategic questions if a tighter UK-German partnership were to manifest. British officials note that Sunak joined the Munich Security Conference in February and has taken part in phone calls and four face-to-face meetings with the Chancellor on the sidelines of international summits this year. Another issue is the Israel-Hamas war. Germany has shown support for Israel and sources told the newspaper that the government would prefer to wait to see how Saudi Arabia positions itself before Berlin takes a decision on weapons deliveries.

The next-generation combat aircraft decision is closely tied to a British-German dispute over the delivery of 48 Eurofighter Typhoon jets to Saudi Arabia in a package that could be worth more than £5billion. Germany blocked a deal for British-made fighter jets to be exported to Saudi Arabia, putting thousands of highly skilled engineering jobs at risk. The Typhoon programme run by Lancashire-based BAE employs more than 6,000 aircraft specialists and supports an estimated 28,000 jobs in the supply chain. The Eurofighter Typhoon was built by a consortium, including the UK and Germany, and export licences must be approved by all its members. Production lines at the company's factories would close without further orders for the aircraft from overseas.

Germany is blocking Britain's deal to sell the 48 aircraft to Saudi Arabia due to the country's controversial human rights record. Berlin adopted this stance following the murder by Saudi agents of dissident Jamal Khashoggi in 2018 – and in protest at the deaths of civilians caused by Saudi air strikes in Yemen. Its veto could cost £15billion, which Britain would have to raise from other markets to maintain the production lines. Scholz is apparently unwilling to upset Green politicians, who strongly oppose arms sales to Saudi Arabia. When asked about the issue at a Nato summit in July, Scholz said 'no decision' on Typhoon deliveries to Saudi Arabia was 'foreseeable at the current time'.

Any funding shortage could also have a knock-on effect on research and development of Britain's next-generation fighter jet, the 'GCAP'. Justin Bronk, from the RUSI military think-tank, said: 'Not securing the sale would be a black mark against the UK' in terms of its reputation as a reliable arms partner. The deal was initially signed by the UK Government five years ago, when it was assumed the sales would be supported by Germany, Italy and Spain.

➤ **10 November 2023**

David Millward, The Telegraph's US Correspondent, reports that the B-21 Raider, the next-generation stealth bomber capable of disguising itself as another object, has taken to the air for the first time. The B-21, the long-awaited successor to the B-2 Spirit stealth bomber that entered service in the late 1990s, took off from the manufacturing plant at Palmdale California on Friday morning. Accompanied by an F-16 chase plane the aircraft completed a 39 mile journey to Edwards Air Force Base where further testing will take place.

The US air force is planning to build 100 of the planes, which will be capable of being flown with and without pilots. Little has been made public about the aircraft's capabilities. Similar in shape to the original stealth bomber it will be built from more advanced materials and use updated technology to make it more capable of surviving in a future conflict. It is also said to have the ability to spoof enemy air defences by disguising itself as other objects, such as other aircraft, by controlling its electronic emissions and radar signature. Read on at: [Next-generation US stealth bomber capable of disguise takes first flight \(telegraph.co.uk\)](https://www.telegraph.co.uk/technology/2023/11/10/b-21-raider-takes-first-flight/)

➤ **13 December 2023**

Guy Taylor writes in City A.M. that the Chairman of Airbus Defence and Space UK, Ben Bridge, has warned that Britain must speed up its defence procurement process amid a fast-evolving global threat environment. "So the thing for me really is speed of procurement," Mr Bridge told City A.M. in an interview, noting the "three to four year cycle of coming up with requirements, staffing it and putting it out as a competition" for tenderers [is far too slow in developing circumstances]. Multiple year waits amid changing governments and challenges throughout the procurement process ultimately result in a final product which "isn't agile and probably isn't giving the UK what it needs," Bridge, a former Royal Navy helicopter pilot with over two decades experience at BAE Systems and Airbus, argued.

The UK's defence procurement system is facing growing scrutiny this year as the war in Ukraine exposes shortfalls in the British military and pushes defence spending up the national agenda. Western governments have beefed up military budgets following Putin's invasion of Ukraine and a new period of instability in the Middle East has only added to concerns in Western capitals. But in January, former defence secretary Ben Wallace described the British military as "hollowed out and underfunded," after a US general privately told the Ministry of Defence it was no longer a top-level fighting force.

A 60-page report from parliament's defence committee followed in July, in which MPs argued the UK must "put its house in order" on procurement, highlighting comparisons with a quicker and more efficient French system. One example cited the laboured delivery of eight anti-submarine Type 26 frigates. An equivalent Japanese warship was brought into military service at a third of the time.

"Because technology is moving extremely quickly [and] threats are emerging and changing in an unprecedentedly quick way, we've seen the benefit of being able to turn around solutions to threats

quickly in Ukraine of course, including with surprise technologies, both in space, in drones, in the rest of it,” Bridge told City A.M. “We know the UK is looking at how it can be more agile than its procurement process, and we really welcome that.”

Airbus is one of the biggest players in the global arms industry. Its defence and space segment netted €11.3bn (£9.8bn) in revenue in 2022. It is also a part of Eurofighter Typhoon, an industry collaboration with BAE Systems and Leonardo, which manages supply of the Typhoon combat aircraft in Europe.

### ➤ 14 December 2023

Sky News reports that the UK has signed an international treaty with Japan and Italy to build the next generation of stealth fighter jet. The deal will see the headquarters for the Global Combat Air Programme (GCAP) - the defence partnership between the three nations - based in Britain. Prime Minister Rishi Sunak announced the collaborative international effort to build military planes with supersonic capability and cutting-edge technology a year ago. Called Tempest in the UK, the ambition is for them to take to the skies by 2035 and serve as a successor to the RAF Typhoon. The Ministry of Defence (MOD) said the signing of the treaty in Tokyo on Thursday marked a "key stage" in the development of the aircraft.

Defence Secretary Grant Shapps was in the Japanese capital to sign the document alongside his Italian and Japanese counterparts, Guido Crosetto and Minoru Kihara. He said: "Our world-leading combat aircraft programme aims to be crucial to global security and we continue to make hugely positive progress toward delivery of the new jets to our respective air forces in 2035. "The UK-based headquarters will also see us make important decisions collaboratively and at pace, working with our close partners Italy and Japan, and our impressive defence industries, to deliver an outstanding aircraft."

When complete the Tempest will boast a powerful radar that can provide 10,000 times more data than current systems, the MOD said. Pilots will be able to use virtual reality in the aircraft's digital cockpit, with vital information displayed directly in front of them. The on-board weapons system will deploy artificial intelligence and machine learning to "maximise the effect" its arsenal can deliver, the department said.

Some £2bn has been committed to the project by the UK Government up to 2025, with the investment announced in 2021 before the partnership with the other two nations on GCAP was confirmed. The MOD awarded the contract to BAE Systems, in collaboration with Leonardo UK, missile maker MBDA UK and Rolls-Royce, as well as industry partners from Japan and Italy. Joint development of the aircraft is due to start in 2025.

The treaty confirms that the UK will host the joint GCAP government headquarters, with a Japanese chief executive at the helm at the outset. Locations for the government HQ and a separate industry base, which will also be in the UK, and led by an Italian, are to be announced in "due course", the MOD said, along with a timeline for opening. The next step is for the treaty signed by the allies on Thursday to be sent to all three national parliaments for ratification.

➤ 1 January 2024

Howard Mustoe writes that a defence company founded by US entrepreneur Palmer Luckey, who sold his virtual reality business to Facebook at the age of 21, will double its UK presence in the next two years as it expects a boom in defence technology.

Anduril develops anti-drone technology, detection equipment and maritime security technology, all centred around its Lattice artificial intelligence-powered software. The company recently developed a vertically launched jet engine powered drone named Roadrunner which is designed to intercept aircraft and other drones and gather intelligence. “We have a strong belief that the UK is rife with engineering in defence and aerospace talent. We plan to continue to hire and grow in that market for the foreseeable future,” says Gregory Kausner, Head of Global Defence. “Our focus is on autonomous systems. Robots capable of acting independently based on conditions set by humans with humans.”



*CREDIT: Anduril*

The company was founded in 2017 and entered the UK in 2019 as its first international market. It plans to double its 40-strong UK workforce to 80 and “plans to design, engineer and manufacture products in the UK for the UK”, Mr Kausner said, opening test ranges and offices.

Founder Palmer Luckey sold Oculus, his virtual reality headset startup, to Facebook in 2014 for more than \$2bn (£1.6bn) and personally made an estimated \$700m. He was let go in 2016, reportedly for making donations to an anti-Hillary Clinton group. The following year he set up Anduril, named after a legendary sword in JRR Tolkien’s Lord of The Rings books, which is meant to bring modern technology onto the battlefield.

