Virgin Galactic's VSS Unity

The Schools' Aerospace Careers Programme Newsletter

Summer 2023

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The Schools' Aerospace Careers Programme is a Registered Charity (#1190721) in accordance with the Charity Commission for England & Wales

COVER PICTURE

VSS *Unity* completed Virgin Galactic's first commercial SpaceShipTwo suborbital flight on 29 June 2023. VSS *Unity*, previously referred to as VSS *Voyager*, is a SpaceShipTwo-class suborbital rocket-powered crewed spaceplane. It is the second *SpaceShipTwo* to be built and is part of the Virgin Galactic fleet. It first reached space as defined by the United States (above 50 miles or 80.5 km) on 13 December 2018, on the VP-03 mission.

On 29 June Unity separated from its VMS *Eve* mothership aircraft at 1119 USA Eastern time having taken off from Spaceport America, New Mexico, at 1030 Eastern time. *Unity*, flying a mission designated Galactic 01, fired its hybrid rocket motor for approximately 60 seconds and reached a peak altitude of 85.1 km before gliding to a runway landing at the spaceport at 1143 Eastern time.

The Galactic 01 mission was a research flight for the Italian Air Force and Italy's National Research Council. Virgin Galactic and the Italian Air Force signed the contract for the flight in October 2019, agreeing to fly three Italian payload specialists on a dedicated research flight. The mission, called Virtute 1 by the Italian government, carried Col. Walter Villadei and Lt. Col. Angelo Landolfi of the Italian Air Force and Pantaleone Carlucci of Italy's National Research Council. The three planned to conduct 13 experiments during the mission ranging from biomedical data collection to microgravity studies of fluid mechanics and combustion.

In a press conference after the flight, the three Italians said they were pleased with the flight. "It was much better than expected," Villadei, who commanded Virtute 1, said. He noted the crew was able to carry out all their planned experiments.

Unity is able to reach space as defined by the U.S. Air Force, NASA, and the FAA, by going over 50 miles (80.5 km) above sea level. However, it is unable to go above the Kármán line, the FAI's defined space boundary of 100 km (62.1 miles). *Unity* was rolled out on 19 February 2016 and completed ground-based system integration testing in September 2016 prior to its first flight on 8 September 2016. The name *Unity* was chosen by British physicist Stephen Hawking. Hawking's eye is also used as the model for the eye logo on the side of the spaceplane.

CONTENTS

Click on the above headings to go straight to the section.

INTRODUCTION

The new Schools' Aerospace Careers Programme is now well underway and, as Mick Jagger and Spot say in the video clip by Boston Dynamics which you can link to on page 6, we "start up" this Summer 2023 edition of our *Newsletter* with an update on the behind the scenes activity during last Spring which has been, in the main, preparation on all fronts for the upcoming 2023/24 Presentation season starting in September plus the continuing development of our growing digital support service and an introduction to our latest Trustee, Elaine Whyte.

We follow that with an optimistic industry preview by Deloitte which explains the five most significant trends they have ascertained from an in-depth survey of senior executives which, we suggest, should be read in conjunction with our section on Careers because both sections reflect each other, especially in respect of the digitalization of aerospace and the workplace. This section concludes with a brief update from ADS on the state of the UK aerospace and space industries as a whole.

Our section on the technologies of the fourth industrial revolution (4IR) in this edition reminds readers of what 4IR actually means and how it is being adopted by an increasingly digitally transforming aerospace industry (Aerospace 4.0). Deloitte identifies four key areas: agility; building new business models; collaborating closely with supply chains; adapting to the new cybersecurity paradigm,

The section on the UK Economy commences with detailed explanations of two fundamental economic terms: Gross Domestic Product, and Inflation. These are then followed by our usual chronological reporting of relevant news items as we have done in all sections as appropriate.

Our entry on Aerospace Manufacturing covers many subjects during what is becoming a period of "unprecedented change" including potential supersonic commercial travel, the first commercial flight of an indigenous Chinese airliner, the development of Blended Wing Body aircraft, the 2023 Paris Air Show and, perhaps most significant of all in regards to the purpose of the Schools' Aerospace Careers Programme (SACP), Boeing's projected demand of 42,600 new commercial aircraft globally over the next 20 years.

Commercial Aviation Operation naturally follows, and here we commence with the three most prestigious awards in the industry: the Skytrax World's Best Airline; the Skytrax World's Best Airport; and the APEX World Class Award.

A new, but increasingly topical section is next, Urban Air Mobility, which we explain in-depth concluding with the opening of the world's first vertiport - in Coventry, UK.

And then, as you will have guessed from our cover picture and comment, we spend some time on Space, a rapidly growing area of interest for the members of the SACP. With that in mind we are delighted to advise that the UK Space Agency – along with a rapidly growing number of companies and organisations – are joining with us.

Our comments in this edition on UK Military Aviation are confined, because of its size and significance, to an extract from a summary of the Future Combat Air & Space Capabilities Summit hosted by the RAeS during May this year which was held, of course, against the background of Russia's invasion of Ukraine.

The section on Cyber – very relevant both internationally as described in the previous section and domestically via your mobile phone, etc. - is introduced by an explanation of what cyberspace really is. It is followed in some depth by a particularly important entry on cyber-security, something that is aimed at readers of all ages.

And then there is the most topical subject of all at the moment within the aerospace industry, the environment, or as it is referred to - sustainability. Consequently, we start the section with an explanation of how sustainability is being addressed in the aerospace industry, a key theme of the Paris Air Show.

Finally, we focus on Careers, but for a change we consider the subject from the future employer's point of view because to understand that will be of fundamental assistance to those young people considering a career, of whatever kind, in the aerospace and space industries. The section concludes with a link to our website (The Schools' Aerospace Careers Programme) and in particular the page entitled Useful Contacts where you will find a host of valuable links. Whilst on the site also visit the page on Supporting Companies and click on their logos to visit their respective websites, plus our page on Articles of Interest for general background information.

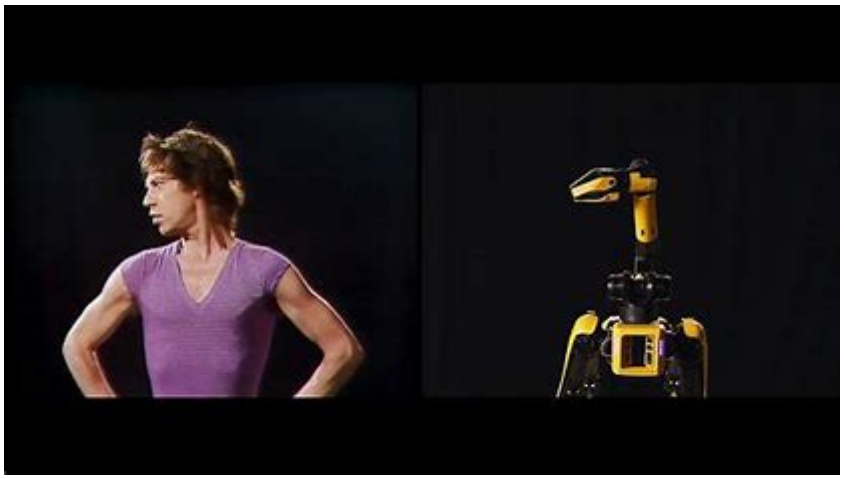
We sincerely hope all readers will find our series of *Quarterly Newsletters* helpful, informative and enjoyable. If you have any questions, or would like to discuss sponsorship/support of the Schools' ACP Charity (#1190721) please do contact me on chairman@aerospacecareersprogramme.co.uk

This *Newsletter* has been released on the News page of our website. The next publication in the series will be the Autumn 2023 *Newsletter* which will be released on 31 October.

Dr Michael Smith FRAeS
Chairman

31 July 2023

THE SCHOOLS'
AEROSPACE CAREERS PROGRAMME



"Spot Me Up" | The Rolling Stones & Boston Dynamics - Bing video

Above is just one of the new videos in our 2023/24 Presentations to schools, the programme of which commences in six weeks' time and is detailed below. But first, click on the above link to watch and listen to Spot, the new member of the SACP team, 'backed' of course, by the recently voted greatest rock band in history – The Stones.