The UK defence sector has seen a wave of investment and expansion since Russia’s attack on Ukraine.

Relatively new technologies to defence, like drones, have meant militaries are trying to adapt quickly to counter them. Now read on at: [Defence company founded by Oculus creator plans to double UK presence \(telegraph.co.uk\)](https://www.telegraph.co.uk/defence/2024/01/12/defence-company-founded-by-oculus-creator-plans-to-double-uk-presence/)

➤ **12 January 2024**

yahoo/news advises that during his visit to Kyiv on 12 January UK PM Rishi Sunak signed a 10-year security agreement with President Volodymyr Zelenskyy which entails the UK providing material and intelligence security support to Ukraine through the next decade, Interfax-Ukraine news agency reported. "We have just reached an agreement with Britain on security in all areas: on the ground, in the air, at sea, in cyberspace," Ukrainian public broadcaster Suspilne quotes Zelenskyy.

The agreement is designed to last until Ukraine joins NATO, but can be extended if needed. "If this [Ukraine's accession to NATO] happens before the expiration of this agreement the security architecture we have created will actually be incorporated into the security system of the entire Alliance," Zelenskyy added.

London will share intelligence with Kyiv, assist with national cybersecurity, military training, and develop mutual defense industry cooperation, according to a statement on the UK Government's website. The deal also commits the UK to consult with Ukraine in case of another Russian invasion and to provide "swift and sustained" military assistance. The agreement marked the first implementation of broad security arrangements reached at the 2023 NATO Vilnius summit between Ukraine, G7 nations, and other partners.

➤ **19 January 2024**



*The DragonFire laser weapon uses electric power, meaning it does not require ammunition - Ministry of Defence© Provided by The Telegraph*

A high-powered laser beam that will “revolutionise the battlespace” has been successfully fired for the first time. The DragonFire’s high-power firing of a laser weapon against aerial targets during a



trial at the Ministry of Defence's Hebrides Range was a UK first. The weapon, developed by QinetiQ, the UK defence contractor, is being developed to hit missiles, drones and other enemy targets. Grant Shapps, the Defence Secretary, said: "This type of cutting-edge weaponry has the potential to revolutionise the battlespace by reducing the reliance on expensive ammunition, while also lowering the risk of collateral damage." He added that such advanced technologies were "crucial in a highly contested world," and helped the UK to "maintain the battle-winning edge and keep the nation safe".



*A Dragon's Fire!*

The weapon's range is classified, but it is highly accurate and reportedly capable of hitting any visible target. Laser-directed energy weapons can engage targets at the speed of light and use an intense beam of light to cut through the target, leading to structural failure or more impactful results if the warhead is targeted. In 2017 a £30 million contract was awarded to the DragonFire consortium to demonstrate the potential of the laser weapon.

The cost of operating the laser is typically less than £10 per shot, which means it has the potential to be a long-term low-cost alternative to certain tasks missiles currently carry out. In comparison the Sea Viper missiles that were shot from HMS Diamond in the Red Sea to take down the Iranian-backed Houthis drones and missiles cost roughly £1 million each.

Although the range of the DragonFire is classified, its precision is equivalent to hitting a pound coin from a kilometre away. The MoD said the tests demonstrated the ability to engage aerial targets at relevant ranges and was a major step in bringing the technology, which is being considered by the British Army and Royal Navy, into service.

The latest milestone builds on a series of successful trials, including the first static high-power laser firing, and demonstration of the DragonFire system's ability to track moving air and sea targets with very high accuracy. The trial was sponsored by the MoD's Defence Science and Technology (DST)

organisation and Strategic Programmes. Dr Paul Hollinshead, DST Laboratory chief executive, said: “These trials have seen us take a huge step forward in realising the potential opportunities of, and understanding the threats posed by, directed energy weapons.”

#### ➤ 25 January 2024

Hannah Baker in **BusinessLive** writes that defence heavyweights including Airbus, BAE Systems and Babcock, have signed up to a new UK charter highlighting their commitment to cutting carbon emissions, building a more diverse and dynamic workforce and keeping Britain safe. The UK Defence ESG Charter, launched on Thursday (January 25), was spearheaded by ADS - the leading trade body for Britain’s defence, aerospace and security industries - and has been signed by some of the biggest names in British industry. Kevin Craven, chief executive of ADS, described the charter as the “foundation for a better sector” and encouraged more firms to sign up to its aims. The charter’s inaugural signatories are ADS, Airbus, Babcock, BAE Systems, Leonardo, MBDA, QinetiQ, and Thales.

Mr Craven said: “The UK is facing an increasingly complex threat landscape: war in Europe, rising cyber-attacks and the devastation of climate change all pose risks to our national security and economic prosperity. We must work together to strengthen our defences, support our armed forces, cut carbon emissions, build a more diverse workforce and deliver sustained growth to every nation and region in the UK. “Sustainability is not the responsibility of a single organisation, it is an effort that requires collective action. This ESG Charter outlines our firm commitment to building a stronger, fairer and more prosperous Britain. It is the foundation for a better sector. We want to enhance our sustainability and secure the long-term access to financial services that are vital for Britain’s safety and prosperity.”

The ESG Charter outlines the industry’s commitment to cutting carbon emissions to help Britain reach its net-zero target by 2050 and develop innovative new technologies for the armed forces. It also pledges to cut Britain’s skills gap by forging more partnerships with colleges, universities and local communities to encourage more people to consider careers in science, technology, engineering and maths (STEM). Additionally, the charter outlines a commitment to improve diversity, equality and inclusion across all levels.

The value of the sector to keeping Britain’s national infrastructure safe, supporting the armed forces and shoring up the nation’s defences against cyber-attacks are also highlighted in the document. It commits to “improve and sustain a strict, efficient and comprehensive export control system” and play a pivotal role in Britain’s prosperity and protection. The defence sector delivers a £9.8bn boost to the British economy every year and employs more than 147,500 people. Seventy per cent of defence jobs are outside London and the industry supports 6,900 apprenticeships.

#### ➤ 27 January 2024

Sean Bell, military analyst, writes for Sky News that four British fighter jets attacked a series of Houthis targets in Yemen after taking off from RAF Akrotiri in Cyprus on Monday. It was the second RAF attack on the Iran-backed militia, and was part of a coordinated wave of strikes with the US. The latest US strikes were all carried out by jets from the USS Eisenhower. So why is the UK using land-based RAF Typhoons flying over 3,000-mile missions from Cyprus rather than the immensely capable carrier strike (CS) ability?

By way of background, in early 1997 the Labour government launched a defence review which sought to build on the global power-projection role developed by Joint Force Harrier. It led to the commissioning of two Queen Elizabeth-class aircraft carriers to act as the foundations of a new, potent CS group. They were built at Rosyth dockyard - in Gordon Brown's then constituency - and entered into service in 2017 and 2019 respectively at a cost of £6bn for the pair. These are now the most powerful ships in the navy's history and were designed to deploy with up to 72 strike aircraft on board [if operating together].

However, unlike the UK nuclear deterrent, which has four Vanguard-class submarines to maintain a "continuous at-sea deterrent", two carriers were not sufficient to maintain any single carrier at continuous readiness for operational duty. Unlike the US carrier fleet which maintains an operational posture around the world 24/7 - each bristling with fighter jets and ready to deploy at very short notice - UK carriers do not routinely have jets on board and often require considerable notice to work up to operational readiness.

When the US and UK forces attacked the Houthis, the two navy carriers were moored up at Portsmouth. Why? Aircraft carriers do not operate autonomously. They routinely deploy with two frigates and two destroyers to provide protection from the air, a submarine, and Royal Fleet Auxiliary (RFA) support ships to replenish fuel and dry stores. However, the RFA Fort Victoria is the only dry store vessel in service and has limited availability due to a staffing crisis and serviceability. Its replacements are not due to enter service for several years. In short, although UK carrier strike has immense potential, it is not a 24/7 capability and has not been resourced effectively.

The option to deploy from Cyprus is very beneficial in some situations. The irony is that the UK CS has never deployed a combat mission from its decks since it was commissioned in 2017. Yet the first occasion when it might have demonstrated its potential [against the Houthis], it was not available. This conundrum is not lost on the Ministry of Defence.

Indeed, as recently as February 2023, politicians have called for the second of the carriers - HMS Prince of Wales - to be either decommissioned and put in the reserve fleet or to be scrapped or sold. But even if the UK CS capability had been available, would it have been used?

The Houthis are apparently becoming increasingly effective at targeting merchant and military shipping - bear witness to the excellent performance of HMS Diamond in providing protection to shipping in the region. Would the UK have risked deploying the carrier and all its support vessels into such a dangerous part of the world?

Although such a deployment would have reduced the distance for the fighters to reach their target, the RAF has the resources and capability to launch such missions from a distance, and at significantly reduced risk. For low-tempo, precision strikes, the option to launch RAF assets from a main operating base in Cyprus carries significant benefits.

Having flown fighters from the decks of an aircraft carrier, I understand well the enormous potential of carrier-based aviation to have global reach. However, in these uncertain times the UK needs assets available at short notice to deliver decisive effect and provide swift and comprehensive options to our political masters. Having a carrier strike capability that is available "some of the time" is just not cost effective. It is like resourcing a fire brigade that is available only part of the year - with the significant risk that the one time they are needed, they are not available.

According to Defence Secretary Grant Shapps, we live in an increasingly dangerous world. When asked if we should increase defence spending as a proportion of GDP to levels seen under Mrs Thatcher (4%), he pointed out it was not just the amount of money spent, but how it's spent. Perhaps the UK carrier strike capability provides a cautionary tale for future defence spending.

#### ➤ 29 January 2024

Nick Gutteridge reports that MP's say cuts to the Air Force make it too small to withstand the levels of attrition to be expected from war with Russia. He goes on to write: Britain has no radar surveillance planes, in what MPs have warned presents a "serious threat" to the nation's "warfighting ability".

The head of the RAF said the UK did "not have an airborne early warning capability at the moment", despite it being "fundamental to our ability to protect our country". Air Chief Marshal Sir Richard Knighton told the Commons last year that it was "important to us – to the country, to the Air Force" that the gap be swiftly plugged.

The RAF retired its seven-strong fleet of E-3 Sentry planes in 2021 amid plans to replace them with the more advanced E-7 Wedgetail made by Boeing. But delivery of the aircraft has been delayed with the first now not expected to arrive until the second half of this year, the Government told MPs. [Furthermore,] ministers have also scaled down the order for Wedgetails from a planned five to just three to save £700 million. Read: [RAF's lack of early warning radar planes poses a 'serious threat' \(telegraph.co.uk\)](#)

#### ➤ 31 January 2024

Tony Diver and Danielle Sheridan write that Britain is poised to send an aircraft carrier to the Red Sea to counter drone and missile attacks from Houthi rebels.

The Royal Navy is preparing to step in to replace USS Dwight D Eisenhower when it returns to America, as the Houthis warned of a "long-term confrontation" in one of the world's busiest shipping lanes. James Heappey, the armed forces minister, said on Tuesday that the UK may "co-operate with the Americans" and step in to "plug a gap" in the Red Sea. The UK has two aircraft carriers designed to carry F-35 fighter jets. One is HMS Prince of Wales, which would face its first combat operation if it were deployed. The other is HMS Queen Elizabeth. Now read on at: [Britain set to deploy aircraft carrier to Red Sea \(telegraph.co.uk\)](#)

#### ➤ January 2024

We conclude this section as we started, with Tempest, and refer the reader to an article on GCAP by Joe Coles in the January edition of AERO SPACE.



# CYBER



*RC-135W Rivet Joint*

*Photographer, Sergeant Si Pugsley RAF. Crown Copyright*

Bearing in mind the current geopolitical situation, courtesy of Wikipedia we commence this edition with an explanation of electromagnetic warfare or electronic warfare (EW). This is warfare involving the use of the electromagnetic spectrum or directed energy to control the spectrum, attack an enemy, or impede enemy operations. The purpose of EW is to deny the opponent the advantage of, and ensure friendly unimpeded access to, the electromagnetic spectrum. EW can be applied from air, sea, land, or space by crewed and uncrewed systems, and can target communication, radar or other military and civilian assets.

Military operations are executed in an information environment. The electromagnetic spectrum portion of that environment is referred to as the electromagnetic environment (EME). The recognized need for military forces to have unimpeded access to, and use of, the electromagnetic environment creates vulnerabilities and opportunities for electronic warfare in support of military operations.

Within the information operations construct, EW is an element of information warfare; more specifically, it is an element of offensive and defensive counter-information. NATO has a more encompassing and comprehensive approach to EW – it is considered to be warfare in the EME.

NATO has adopted simplified language which parallels that used in other warfighting environments like maritime, land, and air/space. For example, an electronic attack (EA) is offensive use of EM energy, electronic defense (ED) and electronic surveillance (ES) speak for themselves. The use of the traditional NATO EW terms, electronic countermeasures (ECM), electronic protective measures (EPM), and electronic support measures (ESM) have been retained as they contribute to, and support, electronic attack (EA), electronic defense (ED) and electronic surveillance (ES). Besides EW, other



EM operations include intelligence, surveillance, target acquisition and reconnaissance (ISTAR), and signals intelligence (SIGINT).

Primary EW activities have been developed over time to exploit the opportunities and vulnerabilities that are inherent in the physics of EM energy. Activities used in EW include electro-optical, infrared and radio frequency countermeasures; EM compatibility and deception; radio jamming, radar jamming and deception and electronic counter-countermeasures (or anti-jamming); electronic masking, probing, reconnaissance, and intelligence; electronic security; EW reprogramming; emission control; spectrum management; and wartime reserve modes.

Electronic warfare consists of three major subdivisions: electronic attack (EA); electronic protection (EP); and electronic warfare support (ES).

### **Electronic attack**

Electronic attack (EA), also known as electronic countermeasures (ECM), involves the offensive use of electromagnetic energy weapons, directed energy weapons, or anti-radiation weapons to attack personnel, facilities or equipment with the intent of degrading, neutralizing or destroying enemy combat capability including human life. In the case of electromagnetic energy, this action is most commonly referred to as "jamming" and can be performed on communications systems or radar systems. In the case of anti-radiation weapons, this often includes missiles or bombs that can home in on a specific signal (radio or radar) and follow that path directly to impact, thus destroying the system broadcasting.

### **Electronic protection**

Electronic protection (EP), also known as an electronic protective measure (EPM) or electronic counter-countermeasure (ECCM) is a measure used to protect against an electronic enemy attack. Flares are often used to distract infrared homing missiles into missing their target. The use of flare rejection logic in the guidance (seeker head) of an infrared homing missile to counter an adversary's use of flares is an example of EP. While defensive EA actions (jamming) and EP (defeating jamming) protect personnel, facilities, capabilities, and equipment, EP protects from the *effects* of EA. Other examples of EP include spread spectrum technologies, the use of restricted frequency lists, emissions control (EMCON), and low observability (stealth) technology.

Electronic warfare self-protection (EWSP) is a suite of countermeasure systems fitted primarily to aircraft for the purpose of protecting the host from weapons fire and can include, among others: directional infrared countermeasures (DIRCM) flare systems and other forms of infrared countermeasures for protection against infrared missiles; chaff (protection against radar-guided missiles); and DRFM decoy systems (protection against radar-targeted anti-aircraft weapons).

An electronic warfare tactics range (EWTR) is a practice range that provides training for personnel operating in electronic warfare. There are two examples of such ranges in Europe: one at RAF Spadeadam in the northwest county of Cumbria, England, and the Multinational Aircrew Electronic Warfare Tactics Facility Polygone range on the border between Germany and France. EWTRs are equipped with ground-based equipment to simulate electronic warfare threats that aircrew might encounter on missions. Other EW training and tactics ranges are available for ground and naval forces as well.

Antifragile EW is a step beyond standard EP, occurring when a communications link being jammed actually increases in capability as a result of a jamming attack, although this is only possible under certain circumstances such as reactive forms of jamming.

In November 2021, Israel Aerospace Industries announced a new electronic warfare system named Scorpius that can disrupt radar and communications from ships, UAVs, and missiles simultaneously and at varying distances.

### **Electronic warfare support**

Electronic warfare support (ES) is a subdivision of EW involving actions taken by an operational commander or operator to detect, intercept, identify, locate, and/or localize sources of intended and unintended radiated electromagnetic (EM) energy. These Electronic Support Measures (ESM) aim to enable immediate threat recognition to focus on serving military service needs even in the most tactical, rugged and extreme environments. This is often referred to as simply reconnaissance, although today, more common terms are intelligence, surveillance and reconnaissance (ISR) or intelligence, surveillance, target acquisition, and reconnaissance (ISTAR). The purpose is to provide immediate recognition, prioritization, and targeting of threats to battlefield commanders.

Signals intelligence (SIGINT), a discipline overlapping with ES, is the related process of analysing and identifying intercepted transmissions from sources such as radio communication, mobile phones, radar, or microwave communication. SIGINT is broken into two categories: electronic intelligence (ELINT); and communications intelligence (COMINT). Analysis parameters measured in signals of these categories can include frequency, bandwidth, modulation and polarization.