13 Sep 2023:	*Bromley High School*
14 & 15 Sep 2023:	*Colchester County High School for Girls x 2*
22 Sep 2023;	*Bablake School – Coventry*
2 Oct 2023:	*St Albans High School*
6 Oct 2023:	*West Buckland School - Barnstaple*
17 Oct 2023:	*Wakefield Girls High School*
7 Nov 2023:	*William Perkin High School – Greenford*
14 Nov 2023:	*St Francis College, Letchworth Garden City*
23 Nov 2023:	*Scarborough UTC*
4 Dec 2023:	*Sheffield School for Girls*
Jan or Feb 2024:	*Emanuel School, London*
27 or 29 Feb 2024:	*Queen Ethelburga's College – York*
4-8 (?) Mar 2024:	*Cedar's Academy - Leicester*
4-8 (?) Mar 2024:	*Sir Jonathan North College - Leicester*
15 Mar 2024:	*The Henrietta Barnett School - London*
27 Mar 2024:	*Wilson's School – Wallington*
24 Apr 2024:	*The Knights Templar School, Herts*

As you would expect, although there are three dates above to be finalised, work has already commenced on the 2024/25 programme of presentations which will involve a major push into Wales and Scotland, and possibly our first presentation in Northern Ireland.

These presentations and our digital support service are two of the four principal elements of the SACP, the other two being the SACP Network which is now building, and the currently being researched work experience placement service due to be launched in 2024/25.

Regarding digital support, as explained in the last Newsletter our website is now undergoing major expansion and improvement. See: www.aerospacecareersprogramme.co.uk and explore. The website and our currently three embryonic social media platforms – Linked in, Twitter (X?) and Facebook – along with our in-person schools presentations will be the core of our 'outreach' strategy, the network events and the work placements will be part of the 'in-industry' follow-up.

But digital support will not stop there. Once the first schools presentation commences this September digital involvement will grow dramatically and will be joined, first by Instagram, and early next year, by our own YouTube channel. Also, new pages will be added to the website, one of which will be headed 'Careers', and the development of 'Useful Contacts' and 'Articles of Interest' will increase considerably as, of course, will 'News' items.

Furthermore, we will be linking our developing social media with that of our supporting companies as we have already done with our website to theirs (just click on a supporting company's logo to enter their website) and with our Host Schools who, in turn, are linked with their outreach schools. The idea is for the SACP to be digitally linked to all members of its rapidly growing 'family' and 'partners' across the UK.

Concerning the Network, the planning for our next event is already well advanced. It will take place on 9 November 2023 in GKN Aerospace's Global Technology Centre (GTC), Bristol, and involve a host of local schools. Go to our website, click on the GKN Aerospace logo, then click on 'Our Technology' and watch the video describing the GTC in Bristol.

Finally, we warmly welcome a new member of the SACP Board of Trustees – Elaine Whyte. Read her Bio under 'About Us/Team' on the SACP website.

INDUSTRY PREVIEW FOR 2023

According to Deloitte's 2023 aerospace and defense industry outlook, economic recovery for the aerospace and defense industry gained momentum in 2022 on the heels of rising demand for air travel. As passenger traffic gradually returns to pre-pandemic levels, increases in new aircraft and military orders signal continued growth in the approaching year. But optimism is held in check by ongoing risks, from inflation to talent shortages to supply chain disruptions.

Supply chain disruptions and talent shortages may be the biggest risks or challenges for aerospace and defense industry (A&D) organizations in 2023. As demand for passenger travel is correlated to ticket prices which, in turn, depend on jet fuel prices, a quick and sustained rise in jet fuel prices can impact traffic and increase market volatility. To address this challenge aircraft manufacturers are investing in aircraft and engine designs to make them more fuel-efficient, lower operating costs, and explore lower-and-zero-emission commercial aircraft for the future.

According to Deloitte's outlook survey, 88% of surveyed senior executives indicated that they believed the general business outlook for the aerospace and defense industry for the next year is "somewhat to very positive." There are more reasons for this optimistic outlook. These include growth in new technologies and segments such as advanced air mobility (AAM), evolving business models in areas such as space, and the use of digital thread and smart factories. A&D companies focused on innovation and prepared to capitalize on new emerging opportunities could outperform their peers in 2023. Below, Deloitte's 2023 outlook considers the latest industry trends.

Focus on supply chain visibility and resilience to mitigate a broader set of risks

The COVID-19 pandemic, workforce shortages and, most recently, the Russian invasion of Ukraine, have exacerbated supply chain complexity for the aerospace and defense industry. Given these challenges, the coming year will likely see an acceleration of the shift from global to regional sourcing, including the exchange of raw materials, parts, and finished A&D goods globally. Most A&D companies are also expected to focus on creating visibility deep into their supply chains to improve supply control and coordination and to better manage third-party risk.

An acceleration of digital thread and smart factories can drive improved efficiencies

Digital technologies and capabilities are expected to be an increasing source of competitive advantage and, in some cases, a requirement to compete for specific government programs. With new entrants disrupting the market, even on legacy platform programs, aerospace and defense companies will increasingly leverage digital thread and the smart factory to streamline the design and development of products and achieve improved efficiencies.

Attracting, retaining, and developing top talent remains a challenge

Although most jobs lost in 2020 were added back the workforce turnover rate is still high, and an aging workforce contributes to the workforce shortage. Automation and the use of advanced digital technologies are bringing a change in the industry's workforce composition, driving the need for a workforce with more advanced aerospace engineering, math, data science, and digital skills than before. To capture growth opportunities A&D companies should have a long-term strategy to meet

existing and future workforce demands. To develop a future-ready workforce, companies should focus on encouraging a culture of innovation and building digital skills.

Lowering emissions and implementing sustainable manufacturing remain business priorities

As one of the most challenging industries to decarbonize, the aerospace and defense industry has been at the forefront of adopting new and advanced manufacturing technologies which can help address the sustainability challenge. The industry is likely to move toward using sustainable aviation fuels (SAFs) at scale and new propulsion technologies such as electric, hydrogen, and hybrid. In its efforts to advance decarbonization the industry will most likely establish multiple partnerships comprising technology investors, energy companies, airlines, and government agencies. Moreover, 2023 could also see commercial aerospace companies expanding renewable electricity use to reduce emissions at manufacturing facilities.

Innovation accelerates growth in emerging areas

Emerging markets such as space, supersonics/hypersonics, and AAM are poised to change the industry landscape and capabilities in the coming years. 2023 will likely be an important year for these emerging markets in terms of investments, technology evolution, and regulation. According to our outlook survey, organizations are most likely to invest in space-related technologies and AAM in 2023.

Moving into Q2 2023, and the UK aerospace sector in particular, ADS, the industry trade body, posted the following on 26 June 2023:

Aerospace Sector Thrives with 300% YoY increase in orders alongside 40% increase in deliveries

The UK's aerospace sector continues to be buoyant in the midst of supply chain challenges and a muted Q1 outlook, according to the latest aircraft orders and deliveries report compiled by ADS. The 146 aircraft orders placed in May 2023 is a 306% increase on the 2022 figures, as the confidence in the UK aerospace sector continues to grow. Deliveries increased 38% over the same time period. The current backlog of aircraft orders is 13,406 aircraft, a positive marker for the health of the sector. The potential value add of this backlog to the UK economy could exceed £205 billion, representing several years' worth of work.

"The staggering year on year increase in aircraft orders highlights growing confidence in the aerospace sector," said Aimie Stone, Chief Economist at ADS Group. "While the sector is not expected to reach post-pandemic levels until 2024, the 38% year on year growth in aircraft deliveries highlights its resilience and is a positive health check in the midst of increased supply chain challenges."

June saw the Paris Air Show 2023 generate aircraft deals worth a projected value of $155bn. The value of firm aircraft deals to the UK is estimated to be worth up to £13.6bn at published list prices and assumed content of production. The firm aircraft orders will be included in the half year results, next month.

The latest figures published by ADS Group showcase exports from the UK aerospace sector being worth £18.6 billion in 2022. It further highlights that businesses in the UK's aerospace sector generate £27 billion in turnover, with value add to the UK economy worth £10.9 billion.

Furthermore, in June ADS posted their UK Space Outlook 2023 (see: UK Space Outlook 2023 - ADS Group). In its covering note Joscelyn Turner said:

The UK space sector is a world leader in a rapidly expanding global space economy with the opportunity to be at the forefront of unlocking new capabilities and skills. The 2023 Space Outlook has been produced by ADS in partnership with UKspace and is supported by the UK Space Agency, which highlights the collaborative nature of the sector as we work together with Industry, Government and space experts to unlock future growth potential.

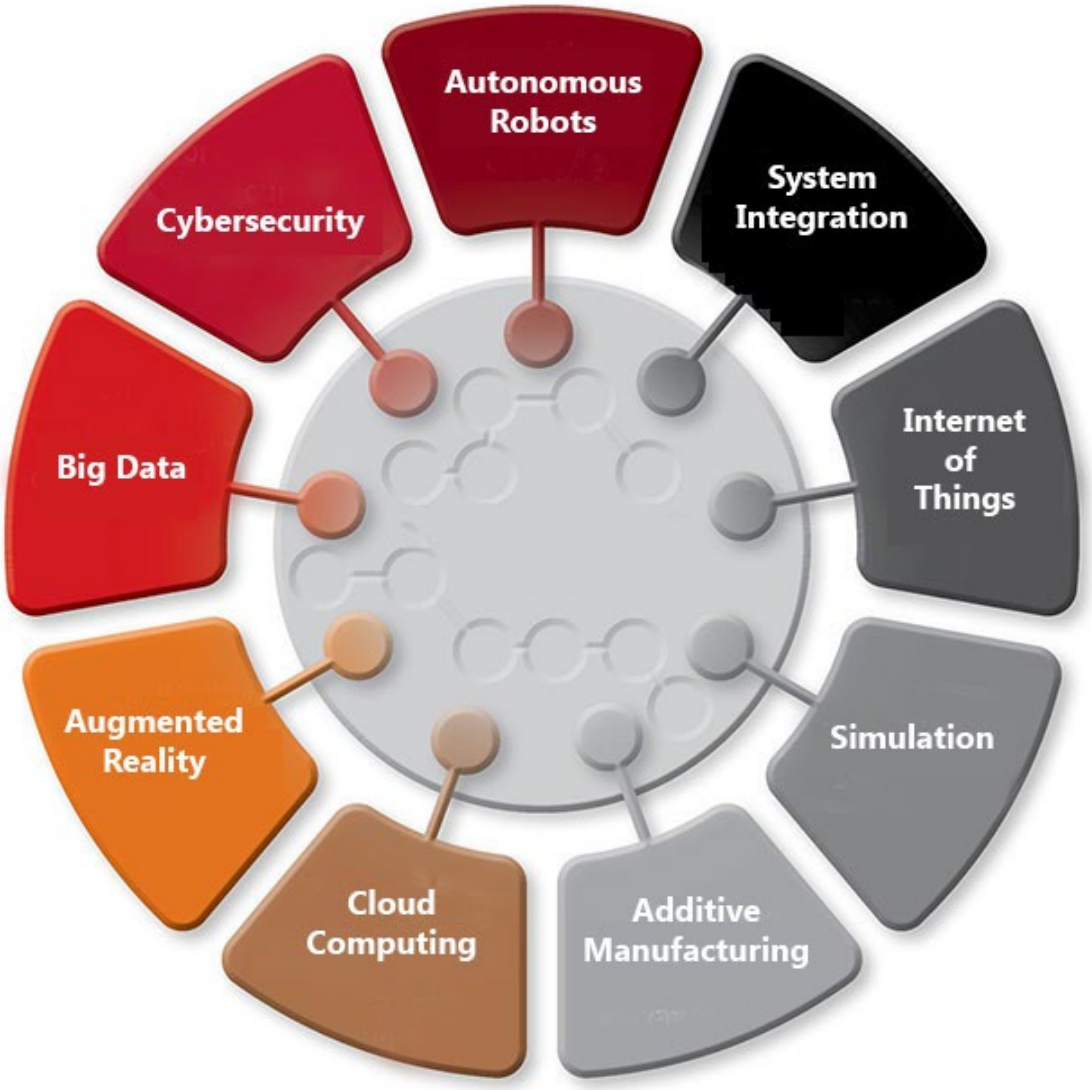
The UK space sector directly employs 48,800 people, delivering high value jobs for a highly skilled workforce, and supports 2,300 apprentices across the sector. Turnover growth continues to increase year on year, reaching £17.5 billion in 2022 and adding £7 billion to the UK economy. Space exports valued £5.9 billion to the UK in 2022.

There are significant business opportunities in the UK space sector including in the areas of space capability synergies, civil capability goals and future UK launch capability.

The growth and success of the UK space sector is underpinned by an evolving policy landscape that is based on a close partnership between Industry and Government that sets a clear, ambitious path for the future of the space sector in the UK working through the National Space Partnership. The Space Partnership will draw on expert knowledge and insight from across the sector and work to support activities, including the evolution and delivery of UK space policy. The sector looks forward to a focused and empowered partnership, representing the whole breadth and expertise of the sector, which will help drive the delivery of our shared goals.

Finally, in June ADS also published its 2023 Industry Facts & Figures: a guide to the UK aerospace, security & space sectors. See: Industry Facts & Figures 2023 - ADS Group

TECHNOLOGIES OF THE FOURTH INDUSTRIAL REVOLUTION

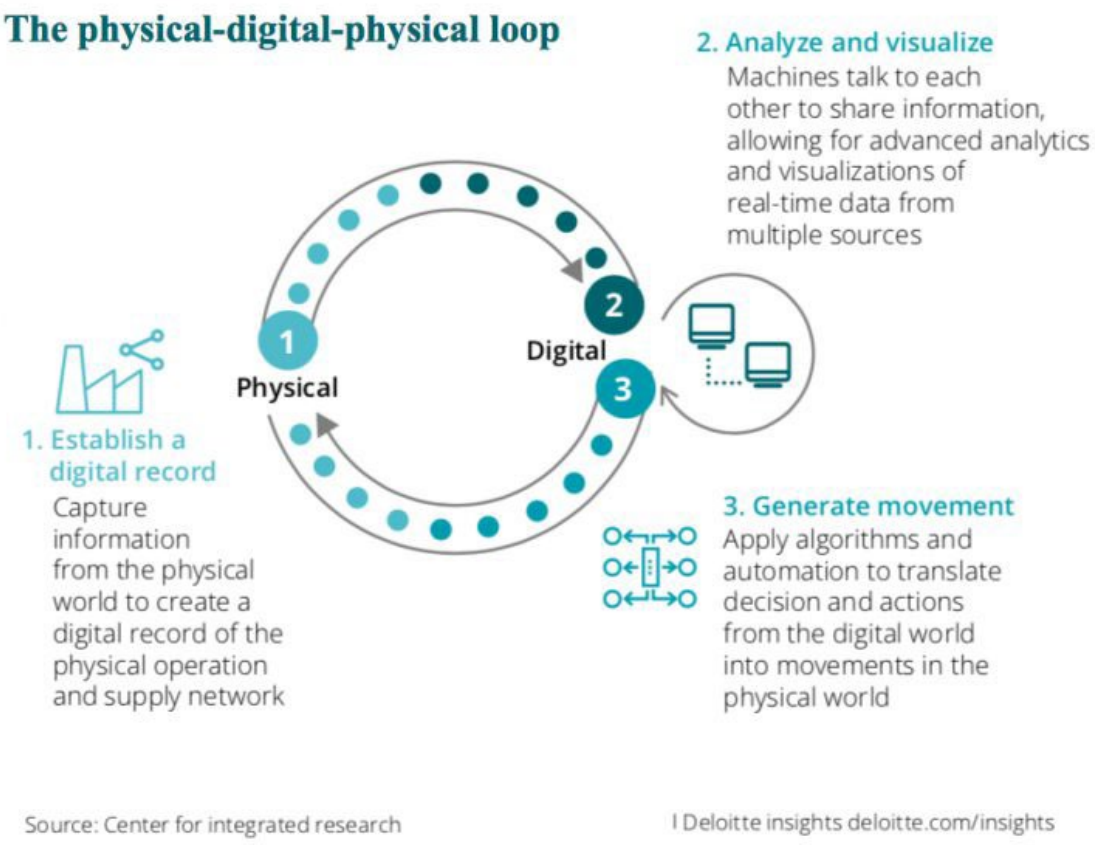


The Fourth Industrial Revolution (4IR or Industry 4.0) when applied to the aerospace Industry is often referred to as Aerospace 4.0, but what are Industry 4.0 and Aerospace 4.0? Acording to Deloitte – a global consultancy, 4IR is the creation of a digital manufacturing enterprise that is not only interconnected but also communicates, analyses, and uses information to drive further intelligent action back in the physical world. It drives the physical acts of designing, manufacturing, distribution and performance in an ongoing cycle known as the physical-to-digital-physical (PDP) loop.

Throughout this cycle real time access to data and intelligence is driven by the continuous and cyclical flow of informtion and actions between the physical and digital worlds. Many organisations already have some portions of the PDP loop in place, namely the physical-to-digital and digital-to-digital processes. However, it is the leap from digital back to physical – from

connected, digital technologies to action in the ophysical world – that constitutes the essence of 4IR.

Digitizing the supply chain:



Some Aerospace & Defence (A&D) companies are already beginning to realise the transformative effects of these technologies (see below). They are exploring significant potential value across a variety of dimensions, from cutting costs and restructuring supply chains to expediting time to delivery and making devices and products connected across the board. For instance, real time flight data collected from sensors in aircraft being used to reduce fuel consumption, improving schduling, and minimising flight delays. Aerospace 4.0 technologies are also improving the aftermarket experience by using data to track asset condition and predicting parts and systems failures beforehand.