The distinction between SIGINT and ES is determined by the controller of the collection assets, the information provided, and the intended purpose of the information. Electronic warfare support is conducted by assets under the operational control of a commander to provide tactical information, specifically threat prioritization, recognition, location, targeting, and avoidance. However, the same assets and resources that are tasked with ES can simultaneously collect information that meets the collection requirements for more strategic intelligence.

Having introduced the electronic ‘battlefield’ we now turn to related news items:

#### **➤ 1 January 2024**

The Rt. Hon Ben Wallace MP, previous Secretary of State for Defence, writes in The Telegraph: *If you are already bored by the pre-election electioneering being mounted by UK political parties, then standby for global pre-election electioneering. This year over 2 billion people will vote for new governments across the globe: the US, the UK, Iran, India, Pakistan, Mexico, EU, Russia (a joke), Indonesia and a host of European nations. In short, a combined population of 49% of the world. That will be good news for journalists and good news for campaigners who will benefit from the billions of pounds spent. But 2024 will also be like no other for the use of social media by those that want to destroy the rule of law and undermine democracy.*

*For years now the Russian state has played a proactive and malign role in attacking elections held in the West. Get used to the terms “bots” “trolls”, “deep fakes” and “dark web”. Trolls deliberately try and provoke online using facts or fiction, hoping to sow division, seeking to intimidate counter*

*narratives on the internet. Russia even has a “troll factory” in St Petersburg specifically for that task. “Bots” on social media use automated software to repeatedly place disinformation anonymously. No prizes for guessing that China, Russia and Venezuela top the charts here.*

*Try to be on the lookout, if you can, for “deep fakes.” Artificial intelligence can now help generate images and videos that are incredibly believable. In the war in Ukraine, in US politics and Gaza we have seen them being pumped onto social media by bots and the army of supporters of one side or another. Once established, people can’t help but share them if they represent what the reader wants to believe or if they collaborate a conspiracy.*

*And then there is the deep web. Think of the internet as a deep well of information. 90% of us get our news and information from the surface. But lurking in the depths are secrets and spies. If an adversary can release information into those depths, they know that gossip and sensationalism will do the rest to infiltrate mainstream media. Russia has often used this method to spread Kompromat (hacked compromising information from a person or government) to destabilise elections. In 2017 Russia hacked one of Macron’s special advisors and released details of his views on political rivals two days before polling day. The unit alleged to be responsible was Russian GRU unit 74455.*

*Our last UK 2019 election saw Russia use the Reddit website to post selective excerpts of hacked UK trade talk details with the US. Jeremy Corbyn even went as far as to brandish them at a press conference.*

*Our precious democracy is thus under attack like never before. Conspiracy and extremes are magnified by social media. Politics gets ever more personal and angry. The good news is that the UK is ahead of the pack when it comes to protecting our elections. We have GCHQ as the vanguard. The UK’s biggest intelligence agency employs some of the finest brains in the world to seek out and spot the agents of state-backed misinformation and hacking. The National Cyber Security Centre was set up in 2016 when I was Security Minister. The NCSC provides a single point of contact for SMEs, government agencies, public and business. We also established the Defending Democracy Taskforce in 2022 which is leading efforts to protect our elections.*

*But what tips can I give the readers? I recommend you stick with the mainstream media. While we may not always agree with the interpretation of the facts, most mainstream media will agree on the facts themselves. But we must also expect those very same media outlets to keep us safe by asking them to question the provenance of their sources of information. And always demand, as a viewer or reader, that media outlets make clear who a contributor is and if they are paid or backed by one group or another. It is more important than you know.*

#### ➤ **20 January 2024**

Matthew Field reports that “Children around the world are consuming – and being consumed by – the social media app [TikTok].” He writes: “It starts on TikTok, runs the video sharing app’s latest advert. Featuring a father and son inspired by the app to get fit, the company adds: You are only ever one swipe away from starting something new.”

Since it launched in Britain in 2018, tens of millions of us have been swiping away on the Chinese-owned app, turning to TikTok’s infinite video scroll for entertainment and distraction. 22 million Brits use TikTok at least once a month, according to mobile analytics firm SensorTower. Data.AI puts the

figure at 25.7 million. Both suggest TikTok is on a par with Instagram. Many of its users are young people. While under-13s are not officially allowed on the app, survey data from regulator Ofcom estimates it is used by 53pc of 3-17 years. Almost a third of 8-11 year olds have a TikTok account, Ofcom believes.

Young people are not just experimenting with the app – they are spending a significant amount of time on it, gorging on TikTok videos. The average UK smartphone user spent 36 hours and 3 minutes per month scrolling TikTok in 2023 according to Data.AI’s estimates. That number rose to 46 hours and 12 minutes for 18 to 24-year-olds. That is just over an hour and a half every day spent on the app, or 11.5 hours a week. Considering TikTok was built on the back of 15-second clips, that equates to thousands of videos beamed at young people every week. Like YouTube before it, TikTok has captured the attention of a generation.

Some data suggests that people are more hooked on the app the younger they are. According to figures published last year by parental controls company Qustodio, kids aged four to 18 in Britain spent 114 minutes – or nearly two hours – each day on TikTok in 2022. Usage among this group had almost doubled in two years. It is not a uniquely British phenomenon. American campaign group Common Sense Media found 11 to 17-year-olds in the US used TikTok for a “median one hour and 52 minutes per day”. Some spent “upwards [of] seven hours a day on the app”.

The app has been credited with helping young people find community and hobbies, from dancing to reading. Yet TikTok’s growing influence and importance among kids and teenagers has sparked alarm in some quarters. Campaigners, academics and politicians are concerned about what the video app could be doing to young people, particularly given its vast scale makes it difficult to monitor what is being watched. Some activists, schools and researchers believe TikTok and short-form video apps leave children vulnerable to “rabbit holes” that can drag them towards extreme, radicalising or depressing content.

More fundamentally, there are concerns about what consuming such large amounts of short-form content are doing to our brains. Andy Burrows of the online safety advocacy group the Molly Rose Foundation, says TikTok has “probably the most impressive algorithm [of] any of the tech platforms”, but with this “the risks are equally higher”.

TikTok, which is ultimately owned by Beijing-headquartered tech giant Bytedance, is under intense scrutiny as a result. Last year it was fined £12.7m for allegedly failing to stop 1.4 million children under the age of 13 accessing its app in Britain between 2018 to 2020. TikTok has disputed the calculations and appealed the fine. It says it makes “extensive efforts” to remove the accounts of users under-13, blocking 6m underage accounts globally each month.

In the US TikTok is facing bans in several states, which it has challenged. Government officials have been barred from using TikTok over security fears that data may be at risk from China, though TikTok has always denied any connection to the Chinese state. Read further at: [How TikTok ate kids’ brains \(telegraph.co.uk\)](https://www.telegraph.co.uk)

## ➤ 22 January 2024

Adam Mawardi reports that at a press conference in the heart of Silicon Valley five men in suits posed for a photograph that shed unprecedented light on the world’s most powerful intelligence partnership.

The men belonged to the Five Eyes intelligence alliance, each representing intelligence services from Britain, Australia, Canada, New Zealand, and the US. Until then they had never appeared together in public. Their smiles to the camera contrasted with a dark warning shared by one group member, Britain's head of MI5, Ken McCallum.

The UK had seen a sharp rise in aggressive attempts by foreign states to steal the country's high-tech secrets, he warned. The biggest threat of all: China. According to McCallum, more than 20,000 people in the UK have been approached by Chinese agents online as part of "epic scale" espionage efforts. One alleged Chinese spy created fake profiles on LinkedIn to contact thousands of British officials – offering cash, trips to China and paid speaking gigs as ways of extracting state secrets. Reports of China's covert spy network in the UK will weigh on the minds of City bosses as corporations fortify their offices with costly cyber defences to protect their data being stolen by ransomware gangs.

While some UK companies are now spending millions of pounds on cyber insurance, many remain uncovered. Most vulnerable are Britain's small and medium-sized businesses, according to Jamie MacColl, a cyber research fellow at defence think tank Royal United Services Institute. "A lot of organisations just don't view it as an important risk, particularly smaller companies. They might think, you know, a cyber attack is something that happens to someone else, or it's something that only happens to large corporations," he says.

The coverage gap can be partly blamed on insurance fees. A decade ago, cyber insurance was cheap and easy to buy. Insurance companies cut their prices to spark demand in a nascent market. "Naive insurers entered into the cyber insurance market with not a lot of cybersecurity expertise, wrote policies that had very high limits and no kind of security requirements to get a policy. They all got burnt when ransomware became an issue," says MacColl. The rise of Russian-backed cyber hackers demanding multi-million pound ransoms from City firms left underwriters lumbered with mounting losses. Some insurers were forced to leave the cyber risk market entirely. Read on at: <https://www.telegraph.co.uk/business/2024/01/22/insurers-city-spies-as-chinese-agents-target-britain/>





## AEROSPACE & THE ENVIRONMENT



We commence this section with an article by Rosa Silverman from the 9 November 2023 edition of The Telegraph (including the photo above) on space debris. She writes:

It started with a glove. When Nasa astronaut Ed White lost one of his in space after stepping out of his Gemini 4 capsule in June 1965, he made history in more than one way. Not only was White the first American spacewalker, he was also the first to leave space debris behind. Since then more than 170 million pieces of such debris are estimated to have floated off into the universe, proving that litter is not only a terrestrial problem. These pieces range from small flecks of paint from spacecraft to old satellites, plus a number of more prosaic items. The latest eye-catching piece of space debris to disappear into the thermosphere is a tool bag. Lost by Nasa astronauts Jasmin Moghbeli and Loral O'Hara during a spacewalk last week, the kit was deemed a low risk to the space station and so was left behind in the darkness.

So what happens to it now? "It's going to drift," says Rory Holmes, the managing director of ClearSpace, a firm developing technology to remove debris from space. "It will slowly come back down to Earth, but this will take many hundreds of years and it will be a risk for that time. This doesn't mean it will be discovered in a field several centuries from now and end up in a museum. Given the tool[bag]'s size, it would probably burn up in the atmosphere eventually. Larger objects will eventually come down to Earth too – though without fully burning up. You do sometimes see bits of rocket or satellite land on the ground," says Holmes. "But Earth is quite big, so unless you're unlucky, one won't land on your head."

This is not the first set of tools to be set adrift in space. During a spacewalk in November 2008, astronaut Heidemarie Stefanyshyn-Piper lost a tool bag while trying to repair a jammed gear on a space station solar panel. The bag and its contents were worth about \$100,000 (£81,000). "I thought,

maybe I can jump for it and grab it,” Stefanyshyn-Piper said later. “But then we would have two floating objects, and one of them would be me. So the best thing was [to] just let it go, and it was very disheartening to watch it float away.” The bag was later spotted in orbit by amateur astronomers. Perhaps the most unusual item of space debris was the spatula lost by the late astronaut Piers Sellers in 2006. Following its sudden and unexpected fame, the spatula was nicknamed “spatsat”. It was tracked through space by NASA as it whizzed towards Earth.

There’s a serious side to all this – and a major industry now working to clean up the galaxy. Space debris can be dangerous to astronauts. “The International Space Station has to be moved every so often to avoid it getting hit by debris,” says Holmes. “We’re pretty good at tracking all these bits in space.” Debris also poses a risk to the roughly 10,000 satellites in space, which provide us with everything from television channels to GPS and internet in remote locations. “The objects we have in orbit criss-cross each other’s paths very quickly,” Holmes explains. “If they collide, something small can still do a huge amount of damage. It could easily destroy your satellite.”

Little wonder the issue of space debris is taken seriously by authorities. Last year the UK Space Agency awarded ClearSpace and another company, Astroscale, £4 million to design missions to remove existing pieces of space debris. Announcing the funding the Agency described orbital congestion and space debris as one of the biggest challenges facing the global space sector. It has committed £102 million up to 2025 to technology that can track objects in space and reduce debris.

ClearSpace and other companies are developing satellites able to grab big pieces of space debris and safely dispose of them. “We have a giant claw, basically,” says Holmes. “We go and grab the bits and pull them down... into the top of the atmosphere so they can safely burn up.” So far, this technology is yet to be put into action. The first ClearSpace satellites for space debris removal are expected to launch in 2026, from the UK and French Guiana.

Experts, meanwhile, talk of the need to make space activities more sustainable. “As humanity we’ve done what we’ve done in every other environment and lost a lot of rubbish and pollutants [in space],” says Holmes. “We’ve been launching stuff into space for 70 years now and not thinking about what happens to it at the end of life. Things smash into each other and can break up into lots of little pieces that smash into each other. If we’re not careful, we get to a point where we’ve left parts of space unusable because they are full of debris.”

This debris does not just preoccupy scientists but has also seeped into popular consciousness, notably in the 2013 science fiction film *Gravity*. Spoiler alert, but what would have happened to George Clooney’s character when he floated off into the darkness? “I don’t think [he’d] live very long,” says Holmes. “You’d run out of oxygen and energy to heat yourself and probably turn into an iceberg.”

And now continuing with our chronological news items:

### ➤ **28 November 2023**

Neil Lancefield reports in the *Independent* that the first transatlantic flight by an airliner powered by pure sustainable aviation fuel (SAF) has taken off. Virgin Atlantic is operating the flight from London’s Heathrow to New York’s JFK airport with a Boeing 787 Dreamliner aircraft. Virgin founder Sir Richard Branson, Transport Secretary Mark Harper and Virgin Atlantic chief executive Shai Weiss are among the passengers on the flight, which is not carrying fare-paying travellers. In a video posted

on LinkedIn, Prime Minister Rishi Sunak said: “Right now something very exciting is happening in the sky above us.” He added: “Not only will SAF be key in decarbonising aviation, but it could create a UK industry with an annual turnover of almost £2.5 billion which could support over 5,000 UK jobs.

### ➤ December 2023

As Boeing’ latest ecoDemonstrator begins SAF contrail testing, Stephen Bridgewater in the RAeS AERO SPACE journal looks back at more than a decade of technology proving flights and how they have changed the way we build and fly airliners.

In the same edition Professor Keith Hayward asks “Can the aviation sector meet IATA’s goal to have net zero carbon emission by 2050?”. He weighs up the evidence.

### ➤ 29 December 2023

Discussing a potential water crisis in the world, Szu Ping Chan writes in The Telegraph that ChatGPT is thirsty. Every time you give it a command, it “drinks” the equivalent of a sip of water. Twenty tasks later and it has already consumed half a litre of the stuff. That’s because cooling the data centres that power it and other artificial intelligence (AI) tools is a huge task, and one that risks exacerbating a looming water crisis.

It may sound implausible. After all 75pc of the Earth is covered in water. However, fresh water accounts for just 3pc, and of that 69pc is locked away in glaciers, 30pc is underground and around 1pc is in lakes, rivers and swamps. In short, less than 1pc can be used to drink or irrigate crops.

Demand for water has increased by around 40pc over the past four decades and is estimated to rise by a further 25pc by 2050. At the same time, supply has halved since 1970 as the global population continues to rise, according to the World Bank. Read on at: [Why thirsty data centres risk plunging the world into crisis \(telegraph.co.uk\)](https://www.telegraph.co.uk/news/technology/2023/12/29/why-thirsty-data-centres-risk-plunging-the-world-into-crisis/)

### ➤ 12 January 2024



Marissa Papanek reports that NASA and Lockheed Martin formally debuted the agency's X-59 quiet supersonic aircraft [above] on Friday. Using this one-of-a-kind experimental airplane, NASA aims to gather data that could revolutionize air travel, paving the way for a new generation of commercial aircraft that can travel faster than the speed of sound.

“This is a major accomplishment made possible only through the hard work and ingenuity by NASA and the entire X-59 team,” said NASA Deputy Administrator Pam Melroy. “In just a few short years we’ve gone from an ambitious concept to reality. NASA’s X-59 will help change the way we travel, bringing us closer together in much less time.” Melroy and other senior officials revealed the aircraft during a ceremony hosted by prime contractor Lockheed Martin Skunk Works at its Palmdale, California facility.

The X-59 is at the centre of NASA’s Quesst mission, which focuses on providing data to help regulators reconsider rules that prohibit commercial supersonic flight over land. For 50 years, the U.S. and other nations have prohibited such flights because of the disturbance caused by loud, startling sonic booms on the communities below. The X-59 is expected to fly at 1.4 times the speed of sound, or 925 mph. Its design, shaping and technologies will allow the aircraft to achieve these speeds while generating a quieter sonic thump. Read further at: [NASA, Lockheed Martin Reveal X-59 Quiet Supersonic Aircraft - NASA](#)

#### ➤ 17 January 2024

Anthony Cuthbertson advises in The Independent that a Japanese startup has unveiled a plan to shoot down space junk using lasers developed for nuclear fusion power. Osaka-based EX-Fusion is taking a novel ground-based approach to dealing with the issue of debris in Earth’s orbit after developing one of the world’s most powerful lasers for the next-generation power source. The diode-pumped solid-state (DPSS) laser was built to blast a hydrogen fuel pellet with a high-powered beam in order to trigger a fusion reaction – the same process that naturally occurs within the Sun.

The startup realised the same technology could be used to knock a piece of space debris out of orbit without sending lasers up to space. “The power of a laser for destroying space junk is an order of magnitude lower than for nuclear fusion, but they share technical challenges such as controlling them via special mirrors,” EX-Fusion chief executive Kazuki Matsuo told Nikkei Asia.