Aerospace 4.0 has a multitude of current and emerging applications; here are some typical examples:

Technology	Current Applications	Emerging Applications
Additive Manufacturing	Prototyping, tooling, and functional end-use parts manufacturing.	Combining new types of novel materials to improve aerospace parts and accessories.

Advanced Analytics	Monitoring real-time aircraft health; identifying system/component failures in advance; making intelligent scheduling and forcasting models.	Developing large-sale digitization of plane maintenance data and schedules; creating synergies across business and functional areas by enabling the 'connected plane'.
Advanced robotics and cognitive automation	Using robots in aircraft manufacturing for more efficient production, and fewer errors and quality issues.	Simplifying simulations of aircraft, weapons, and satellite performance, avoiding time-consuming analysis and test of algorithms, software and hardware.
Artificial Intelligence	Applying AI to robotics, automatic programming of tasks and processes in industrial settings, and enabling predictive maintenance.	Leveraging AI and computer vision technologies to augment safety features in aircraft; incorporating advanced AI into drones; and replacing human co-pilots in new, autnomous aircraft.
Blockchain	Enabling greater transparency of information between different parties; improving just-in-time logistics; reducing erroneous orders; improving inventory turnover.	Improving tracking in supply chains and procurement using a shared database with suppliers and partners; improving validation of suppliers performance and reputation; and time-stamping records to reduce fraud and improve supply chain security.
Digital Reality (AR/VR/Mixed Reality)	Replacing assembly manuels with smart-glasses displays, which substantially reduces wiring production time.	Using VR to optimize and design factories, and simulate an entire fectory or warehouse to train workers to use equipment more safely and efficiently.
Internet of Things	Monitoring aircraft engine health and optimizing engine performance based on data collected from sensors.	Managing material costs and demand fluctuations by analyzing big data, enabling integrated smart connected assets and operations and, eventually, an autonomous production environment.

According to Deloitte, as the market impact of A&D 4.0 technologies plays out, barriers to entry are lowering and industry lines are blurring. Competition is emerging from new entrants into the market who are moving beyond creating traditional physical products to using data gleaned from customers and product functioning to create new revenue streams. In the long run players that are nimble and adept at leveraging multiple advanced technologies could scale-up, out perform and outcompete their industry counterparts. Deloitte's research suggests there are four key areas A&D companies should focus on to become digitally transformed enterprises: agility; building new business models; collaborating closely with supply chains; adapting to the new cybersecurity paradigm.

Having introduced the subject in depth we now continue with our usual chronological news reporting:

➢ 8 May 2023

Gareth Corfield in Washington, USA, writes that as fears grow over AI, Big Tech companies are racing to be the first to crack the technology. "As scientists and ethicists argue over whether the advent of advanced chatbots will usher in a new industrial revolution or the end of humanity itself, the businesses developing AI are rushing to put it into everything they can.

Microsoft is at the front of the race. The PC-pioneer was quick to back OpenAI, the start-up behind transformational software ChatGPT. The Bill Gates-founded company signed a deal to use OpenAI's technology in its Bing search engine and reportedly invested $10bn (£7.95bn) in the company. ChatGPT offers Microsoft a chance to leapfrog Google in search, but the technology offers far more than just that. Chief executive Satya Nadella has said AI will shape everything the company does in future.

One example: the technology has been plugged into its PowerPoint software to help office workers complete hours of work on presentations in minutes. A series of bullet points fed to Copilot - Microsoft's name for its AI chatbot integrations - result in the creation of an entire slide deck, complete with stock images, corporate branding and even the right colour scheme. Full sentences extrapolated from the terse bullet points garnish each slide.

Walter Sun, the company's vice president of AI for business applications, believes Copilot could even become an "autopilot" by 2028. Rather than tasking a human to oversee the creation of a slide deck with the help of AI, an executive could simply ask software directly to do all the legwork. Read on at: https://www.telegraph.co.uk/business/2023/05/08/inside-microsofts-bid-to-win-silicon-valleys-ai-race/

➢ 10 May 2023

And Matthew Field advises two days later that Google is revamping its 25-year-old internet search engine with artificial intelligence and features akin to a digital chatbot in a race against upstart rival OpenAI. The $1.4 trillion internet giant unveiled a taste of the biggest redesign in its search engine's history at its annual conference, featuring a "conversational" interface in addition to its now ubiquitous search bar.

While the search bar - which has hardly changed since Google first launched it - is not going away, users will be able to engage in 'question and answer style chats' with it. Instead of simply providing a list of links, Google will feature more elaborate text answers and explanations, generated by AI, at the top of its search results. For example, users looking for inspiration for travel, recipes or shopping can ask Google to generate ideas for them.

The new features pit Google against rival tech giant Microsoft, which is working with start-up OpenAI to reinvent its own internet search technology. Google, which first launched its search engine in 1998, has been scrambling to keep up as Microsoft unleashed its own wave of AI products. Read on at: Google to launch AI search engine (telegraph.co.uk)

➢ 18 May 2023

However, Kieren McCarthy reports in The Telegraph that "AI and ChatGPT aren't intelligent, they just parrot human thought – and lies." He goes on to say that "at a hot-ticket hearing in the US Congress this week, we got to hear from a man who six months ago was little known outside Silicon Valley. Sam Altman has joined an echelon of American tech CEOs who are loved and feared in equal measure due to his position as the head of OpenAI, the creator of ChatGPT, a text-based online chat program that has led to an explosion of headlines and tech industry heartburn because it is able to produce better computer responses to human questions than anything before it.

The hearing was a surreal one, as it often is when politicians in the limelight question people aggressively on a subject they know nothing about. But it was all the more unusual in that, unlike social media posts or search engines, the way AI actually works is so little understood while its results are so immediately understood that it feels akin to magic.

You can ask ChatGPT a question – any question – and it will provide, within seconds, a startlingly decent response. What do people understand least about AI? I asked. *"One common misunderstanding people have about AI is that it is a sentient being capable of emotions and consciousness. In reality, AI is a programmed system designed to perform specific tasks and make decisions based on data and algorithms. Additionally…"* It goes on for another three sentences, all of which were perfectly reasoned and accurate". See: AI and ChatGPT: basically just the distilled wisdom of Wikipedia (telegraph.co.uk)

➢ 19 May 2023

Ambrose Evans-Pritchard explains in the Telegraph today that solid state batteries for electric vehicles will start to enter our consciousness within two or three years. Hi-tech pioneers will be rolling out the first commercial products by the late 2020s. Progress will be jerky but this leap-frog technology promises a radical improvement in the range, weight, and cost of EV batteries, disrupting the global car industry and its existing supply chains.

The US Energy Department's *National Blueprint* is targeting EV pack costs of $60 per kWh by 2030 without the need for cobalt or nickel. This demolishes the business model for petrol and diesel cars, but it also renders today's gigafactories obsolete in short order.

The frenetic dash for subsidised gigafactories in Europe, America, and Asia is likely to lead to a glut of generic batteries, just as the parallel dash for semiconductors will lead to a chip glut. Much taxpayer money will be sacrificed on the altar of industrial sovereignty.

As this newspaper has reported before, the US Argonne National Laboratory has found a way to quadruple energy density with a lithium-air battery using a solid electrolyte based on nanoparticles, able to charge and discharge for over 1,000 cycles. It does not require expensive materials. It can switch to sodium-air if need be, and salt is ubiquitous. Britain has ample rock deposits in Cheshire and Dorset.

There are such breakthroughs almost every month. I cite this only as caution that we should not overreact – or react in the wrong way – to this week's fracas over Britain's lack of gigafactories and warnings by Stellantis, owner of Vauxhall, Peugeot, and Fiat. See: Britain should not join the gigafactory stampede: technology is already vaulting far ahead (telegraph.co.uk)

➢ 26 May 2023

Elon Musk's brain implant company, Neuralink, can begin testing its chips in humans after it received approval from the US regulator. The tech company, which hopes to implant tiny chips into people's brains to treat conditions such as paralysis and blindness, had previously been denied permission for clinical trials because of the associated risks. Neuralink said clearance from the US Food and Drug Administration (FDA) was "an important first step" in creating the coin-sized chips, which have so far been tested on monkeys and pigs.

The company gave no details about the trial, saying only that recruitment for the study was not yet open. However, there is an option for people in the US with quadriplegia, paraplegia, vision or hearing loss and the inability to speak, to sign up to the firm's "patient registry" on its website. "We are excited to share that we have received the FDA's approval to launch our first-in-human clinical study," Neuralink wrote on Twitter on Thursday.