The startup has already signed a memorandum of understanding with Australian contractor EOS Space Systems which tracks space junk from an observatory near Canberra. Ex-Fusion will initially target small space debris measuring less than 10cm, which has previously been impossible to impact using ground-based lasers. Read further at: [Nuclear fusion laser could shoot down space junk \(msn.com\)](#)





# STEM RELATED CAREERS & USEFUL CONTACTS

In this quarter we feature two of our supporting companies: Babcock International and QinetiQ.

## **Babcock International:**



*Babcock has signed an 11-year agreement with BAE Systems for continued support to the Royal Air Force's Hawk fleet at RAF Valley, Anglesey. The contract will secure hundreds of jobs in North Wales, and provide local economic value and job opportunities, including aeronautical engineering apprenticeships. As part of the contract, Babcock will continue to provide maintenance and groundcrew training in support of the RAF's Hawk TMk2 fleet ensuring the output of fast jet pilots who then go on to operate the Typhoon and F-35 aircraft.*

Babcock is an international defence company operating in their focus areas of Australasia, Canada, France, South Africa and the UK, with exports to additional markets with potential to become focus countries such as Japan, Oman, Poland and the USA. The Group specialises in managing complex assets and infrastructure by providing through-life technical and engineering support to naval, land, air and nuclear operations, specialist training and asset management.

Additionally, Babcock designs and manufactures a range of defence and civil specialist equipment from naval ship and weapons handling systems to liquid gas handling systems. They also provide integrated, technology-enabled solutions to their defence customers in areas such as secure communications, electronic warfare and air defence.

The Group employs 26,000 people, had a turnover of almost £4.5 million in 2023, and is listed on the London Stock Exchange as a constituent of the FTSE 250 Index. Today, Babcock has four operating sectors: marine; nuclear; land; aviation.



Babcock International traces its history back to the 19th century and the American heavy industrial manufacturers, Babcock & Wilcox Company, which had been founded in 1867 by partners Stephen Wilcox and George Babcock to manufacture and market Wilcox's patented water-tube boiler. During the 1870s and 1880s the company, having decided to expand internationally, developed an initial footprint in the British market centring on cities such as Glasgow. In 1891, Babcock & Wilcox chose to establish a separately financed British company called Babcock & Wilcox Ltd.

Following its establishment, the British company's sphere of operation was defined as 'the world except for North America and Cuba', which was the preserve of the US Babcock & Wilcox venture. Starting in 1885, B&W's steam boilers were manufactured in the Singer Manufacturing Company's Kilbowie Works at Clydebank near Glasgow. During 1895 Babcock & Wilcox Ltd opened a new boiler making works based on the 33-acre (130,000 m<sup>2</sup>) site of the Porterfield Forge on the opposite side of the River Clyde near Renfrew.

In 1900 the company secured £1.57 million of investment which was used to finance the expansion of its global presence via numerous overseas subsidiary ventures. During 1913 B&W began its involvement with the Rosyth Dockyard after winning a bid to construct a steam generation plant on the site; this presence served as a starting point for the firm's subsequent extensive involvement in the ship repair sector.

During both the First World War and Second World War, B&W was a major supplier to Britain's defence establishment. During the 1940s the workforce at Renfrew peaked at approximately 10,000. In the post-war era the manufacture and support of defence equipment continued to be a long-running and key business area of the company.

Throughout the 20th century B&W was a major supplier of boilers for power stations. During the 1960s the company became involved in the development of civil nuclear power stations in the United Kingdom. B&W also continued to diversify internationally, including into the North American market; by 1979 the company's North American subsidiary was being attributed for generating one-third of total sales (£844 million) and more than half of the business's overall profits. That same year Babcock & Wilcox Ltd was renamed *Babcock International Ltd*.

During 1982 Babcock International was floated on the London Stock Exchange, becoming *Babcock International PLC*. Around this time subsidiary company *Babcock & Wilcox (Operations) Ltd* was rebranded *Babcock Power Ltd*; this division subsequently became *Babcock Energy Ltd*. By 1985 Babcock International's turnover had reached £1.1 billion; its subsidiaries were engaged in ventures and projects across the world, typically focusing on its contracting activities. Its materials-handling business, which had been unprofitable since the 1970s, was restructured.

During 1987 Babcock merged with rival engineering company FKI Electricals plc, forming *FKI Babcock PLC*. Shortly thereafter the newly merged company's head office in London and more than two-dozen plants were closed, causing the loss of around 6,000 jobs, over half of these based in Britain, reducing its workforce to less than 30,000. Several engineering and transport businesses were purchased during this period. During August 1989 FKI Babcock PLC demerged to form Babcock International Group PLC and FKI plc.

The newly independent Babcock International soon engaged in several acquisitions. In April 1992 the firm bought Middle Eastern energy industry contractor *King Wilkinson*. That same year,

the Swedish ship-to-shore handling business, Consilium, was also acquired. During 1994 Babcock acquired British conglomerate Thorn EMI's 35 per cent stake in the Rosyth Dockyard resulting in the creation of *Babcock Rosyth Defence*. In the same year Babcock's material handling business, centred in Germany, was reorganised and rebranded as *Babcock Materials Handling*.

Following the recording of a £42 million loss for the business in 1994, which was largely attributed to its energy division and repercussions from a contract at Drax Power Station, Babcock International responded by strategically avoiding overly-large contracts unless the associated risk was being shared with other partners. Furthermore, the business decided that it would dispose of its more risky business ventures altogether. Amongst other changes Babcock International's works at Rosyth was heavily impacted, being redirected towards the civil sector, such as the oil industry. During late 1996 Babcock purchased Rosyth from the Ministry of Defence at a net cost of £21m.

During 1995 a 75% stake in the boiler manufacturing and energy services activities (originally the core businesses of Babcock), by then known as Babcock Energy Ltd, was sold to Mitsui Engineering & Shipbuilding of Japan, and became Mitsui Babcock Energy Ltd. In November 2006 Mitsui sold the company to Doosan Heavy Industries & Construction, a subsidiary company of the Doosan Group of South Korea; at that time the company was renamed Doosan Babcock Energy Ltd. In September 2009 the Czech-based steam turbine manufacturer, Skoda Power, became part of Doosan Babcock Energy Ltd; this venture was subsequently rebranded Doosan Power Systems Ltd in 2010.

In 2000 Babcock took the strategic decision to move away from manufacturing towards maintaining and supporting the critical equipment and infrastructure of customers. Reflecting the successful shift in the company's strategic focus, in 2002 Babcock was duly reclassified on the London Stock Exchange from 'Engineering' to 'Support Services'.

On 19 June 2002 the company acquired Service Group International Ltd, a provider of support services in defence and civil markets. It successfully bid for Peterhouse Group plc, and on 18 June 2004 its bid was declared unconditional as over 50% of shares were held. On 30 September 2004 it acquired Turner and Partners, a provider of professional services to the telecoms industry.

On 9 May 2006 it went on to acquire Alstec Group Ltd, a nuclear and airport services operator, and on 13 June 2006 it bought the high voltage power lines and mobile telecoms business of ABB South Africa (Pty). On 10 May 2007, 19 million new shares were placed to fund acquisitions, and on 28 June 2007 it acquired Devonport Management Limited, operators of the Devonport Dockyard nuclear submarine and surface vessel facilities and Appledore Shipbuilders.

On 25 July 2007 the United Kingdom Government announced that the Aircraft Carrier Alliance, of which Babcock International was a part, would carry out final assembly of two new aircraft carriers for the Royal Navy at their Rosyth Dockyard.



*HMS Queen Elizabeth - built by BAE Systems, Thales and Babcock International.*

*The ship is designed to operate V/STOL aircraft. The air wing (up to 60 aircraft when provided) will typically consist of F-35B Lightning II multirole fighters, and Merlin helicopters for airborne early warning and anti-submarine warfare. The design emphasises flexibility, with accommodation for 250 Royal Marines and the ability to support them with attack helicopters and large troop transports such as Chinooks.*

On 7 August 2007 acceptances for the acquisition of International Nuclear Solutions PLC reached 58.9% of issued share capital, and a takeover was then completed. On 22 April 2008, to further strengthen the brand in the nuclear sector and submarine support sector, Babcock acquired Strachan & Henshaw from the Weir Group for £65m; at the time of the transaction the company had over 50 years of experience in high integrity material handling. In September 2009 Babcock acquired the UK Atomic Energy Authority's commercial arm, UKAEA Ltd; this acquisition extended Babcock's existing nuclear skills bringing additional expertise in waste categorisation, decommissioning of high hazard facilities, encapsulation and storage of hazardous materials and transportation of waste. The deal also provided Babcock with its first operational Tier 1 position in the civil nuclear market and a direct relationship with the Nuclear Decommissioning Authority, complementing its existing Tier 1 position in the military nuclear market.

In March 2010 Babcock acquired VT Group for £1.32bn. The acquisition, which was completed on 8 July 2010, created a combined defence and support services group that annually accrued sales of £3bn and had more than 25,000 employees who were mainly based in Britain and the United States. As a result of the merger Babcock took over the contract to operate the Defence High Frequency Communications Service on behalf of the Ministry of Defence; this contract was originally awarded to VT Merlin Communications in 2003 for a period of 15 years.

During March 2014 it was announced that Babcock had agreed to wholly acquire Avincis Group, including its subsidiary Bond Aviation Group, in exchange for £1.6 billion. The former Avincis units was subsequently rebranded under the Babcock name in January 2015. In July 2013 Babcock's

Support Services division acquired Conbras Serviços Técnicos de Suporte LTDA in Brazil for a cash consideration of £18.2 million plus deferred consideration of £4.4 million.

In April 2014 Babcock Dounreay Partnership (BDP), a consortium of Babcock International Group PLC (50%), CH2M Hill (30%) and URS (20%), was selected as preferred bidder and eventually awarded a £1.6bn contract by the Nuclear Decommissioning Authority for the management and decommissioning of the Dounreay nuclear site in Scotland. In November 2014 Babcock was named as the British Government's preferred buyer of the land repair and maintenance business of the Defence Support Group, an executive agency and trading fund of the Ministry of Defence. The sale and transfer to Babcock was completed on 1 April 2015.



*On 10 July 2020 the Nuclear Decommissioning Authority made the following announcement regarding the Dounreay decommissioning contract, operated by a joint venture of Babcock-subsidary Cavendish Nuclear, Jacobs and Amentum. The announcement also refers to LLW Repository Ltd, which is not owned by Babcock. “Dounreay Site Restoration Ltd (DSRL) and LLW Repository Ltd (LLWR) will become wholly owned subsidiaries of the NDA next year. DSRL is responsible for the safe and secure clean-up of the NDA’s Dounreay site in Scotland, while LLWR manages and operates the NDA’s Low Level Waste Repository in Cumbria and the provision of waste disposal treatment services”.*

Throughout the 2010s the company secured numerous naval contracts. In May 2012 Babcock was awarded a £15m contract by the Ministry of Defence to support the design of the United Kingdom's next generation nuclear-armed submarines. In August 2014 Babcock issued a statement declaring that there would be job losses at HMNB Clyde if Scotland were to vote in favour of independence in the 2014 Referendum. In October 2014 both Babcock and BAE Systems won contracts from the Ministry of Defence worth a total of £3.2 billion to maintain British warships, submarines and naval bases for the following five years.



In September 2019 it was announced that Babcock had been selected as the preferred bidder to build the new fleet of five Type 31 frigates for the Royal Navy. During 2018 and 2019 Babcock rebuffed multiple unsolicited advances by public services provider Serco to merge the two businesses together. Merger proposals had been unanimously rejected by Babcock's board, having reportedly found the proposal to lack strategic merit.



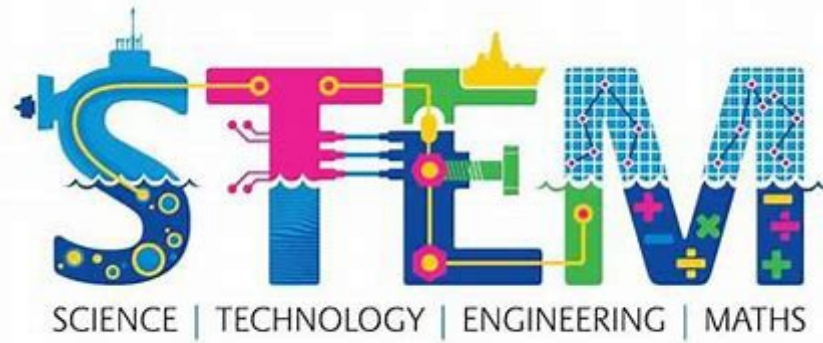
*Awarded to Babcock in November 2019, the UK MoD contract to deliver five Type 31 general purpose frigates by the end of 2028 signalled another decade of ship-build activity for the historic dockyard at Rosyth, one of the largest waterside manufacturing and repair facilities in the UK.*

On multiple occasions in 2019 and early 2020 Babcock issued profit warnings, which the firm attributed to a downturn in government orders and issues with its aviation division, necessitating a £85m write-down on leases for its North Sea helicopter fleet. During February 2020 it was reported that the company was considering exiting the off-shore helicopter sector amid intense competition; Babcock had already reduced its Sikorsky S-92 and Eurocopter EC225 Super Puma fleets from 15 to seven helicopters and 13 to one helicopters respectively. The firm's decision to downsize its S-92 inventory caused manufacturer Sikorsky to sue Babcock over its refusal to accept delivery of units ordered in 2011.

In April 2021, as part of a wide-ranging restructuring program, Babcock announced that it would be selling off a number of its business lines; as part of this the firm would sell its oil and gas aviation transport arm to CHC Group. The company also confirmed the disposal of its helicopter support business in July 2022. In March 2023 Babcock International sold the emergency aviation businesses in Finland, Italy, Norway, Portugal, Spain and Sweden to UK group Alacala Partners which re-formed them into the Avincis Group.



On 25 January 2024 it was announced that Babcock was an inaugural signatory to the ADS UK Defence ESG Charter, a groundbreaking, unified agreement on behalf of the defence sector to highlight its ongoing support to environmental, social and governance considerations. Alongside trade association ADS, eight UK defence OEMs form the inaugural signatories of the Charter, which enhances commitments made by the sector and provides a framework for greater ambitions around climate transition and clean technology, societal impact, governance and ethics.



As they advise on their website ([Babcock and STEM - Babcock International](#)) “STEM is everywhere in Babcock; from our naval architects and designers overhauling and maintaining warships, through to the finance teams ensuring that our complex and critical projects are delivering value to our customers. Research shows that not enough young people are studying the STEM subjects which will equip them with the knowledge to pursue a career in this area. By engaging with young people, their parents and teachers, we seek to spark an interest in studying STEM subjects and pursuing a rewarding career in the industry.”



*And with those careers in mind we direct readers to [Babcock Early Careers - Creating futures - where information is available in respect of Apprenticeships, Undergraduate Work Placements, Undergraduate Summer Intern Camps and Graduate Programmes plus, of course, how to contact the company and learn more.](#)*

## **QinetiQ:**



*"QinetiQ" is an invented name. "Qi" is supposed to reflect the company's energy, "net" its networking ability, and "iq" its intellectual resources. QinetiQ (as in kinetic) is a multi-national defence technology company which operates primarily in the defence, security and critical national infrastructure markets and runs testing and evaluation capabilities for air, land, sea and target systems. The company had a 2023 turnover of almost £1.6B and employs circa 7,000 people within principally, but not exclusively, the UK, USA and Australia.*

The following link is a detailed overview of the company: [Investor Relations - QinetiQ](#) Watch the FY 2023 video

As a private entity, QinetiQ was created in April 2001; prior to this its assets had been part of the Defence Evaluation and Research Agency (DERA), a now-defunct British government organisation. While a large portion of DERA's assets, sites, and employees were transferred to QinetiQ, other elements were incorporated into the Defence Science and Technology Laboratory (DSTL) which remains in government ownership. Some former DERA locations have thus become key sites for QinetiQ. These include Farnborough, Hampshire; MoD Boscombe Down, Wiltshire; and Malvern, Worcestershire.

In February 2006 QinetiQ was floated on the London Stock Exchange. QinetiQ has completed numerous acquisitions of defence and technology related companies, primarily those that are based in

the United States, and is a trusted supplier to the US government. QinetiQ USA operates under a Special Security Arrangement which allows it to work independently and separately on some of the most sensitive United States defense programs despite its foreign ownership. It has also spun off some of its technologies into new companies, such as Omni-ID Ltd. It is currently a constituent of the FTSE 250 Index.

Initially, QinetiQ was entirely owned by the British government; it was planned for a stock market flotation of the firm to be conducted sometime during 2002. However, this flotation was postponed; according to aerospace industry periodical *Flight International*, a lack of investor confidence was the principal reason for the delay. In late 2002 the Carlyle Group, an American private equity firm, publicly declared its intention to purchase a large stake in QinetiQ. In February 2003, the Carlyle Group completed the acquisition of a 33.8% share for £42 million. Prior to QinetiQ's flotation years later, ownership of the firm was divided between the MoD (56%), Carlyle Group (31%) and staff (13%). The Carlyle Group was expected to remain invested in QinetiQ for between three and five years after which a stock exchange float would take place.