The technology is designed to be threaded into the brain using tiny filaments and harness AI technology to pick up brain activity using a so-called "brain computer interface". Mr Musk previously said the firm had been "working hard to be ready for our first human [implant], and obviously we want to be extremely careful and certain that it will work well before putting a device in a human".

US medical regulators were last year said to have "dozens" of concerns over the risks posed by the device. These included fears that tiny electrodes could get lodged in other parts of the brain, which could impair cognitive function or rupture blood vessels. To help overcome the concerns, Neuralink reportedly launched a collaboration with Barrow Neurological Institute, a Phoenix, Arizona-based neurological disease treatment and research organisation, to help carry out the human trials, sources told US news agency Reuters. Read further at: Elon Musk can start implanting brain chips in people as study gets US approval (telegraph.co.uk)

➢ 27 May 2023

Steve Bird advises that scientists have created a cloud device that can harvest electricity from the humidity in air, an academic paper reveals. The fingernail-sized device, called Air-gen, is made from a material filled with holes less than a thousandth of the width of a human hair. The holes, called nanopores, make power by harvesting the energy from electrically charged water in the air that passes through them. Essentially, the device harnesses the power in clouds that produce lightning.

Dr Jun Yao, the senior author from Massachusetts University in the US, said: "The air contains an enormous amount of electricity. Think of a cloud, which is nothing more than a mass of water droplets. "Each of those droplets contains a charge, and when conditions are right, the cloud can produce a lightning bolt - but we don't know how to reliably capture electricity from lightning. "What we've done is to create a human-built, small-scale cloud that produces electricity for us predictably and continuously so that we can harvest it." The technique can be scaled-up for use in numerous different environments, from an Amazon rainforest to the Sahara Desert. Read on at: Scientists create machine that harvests clean energy out of thin air (telegraph.co.uk)

➢ 4 June 2023

The Telegraph suggests that "Rishi Sunak's global summit on artificial intelligence is a further marker of Britain's intent to establish itself as a force in the technology revolution. As the capabilities of AI models advance, such as their ability to solve complex medical problems and enormously boost productivity, the risk they pose develops also. The purpose of the autumn summit is to devise international rules on how the technology is developed and applied with the goal of minimising this risk.

The great threat in the near term is likely to be the misuse of models by individual or state actors, such as deploying systems to identify and exploit cyber-security vulnerabilities or producing convincing misinformation at significant scale. In the future, these systems could become threats of their own. Complex artificial intelligence is hard to control, and we have not fully solved the problem of aligning such models to our interests. There is a risk that firms racing to develop more powerful models may do so without giving sufficient thought to what they may unleash, or that state actors may try to use them to gain an edge over the West.

For the moment, artificial intelligence that exceeds human capabilities in a broad swathe of fields is the preserve of science fiction. But 10 years ago, so was ChatGPT, OpenAI's revolutionary text-generating chatbot. It is no longer implausible that in the not-too-distant future, we may face powerful AI systems we do not know how to control."

➢ 8 June 2023

Advances in artificial intelligence will result in more jobs being created rather than triggering mass layoffs, bosses have said. More than half of British companies said AI will boost their staff headcount over the next two years, a survey of 2,000 employers by the recruitment giant Manpower Group showed. It comes despite reports that companies are already cutting their workforce because of the threat of AI. Telecoms giant BT said last month that it would cut 55,000

jobs by the end of the decade, with automation replacing some 10,000 workers largely in its customer service division.

However, Rahul Kumar, director at recruiter Experis, which conducted the polling, said: "These findings suggest the mood amongst employers is largely at odds with wider concerns for AI having a negative impact on future jobs." Mr Kumar said that businesses needed to hire new people to build up the skills internally to use AI and machine learning more effectively to boost creativity and generate efficiencies.

He added: "A lot of our clients that we surveyed are looking to invest in this area and to explore what AI could mean for their businesses. That's where this improvement in job outlook is coming from. "It will create more employment but it will require a slightly different skill set." Now read further: AI will mean companies hire more staff, not less, say bosses (telegraph.co.uk)

- **11 June 2023**

Roger Bootle suggests that "This technology can be dangerous, but threats of AI extinction are overblown." He goes on tht say that there has long been an awareness that, for all its possible benefits, AI was potentially dangerous. In 2014, the late Sir Stephen Hawking said: "the development of full artificial intelligence could spell the end of the human race".

What has injected new life into these fears is the revelation of the extraordinary capabilities of ChatGPT. But we should distinguish between different sorts of danger. The danger that Sir Stephen Hawking was referring to is the threat that AI would become more intelligent than humans and that we would effectively be left behind. In the literature, this is referred to as "the singularity". After this point, super AIs imbued with not just general intelligence but perhaps also the attributes of consciousness, including intention, could set out to destroy us.

This is the Frankenstein scenario that is echoed in many science fiction books and films. For a long time such prospects were regarded as so far-fetched that they could be disregarded in practical questions about what to do about AI now. Indeed, this was the line I took in my 2019 book "The AI Economy". And the singularity is still far distant, if indeed it can ever be realised. Read further at: Ignore the doom-mongers, AI will give us more leisure time (telegraph.co.uk)

- **13 June 2023**

Demis Hassabis writes in The Telegraph that "When I began working on my PhD in cognitive neuroscience at UCL in 2005, seeking inspiration for artificial intelligence from the inner workings of the brain, AI was almost an embarrassing term in academic circles. If you talked about bringing intelligence to machines, many professors would instantly dismiss you as a serious scientist.

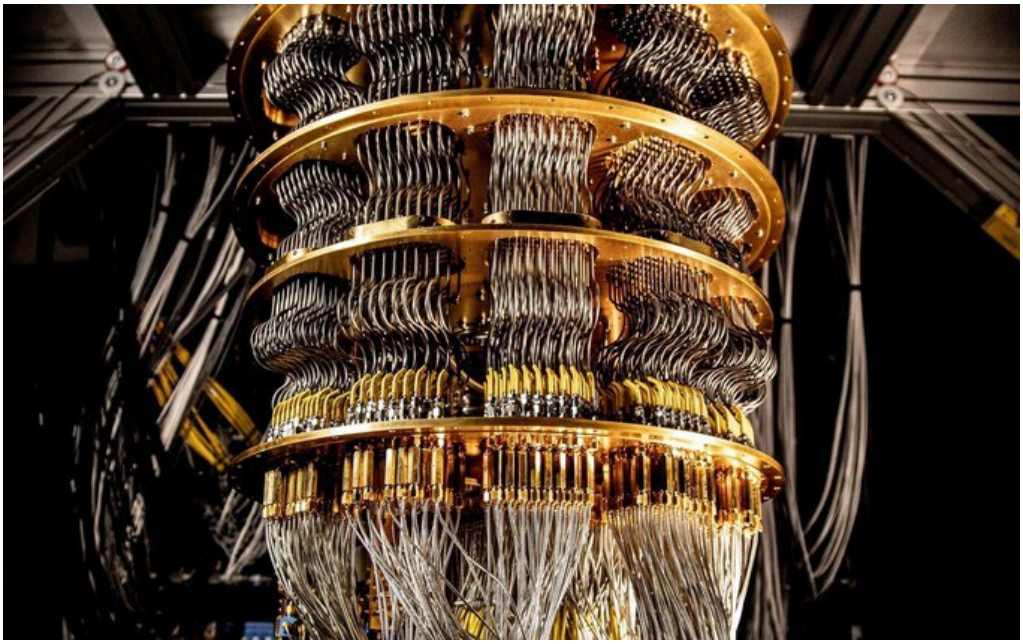
Fast forward to today, and there is widespread recognition that AI will play a critical role in the next chapter of our society and economy. By accelerating science to operate at digital speed, transforming industries, and enabling new forms of creativity and artistic expression, AI is the defining technology of our time. Yet, there are also growing concerns about potential misuses of AI, such as disinformation, cyber-attacks and the impact of automation on jobs.

As I joined Prime Minister Rishi Sunak to open London Tech Week, we agreed that 2023 could be a defining moment for the UK and the world when it comes to the emergence of AI. If we manage this moment well – which I believe we can – this could mark the beginning of a new era of growth, innovation and scientific discovery for the UK. But how can we seize this opportunity as a society? First, we need to recognise the massive potential of AI to improve people's lives. Now read on at: AI could herald a new era of scientific discovery for Britain if we are bold (telegraph.co.uk)

- **18 June 2023**

A salutary tale by Rosa Silverman. Have a look at: 'You're addicted to your phone – it's a bit like heroin' (telegraph.co.uk)

- **2 July 2023**



James Titcomb writes that Google has developed a quantum computer that instantly makes calculations that would take the best existing supercomputers 47 years, in a breakthrough meant to establish beyond doubt that the experimental machines can outperform conventional rivals. A paper from researchers at Google published online claims that the company's latest technology is "beyond the capabilities of existing classical supercomputers".