In September 2004, QinetiQ acquired the US defence companies *Westar Corporation* and *Foster-Miller*, maker of the Talon robot. Also in 2004 it acquired *HVR Consulting Services*, a leading UK-based engineering consultancy. In early August 2005 the company announced it would acquire *Apogen Technologies, Inc.*, pending regulatory approval; according to QinetiQ's website, the purchase came at a cost of \$288m (£162.7m). In September 2005, the company acquired a 90% share of *Verhaert Design and Development NV* (VDD), a Belgian space systems integrator. In October that year it acquired Broadreach Networks Limited, a supplier of Wi-Fi internet equipment to the European rail industry, and in February 2006 it bought Graphics Research Corporation Ltd, developer of the Paramarine software suite of ship and submarine design tools.

In January 2007 the company bought *Analex*, a US corporation that provides high technology professional services, principally to the US government and its agencies. It was originally incorporated in 1964 under the name *Biorad* and evolved into *Hadron*, a US government systems consulting firm. In February 2007 the acquisition of ITS Corporation, a provider of IT services to the US government and its agencies, was announced. The disposal of Aerospace Filtration Systems (formerly part of Westar) was announced at the same time. In June of that year QinetiQ announced that Apogen Technologies Inc., its US subsidiary, had completed the acquisition of 3H Technology LLC, a specialist IT company with US government and commercial clients. In October the company completed the acquisition of Boldon James Holdings Limited, a UK-based provider of software for high end secure messaging, primarily for military, government and security customers world-wide.

In March 2007 QinetiQ spun off a new company, Omni-ID Ltd; this entity specialises in the commercial opportunities for passive UHF radio-frequency identification (RFID) tags. Prior to the spin off a research team at QinetiQ had been active since the 1990s to develop new and more effective RFID technologies. On 9 February 2007 the Carlyle Group sold its remaining 10.3% stake in the group at 205p per share, resulting in a £290 million return on its original investment. During September 2008 the MoD sold its remaining 18.9% holding in QinetiQ at 206p per share raising £254 million. The British government retained its 'special share', giving it control over any potential takeover. In February 2020 QinetiQ acquired military training specialist Newman & Spurr Consultancy Ltd for £14 million. In November 2022 it was announced QinetiQ had completed the acquisition of the McLean-headquartered provider of cybersecurity and data analytics software to US government agencies, Avantus Federal, for \$590 million USD.

During mid-2013, reports emerged that Chinese hackers had allegedly compromised sensitive military research being performed by QinetiQ. It was claimed that, between 2007 and 2010, QinetiQ's North American business was the subject of a cyber-attack. At the time of the incidents the company said it disclosed all of its breaches to the responsible government agencies and these were resolved to their satisfaction. The Pentagon has stated that it still entrusts QinetiQ with sensitive defence technology. The issue of cyber security affected other organisations; a Pentagon report stated that various US government agencies had been victims of cyberattacks.

QinetiQ provides auditing and consultancy services on cyber security to third party businesses. In 2011 the company announced the launch of a strategic collaboration with information security firm Nexor to pool their cyber security portfolios. During 2016 QinetiQ released a whitepaper on the topic which identified employee behaviour as a major contributing factor in the majority of security breaches. QinetiQ has partnered with mobile phone network provider Vodafone to support end-to-end internet security services.

QinetiQ provides technology-based products and services to numerous government and commercial customers. More than 2,000 of QinetiQ subsidiary Foster-Miller's Talon robots have been deployed to Iraq and Afghanistan, most used to remotely locate and disable roadside bombs. QinetiQ's SPO stand-off threat detection system has been sold to the US Transportation Security Administration for railway stations and airports.

During August 2008 QinetiQ's Zephyr, a solar powered unmanned aerial vehicle (UAV), performed a non-stop flight spanning 14 days; this was a world record for the longest duration unmanned flight. Over the following years, QinetiQ performed further record-breaking flights of the UAV. During summer 2018 an improved model of the Zephyr conducted an even longer flight, lasting nearly 26 days. The Zephyr UAV has been offered as a commercial product, the programme having been acquired by multi-national aerospace company Airbus Group. QinetiQ have been involved in the further development of the Zephyr, such as the provision of a LIDAR payload for the type.



*Zephyr*

QinetiQ has a 25-year T3E (Test, Trials, Training and Evaluation) agreement formerly called the Long Term Partnering Agreement (LTPA) with the UK Ministry of Defence (MoD) to provide test and evaluation services and manage military ranges. It is a major stakeholder in the UK Defence Technology Centre, which places military research contracts on behalf of the MoD.



QinetiQ also has a 25-year Maritime Strategic Facilities Agreement (MSCA) with the MoD to provide strategic maritime facilities and capabilities, including hydromechanic facilities at Haslar, biomedical facilities on the UK's South Coast, and submarine structures, survivability and shock testing facilities at Rosyth.

The QinetiQ Group comprises QinetiQ EMEA (Europe, Middle East and Australasia) and QinetiQ North America. QinetiQ North America, which was set up after the takeover of Foster-Miller, is a wholly owned subsidiary of QinetiQ, but remains independent and separated from the QinetiQ group by a proxy agreement with the US to comply with US laws that prevent sensitive technology coming under the control of a foreign venture that takes over a US company.

QinetiQ describe their capabilities as follows:



### **Robotics & Autonomy**

Robotic and autonomous systems that operate in the maritime, land and air domains can provide significant operational advantage, while increasing safety, mission tempo and reducing the burden on troops, field workers, and first responders.



### **Secure Communications & Navigation**

In the ever-hyperconnected world in which defence and commercial organisations operate, it is vital that all communication is appropriately secured against threats.



### **Sensing, Processing & Data Fusion**

Sensing and associated processing forms a critical and fundamental component in almost all defence and security systems, and is a key enabling technology for autonomous systems.



### **Advanced Materials & Manufacturing**

Harnessing advanced materials and manufacturing processes is critical to maximising success in all sectors.



### **Artificial Intelligence, Analytics & Advanced Computing**

Artificial Intelligence (AI), Analytics and Advanced Computing are becoming increasingly important across all aspects of consumer and operational technology and services.





### **Cyber & Electromagnetic Activities**

We help customers achieve superior, mission critical levels of security by managing risk and boosting resilience.



### **Human Protection & Performance**

We undertake research, test and evaluation, and provide guidance and advice to protect personnel, maximise survival, enhance personnel performance, minimise impact of stressors, and inform design.



### **Directed Energy and other Novel Weapon Technology and Effects**

Technology is at the forefront of enabling operational advantage against sophisticated and agile threats by delivering effects with precision.



### **Platform & System Design & Assessment**

Working across multiple domains for a range of military and commercial customers, our expertise in platform and system design and assessment enables customers to generate capability and deliver operational effectiveness.



### **Power Sources, Energy Storage & Distribution**

We develop devices to meet specific application requirements, e.g. high energy for space or portable use, high power for motorsport, smart batteries for electric vehicles, and we have a pilot production facility for manufacture of Li-ion cells.

QinetiQ is an inaugural signatory to the ADS UK Defence ESG Charter.

**QinetiQ is one of the ten largest UK employers of science and engineering graduates, recruiting around 150 per year. Have a look now at [QinetiQ Security & Defence Contractors](#) to find out more about the company as a whole and, in particular, click on [Early Careers](#) ([qinetiq.com](#))**



*Early Careers Leadership Event*

QinetiQ advise that their Early Careers programme “... is designed for our apprentices, year in industry, summer placement students and graduates, to provide a rich and rewarding learning experience for them as they start their career with us. Over the last few weeks, more than 70 of our second-year Early Careers Apprentices and Graduates in the UK completed a three-day residential outdoor leadership event.”

Based at the Brenscombe Outdoor Centre in Dorset, in 2023 the event focused on personal development through experience, building on activities that they have already completed as part of their Early Careers Programme. In small teams the apprentices and graduates were faced with a number of challenges to explore strategic planning and creative problem solving skills, as well as giving individuals the opportunity to experiment and do things differently.

The second day saw the groups navigating different challenges spaced across the Isle of Purbeck terrain, with teams being awarded points for both task completion and the values and behaviours they demonstrated in doing so. The day culminated in an element of personal challenge on the high ropes course, with colleagues setting their own limits and pushing themselves out of their comfort zones.

By the end of the three days the apprentices and graduates had not only explored their communication styles and leadership techniques and how, ultimately, these impact the efficiency and success of a team, but also built a valuable network of peers to continue to support their development going forward.

To put it simply, QinetiQ solves some of the world’s most complex defence and security challenges – look them up!



**And now we recommend readers look at:**  
**[www.aerospacecareersprogramme.co.uk](http://www.aerospacecareersprogramme.co.uk)**



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