Proponents of quantum computers say the technology, which relies on the peculiar states of quantum physics, can create hugely powerful machines able to battle climate change and create breakthrough drugs. However, they also threaten to undermine today's encryption systems, making them a national security priority.

Four years ago, Google claimed to be the first company to achieve "quantum supremacy" – a milestone point at which quantum computers surpass existing machines. This was challenged at the

time by rivals who argued that Google was exaggerating the difference between its machine and traditional supercomputers.

The company's new paper – Phase Transition in Random Circuit Sampling – published on the open access science website ArXiv, demonstrates a more powerful device that aims to end the debate. While the 2019 machine had 53 qubits, the building blocks of quantum computers, the next generation device has 70. Adding more qubits improves a quantum computer's power exponentially, meaning the new machine is 241 million times more powerful than the 2019 machine.

The researchers said it would take Frontier, the world's leading supercomputer, 6.18 seconds to match a calculation from Google's 53-qubit computer from 2019. In comparison, it would take 47.2 years to match its latest one. The researchers also claim that their latest quantum computer is more powerful than demonstrations from a Chinese lab which is seen as a leader in the field. Google's paper demonstrates how larger quantum computers can manage "noise" – interference that threatens to disrupt the fragile states in which qubits operate – to continue to make calculations. See: Google quantum computer instantly makes calculations that take rivals 47 years (telegraph.co.uk)

- **26 July 2023**

Max Stephens advises in The Telegraph that a major UN report has recommended smartphones should be banned from schools to help stop classroom disruption. UNESCO, the educational, scientific and cultural wing of the UN, said the ban would improve learning and help protect children from online bullying. Excessive mobile phone use was associated with poor educational performance, and screen time worsened children's emotional stability.

Digital technology as a whole, including artificial intelligence, should never take precedence over a "human-centred vision" of education or replace face-to-face interaction teaching, the report added. "Not all change constitutes progress. Just because something can be done doesn't mean it should be done", it concluded. The report also called for policymakers to take heed of the "social dimension of education". "Those urging increasing individualisation may be missing the point of what education is about", it added.

Audrey Aloza, UNESCO's director general said: "The digital revolution holds immeasurable potential but just as warnings have been voiced for how it should be regulated in society, similar attention must be paid to the way it is used in education. Read further at: Ban smartphones from schools, says major UN report (telegraph.co.uk)

THE UK ECONOMY

In this edition we examine two of the most used, but often misunderstood, terms in any country's economy: Gross Domestic Product (GDP); and inflation.

Gross Domestic Product

GDP is a monetary measure of the market value of all the final goods and services produced in a specific time period by a country. GDP is most often used by the government of a single country to measure its economic health. Due to its complex and subjective nature, this measure is often revised before being considered a reliable indicator.

GDP definitions are maintained by a number of national and international economic organizations. The Organisation for Economic Co-operation and Development (OECD) defines GDP as "an aggregate measure of production equal to the sum of the gross values added of all resident and institutional units engaged in production and services (plus any taxes, and minus any subsidies, on products not included in the value of their outputs)". An IMF publication states that, "GDP measures the monetary value of final goods and services - that are bought by the final user - produced in a country in a given period of time (say a quarter or a year)."

GDP (nominal) per capita does not, however, reflect differences in the cost of living and the inflation rates of the countries; therefore, using a basis of GDP per capita at purchasing power parity (PPP) may be more useful when comparing living standards between nations, while nominal GDP is more useful comparing national economies on the international market. Total GDP can also be broken down into the contribution of each industry or sector of the economy. The ratio of GDP to the total population of the region is the per capita GDP (also called the Mean Standard of Living).

GDP is often used as a metric for international comparisons as well as a broad measure of economic progress. It is often considered to be the world's most powerful statistical indicator of national development and progress. However, critics of the growth imperative often argue that GDP measures were never intended to measure progress, and leave out key externalities, such as resource extraction, environmental impact and unpaid domestic work. Critics frequently propose alternative economic models which use other measures of success or alternative indicators, for example the OECD's Better Life Index to measure the effect of the economy on human development and wellbeing.

GDP can be determined in three ways. They are the production (or output or value added) approach, the income approach, and the speculated expenditure approach; all three are used by the UK. The most direct of the three is the production approach which sums up the outputs of every class of enterprise to arrive at the total. The expenditure approach works on the principle that all of the product must be bought by somebody, therefore the value of the total product must be equal to people's total expenditures on buying things. The income approach works on the principle that the incomes of the productive factors ("the producers") must be equal to the value of their product, and determines GDP by finding the sum of all producers' incomes.

Production approach

Also known as the Value Added Approach, it calculates how much value is contributed at each stage of production. This approach mirrors the OECD definition given above. The sequence is as follows: (1) estimate the gross value of domestic output out of the many various economic activities; (2) determine the intermediate consumption, i.e., the cost of material, supplies and services used to produce final goods or services; (3) deduct intermediate consumption from gross value to obtain the gross value added.

Gross value added = gross value of output minus value of intermediate consumption. Value of output = value of the total sales of goods and services plus value of changes in the inventory. The sum of the gross value added in the various economic activities is known as "GDP at factor cost". GDP at factor cost plus indirect taxes less subsidies on products = "GDP at producer price".

For measuring output of domestic product, economic activities (i.e. industries) are classified into various sectors. After classifying economic activities, the output of each sector is calculated by either of the following two methods: (1) by multiplying the output of each sector by their respective market price and adding them together; or (2) by collecting data on gross sales and inventories from the records of companies and adding them together.

The value of output of all sectors is then added to establish the gross value of output at factor cost. Subtracting each sector's intermediate consumption from gross output value gives the GDP at factor cost. Adding indirect tax minus subsidies to GDP at factor cost gives the GDP at producer price.

Income approach

The second way of estimating GDP is to use "the sum of primary incomes distributed by resident producer units". If GDP is calculated this way it is sometimes called gross domestic income (GDI). GDI should provide the same amount as the expenditure method described later. By definition, GDI

is equal to GDP. In practice, however, measurement errors will make the two figures slightly different when reported by national statistical agencies.

This method measures GDP by adding incomes that firms pay households for factors of production they hire - wages for labour, interest for capital, rent for land and profits for entrepreneurship.

Two adjustments must be made to establish GDP: (1) taxes on production, and imports minus subsidies, are added to get from factor cost to market prices; (2) depreciation (or capital consumption allowance) is added to get from net domestic product to gross domestic product.

Expenditure approach

The third way to estimate GDP is to calculate the sum of the final uses of goods and services (all uses except intermediate consumption) measured in purchasers' prices.

Market goods that are produced are purchased by someone. In the case where a good is produced and unsold, the standard accounting convention is that the producer has bought the good from themselves. Therefore, measuring the total expenditure used to buy things is a way of measuring production. This is known as the expenditure method of calculating GDP.

GDP is the sum of consumption (C), investment (I), government Expenditures (G) and net exports (exports – imports). Expressed as: $Y = C + I + G + (X – M)$.

The impact of digitalisation

There are many limitations to and criticisms of these three approaches, one of which is that they do not truly reflect today's digital economy. This subject has been studied by many organisations, one of which is the OECD. The following is an extract from the Introduction to their OECD/STD Working Paper #2016/7:

"Recent years have seen a rapid emergence of new disruptive technologies with new forms of intermediation, service provision and consumption, with digitalisation being a common characteristic. These include new platforms that facilitate Peer-to-Peer transactions, such as AirBnB and Uber, new activities such as crowd sourcing, a growing category of the 'occasional self-employed' and prevalence of 'free' media services, funded by advertising and 'Big data'. Against a backdrop of slowing rates of measured productivity growth, this has raised questions about the conceptual basis of GDP and output, and whether current compilation methods are adequate to capture them.

This paper frames the discussion under an umbrella of the Digitalised Economy, covering also statistical challenges where digitalisation is a complicating feature such as international transactions and knowledge based assets. It delineates between conceptual and compilation issues and highlights areas where further investigations are merited. The overall conclusion is that, on balance, the accounting framework for GDP looks to be up to the challenges posed by digitalisation. Many practical measurement issues remain, however, in particular price changes and where digitalisation meets internationalisation."

Now read on at: Measuring GDP in a Digitalised Economy | OECD Statistics Working Papers | OECD iLibrary (oecd-ilibrary.org)

For the Record …

Based on data available from the world Bank the UK economy was fifth largest in the world in 2022. The top 10 countries were:

1. United States: $20.89 trillion
2. China: $14.72 trillion
3. Japan: $5.06 trillion
4. Germany: $3.85 trillion
5. United Kingdom: $2.67 trillion
6. India: $2.66 trillion
7. France: $2.63 trillion
8. Italy: $1.89 trillion
9. Canada: $1.64 trillion
10. South Korea: $1.63 trillion

UK GDP growth during the first quarter of 2023 was 0.1%. UK GDP climbed by 0.2% in April 2023, but is estimated to have fallen by 0.1% in May 2023.

Inflation

In economics inflation is an increase in the general price level of goods and services in an economy. When the general price level rises each unit of currency buys fewer goods and services; consequently, inflation corresponds to a reduction in the purchasing power of money. The common measure of inflation is the inflation rate, the annualized percentage change in a general price index. As prices faced by households do not all increase at the same rate, the consumer price index (CPI) is often used for this purpose.

There is disagreement among economists as to the causes of inflation. Low or moderate inflation is widely attributed to fluctuations in real demand for goods and services or changes in available supplies such as during scarcities. Moderate inflation affects economies in both positive and negative ways. The negative effects would include an increase in the opportunity cost of holding money, uncertainty over future inflation which may discourage investment and savings, and if inflation were rapid enough, shortages of goods as consumers begin hoarding out of concern that prices will increase in the future. Positive effects include reducing unemployment due to nominal wage rigidity, allowing the central bank greater freedom in carrying out monetary policy, encouraging loans and investment instead of money hoarding, and avoiding the inefficiencies associated with deflation.

Today, most economists favour a low and steady rate of inflation. Low (as opposed to zero or negative) inflation reduces the probability of economic recessions by enabling the labour market to adjust more quickly in a downturn and reduces the risk that a liquidity trap prevents monetary policy from stabilizing the economy, while avoiding the costs associated with high inflation. The task of keeping the rate of inflation low and stable is usually given to monetary authorities. Generally, these monetary authorities are the central banks that control monetary policy through the setting of interest rates by carrying out open market operations and (more rarely) by changing commercial bank reserve requirements.

Other economic concepts related to inflation include: deflation – a fall in the general price level; disinflation – a decrease in the rate of inflation; hyperinflation – an out-of-control inflationary spiral; stagflation – a combination of inflation, slow economic growth and high unemployment; reflation – an attempt to raise the general level of prices to counteract deflationary pressures; and asset price inflation – a general rise in the prices of financial assets without a corresponding increase in the prices of goods or services.

Given that there are many possible measures of the price level, there are many possible measures of price inflation. Most frequently the term "inflation" refers to a rise in a broad price index representing the overall price level for goods and services in the economy. The Consumer Price Index (CPI), the Personal Consumption Expenditures Price Index (PCEPI) and the GDP deflator are some examples of broad price indices.

However, inflation may also be used to describe a rising price level within a narrower set of assets, goods or services within the economy, such as commodities (including food, fuel, metals), tangible assets (such as real estate), services (such as entertainment and health care), or labour. Although the values of capital assets are often casually said to "inflate," this should not be confused with inflation as a defined term; a more accurate description for an increase in the value of a capital asset is appreciation. Core inflation is a measure of inflation for a subset of consumer prices that excludes food and energy prices, which rise and fall more than other prices in the short term.

The inflation rate is most widely calculated by determining the movement or change in a price index, typically the Consumer Price Index. The inflation rate is the percentage change of a price index over time. The Retail Prices Index is also a measure of inflation that is commonly used in the United Kingdom. It is broader than the CPI and contains a larger basket of goods and services. Given the recent high inflation, the RPI is indicative of the experiences of a wide range of household types, particularly low-income households.

For the record …

In the UK, prices as measured by the CPI rose 7.9% in the year to June 2023 according to the Office for National Statistics. This means the UK's rate of inflation is currently the highest in the G7 group of nations, an intergovernmental political forum consisting of Canada, France, Germany, Italy, Japan the UK and the USA. The G7 is organized around shared values of pluralism, liberal democracy, and representative government. As of 2020, G7 members are large IMF defined advanced economies and account for over half of global net wealth (at over $200 trillion), 30 to 43 percent of global gross domestic product, and 10 percent of the world's population (770 million people). Its members maintain mutually close political, economic, diplomatic, and military relations in global affairs.

We now follow with a chronological series of links to, we suggest, some relevant and interesting articles.

- **2 May 2023**

City to slash red tape in effort to rival New York (telegraph.co.uk) "Watchdog to change rules to encourage fast growing companies to float on the London Stock Exchange" writes Simon Foy.

- **11 May 2023**

The charts that show Andrew Bailey was wrong about Britain's economy (telegraph.co.uk) "Bank of England forced to admit there will be no recession at all." writes Melissa Lawford.

- **20 May 2023**

The export boom Brexit naysayers want to overlook (telegraph.co.uk) "A weaker pound is making Britain more attractive on the world stage." explains Eir Nolsøe.

- **22 May 2023**

It may not be 'Made in Britain', but we still dominate this lucrative niche (telegraph.co.uk) "Our Country's successful semiconductor sector is anything but flacid." reports Andrew Orlowski.

- **1 June 2023**

The quiet Brexit success story Remainers don't want to talk about (telegraph.co.uk) "Britain boasts a resilient services sector in spite of many doomsday predictions." explains Julian Jessop.

- **2 July 2023**

Britain does not have to accept economic oblivion (telegraph.co.uk) "We can break out of our low growth trap with the right policies." writes Roger Bootle.

- **11 July 2023**

Calm down, the UK is not an emerging market – and nor is it Greece (telegraph.co.uk) "Rising borrowing costs may be poisonous – but they will soon come tumbling down." states Ambrose Evans-Pritchard

- **12 July 2023**

Higher interest rates won't trigger financial crash, says Bank of England (telegraph.co.uk) "Banks remain resilient after Britain's eight largest lenders pass stress test." advises Melissa Lawford.

- **15 July 2023**

Public must rediscover love for investment to make Hunt's pension reforms a success (telegraph.co.uk). Jonathan Symonds and Peter Harrison suggest that "Hunt's speech was on the money – now it's time to put it into action."

- **19 July 2023**

UK inflation falls more than expected to 7.9% in June | Financial Times (ft.com) reports Valentina Romei, George Parker and Delphine Strauss.

- **23 July 2023**

Why interest rate pain will continue despite falling inflation (telegraph.co.uk) "We are merely at the end of the beginning of this economic shock." explains Roger Bootle.

- **29 July 2023**

India-UK free trade deal could be struck before the end of the year (telegraph.co.uk) "A free trade deal between India and the UK could be struck before the end of the year" the Indian commerce secretary has said, reports Ben Riley-Smith. Sunil Barthwal said that he wanted to "finalise the deal at the earliest" and that it could be signed "much before" the end of the year amid reports that both countries had reached a broad consensus on the shape of the deal.

- **31 July 2023**

Callum Muirhead reports in 'This is Money' that despite rising to 101% of GDP during the pandemic UK debt is amongst the lowest in the G7. Germany was the only country in the group to have a lower level at 66.5% for the final quarter of 2022. The UK's Office for National Statistic's also noted that the UK's £2.5 trillion debt had improved in the first three months of 2023, falling slightly to 100.5% of GDP.

AEROSPACE MANUFACTURING

Boom Supersonic Overture

Howard Mustoe advises that a plan to build the first supersonic passenger jet since the Concorde has taken a significant step forward after the company behind the effort signed key deals to design and build the plane. Boom Supersonic, which aims to have Concorde-style jets flying by 2027, said Italian aerospace giant Leonardo will make part of the fuselage on its new aircraft, Spain's Aernnova will design the wings and Aciturri has agreed to work on the tail.

Founder Blake Scholl, who started Boom in 2014, is hoping to have his supersonic jets certified for commercial use by 2029. The company has 130 orders and commitments for its planes already, including deals with United, American Airlines and Japan Airlines. It has broken ground on a factory in Greensboro, North Carolina, which will produce 33 aircraft a year. A second production line to double capacity is planned.

Boom's sustainable Overture aircraft will fly 65 to 80 passengers at Mach 1.7, or about 1,300 miles per hour, at 60,000 feet. The company is also working on a defence variant with Northrop Grumman.

Following the positive news above, we open this section with the further encouraging news that the first quarter of 2023 has seen a stable start to the year for aircraft orders and deliveries with 276 orders placed and 257 aircraft delivered. Although the overall order book is 34% less than Q1 2022, orders for wide-body aircraft increased a significant 95%, indicating strong market confidence in the return of international travel. Global aircraft deliveries for Q1 2023 represent a significant value of £4bn to the UK as the advanced aerospace manufacturing sector looks towards blue skies.

Following analysis of current delivery trends and production expectations from manufacturers, ADS forecasts a final 2023 aircraft delivery figure of 1,190 aircraft. The forecast is a 4% increase from 2022, expectations are that production rates will ramp up as we head towards 2024. Over the coming months it is essential the supply chain and labour market absorb planned production increases.

The backlog of aircraft remains above 13,000 at 13,466 aircraft, an important indicator of the positive health of the sector. Following three per cent growth on Q1 2022 the backlog represents several years' worth of work worth around £212bn to UK industry. The latest flight data shows continuing signs of recovery with UK flight arrivals and departures now recovering to under a 14% reduction from comparable data in 2019.

ADS chief executive, Kevin Craven said: "For the first quarter of Q1, aircraft deliveries have led global manufacturing particularly for wide body-aircraft, helpful for the UK in having a higher exposure to propulsion and wings. Order books have been stable but remain down on previous quarters reflecting the wider operating environment of manufacturing and the rising cost of doing business. It is encouraging to see orders for wide-body aircraft increasing, indicating strong market confidence in international travel. As we enter the second quarter of 2023, I hope to see deliveries continue to increase in line with ADS's post-pandemic recovery expectations of the sector achieving pre-COVID levels in 2024."

We turn now to our chronological news reporting.

➢ 28 May 2023

CNN reports that China's first large homegrown passenger jet - the narrow body C919 - made its inaugural commercial flight on Sunday, flying from Shanghai to Beijing. After years of research and development, the launch of the C919 is seen as a pivotal moment in Beijing's "Made in China 2025" strategy, which aims to boost local manufacturing, including reducing reliance on foreign airplanes for its aviation sector.

With a range of up to 5,555 kilometres (3,452 miles), the C919 will take on the world's two major aircraft manufacturers, Airbus and Boeing. It will be a direct competitor to their A320 and B737 narrowbody jets, most commonly used for domestic and regional international flights. Built by COMAC (Commercial Aircraft Corporation of China) the first C919 was delivered to China Eastern Airlines in December 2022 and in the months since has been put through a series of test flights.

The single-aisle, twin-engine aircraft has 164 seats in a two-class cabin configuration consisting of business and economy seats. According to the 2022 Shanghai Science and Technology Progress Report issued by the Shanghai government, 32 clients had placed a total of 1,035 orders for the plane as of the end of 2022.

Many of the plane's major elements such as the nose, fuselage, outer wing, vertical stabilizer and horizontal stabilizer were designed by COMAC. However, the company enlisted Western companies to assist with some components. This includes the plane's LEAP-1C engines, which were developed by CFM International, a joint venture between General Electric and French industrial group Safran.

Also in May, Airbus opened their second assembly line for the A320neo family in China.

➢ JUNE 2023

Partnering with Northrop Grumman, JetZero has proposed the Z-5 for the U.S. Air Force's programme to build a large-scale advanced tanker-transport demonstrator. Credit: JetZero

Guy Norris and Graham Warwick ask in Aviation Week, has the time for the blended wing body finally arrived? JetZero thinks so, and the California start-up has emerged from stealth mode to unveil a multi-mission design targeting the midsize commercial and military tanker-transport markets.

First appearing as a concept in the late 1980s, and studied on and off ever since, the blended wing body (BWB) has failed to gain traction despite promising performance projections. Now, JetZero says, "a yawning market gap for a sustainable mid-size airliner and the U.S. Air Force's simultaneous quest for a similarly sized advanced tanker-transport, means the stars are aligned for a BWB as never before."

The BWB concept blends the airframe structure and aerodynamics to reduce weight and drag while enabling the fuselage to contribute to lift. Also known as a hybrid wing body, the configuration is usually tailless and more efficient than a conventional tube-and-wing design because of its reduced wetted area, friction drag and lower form drag. BWBs are also inherently quieter than current airliners because the airframe shields most of the noise from engines mounted on the upper surface.

JetZero's Z-5 design, the first in a proposed family of Z-series aircraft, is optimized for a range of at least 5,000 nm and up to 250 passengers. The all-composite aircraft has a wide single deck and high-aspect-ratio wing. Although this extends the wingspan to close to 200 ft., similar to an Airbus A330, the body length is shorter than a Boeing 767. Despite the overall size, JetZero says the mid-market aircraft "will be about half the weight and require half the power of aircraft it replaces, such as the

767." See: JetZero Unveils Midmarket Airliner And Air Force Tanker BWB Plan | Aviation Week Network and RAeS AERO SPACE June 2023 edition.

Also in this month's edition of AERO SPACE Stephen Bridgewater writes, hydrogen, electric and hybrid-electric powered airliners may be coming one day, but asks what is being done to existing jet gas turbine engines in the meantime to improve their sustainability? To answer that question he speaks with Rolls-Royce, GE Aerospace and Pratt & Whitney about the small tweaks that could make a huge difference.

Furthermore, included in that edition are the results of a joint 2023 survey from the Royal Aeronautical Society and digital manufacturing specialists, Protolabs, that was conducted to learn more about the aerospace sector's most important concerns and top priorities. Tim Robinson FRAeS examines the results and writes:

"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." Read on at: Aerospace manufacturing in 2023 – the big issues (aerosociety.com)

➢ 21 June 2023

Boeing has released new projections for the commercial jet market over the next two decades which suggest a global demand for 42,595 aircraft by 2042 valued at $8 trillion. "The aviation industry has demonstrated resilience and adaptability after unprecedented disruption, with airlines responding to challenges, simplifying their fleets, improving efficiency and capitalizing on resurgent demand," said Brad McMullen, Boeing senior vice president of Commercial Sales and Marketing. "Looking to the future of air travel, our 2023 CMO reflects further evolution of passenger traffic tied to global growth of the middle class, investments in sustainability, continued growth for low-cost carriers, and air cargo demand to serve evolving supply chains and express cargo delivery."

Boeing's projections for regional demand and key trends through 2042 include:

- Asia-Pacific markets to represent more than 40% of global demand with half of that total in China.
- South Asia's fleet will expand more than 7% annually, the world's fastest rate, with India accounting for more than 90% of the region's passenger traffic.
- North America and Europe each will account for about 20% of global demand.
- Low-cost carriers will operate more than 40% of the single-aisle fleet in 2042, up from 10% 20 years ago.
- After omitting demand for Russia and Central Asia in last year's CMO due to uncertainty in the region, this year's forecast covers Russia and Central Asia in the Eurasia region, which comprises about 3% of the global fleet by 2042.
- Commercial Services forecasts a total served market worth $3.8 trillion including digital solutions that increase efficiency and reduce cost, robust demand for parts and supply chain solutions,

growing maintenance and modification options, and effective training to enhance safety and support the pilot and technician pipeline.

Also in the 20-year forecast period, Boeing expects:

- New single-aisle airplanes will account for more than 75% of all new deliveries, up slightly from the 2022 outlook, and totalling more than 32,000 airplanes.
- New widebody jets will be nearly 20% of deliveries, with more than 7,400 airplanes enabling airlines to open new markets and serve existing routes more efficiently.
- Air cargo will continue to outpace global trade growth, with carriers requiring 2,800 dedicated freighters. This includes more than 900 new widebodies as well as converted narrow-body and widebody models.

Read further at: https://investors.boeing.com/investors/news/press-release-details/2023/Boeing-Forecasts-Demand-for-42600-New-Commercial-Jets-Over-Next-20-Years/default.aspx

- **26 June 2023**

The Farnborough International News Network (FINN) announces that the UK's aerospace sector continues to be buoyant in the midst of supply chain challenges and a muted Q1 outlook, according to the latest aircraft orders and deliveries report compiled by ADS. The 146 aircraft orders placed in May 2023 is a 306% increase on the 2022 figures, as the confidence in the UK aerospace sector continues to grow. Deliveries increased 38% over the same time period. The current backlog of aircraft orders is 13,406 aircraft, a positive marker for the health of the sector. The potential value add of this backlog to the UK economy could exceed £205 billion, representing several years' worth of work.

"The staggering year-on-year increase in aircraft orders highlights growing confidence in the aerospace sector," said Aimie Stone, Chief Economist at ADS Group. "While the sector is not expected to reach post-pandemic levels until 2024, the 38% year-on-year growth in aircraft deliveries highlights its resilience and is a positive health check in the midst of increased supply chain challenges."

June also saw the Paris Air Show 2023 generate aircraft deals worth a projected value of $155 bn. The value of firm aircraft deals to the UK is estimated to be worth up to £13.6 bn at published list prices and assumed content of production. The latest figures published by ADS Group showcase exports from the UK aerospace sector being worth £18.6 bn in 2022. It further highlights that businesses in the UK's aerospace sector generates £27 bn in turnover, with value add to the UK economy worth £10.9 bn. See: Aerospace sector thrives with 300% YoY increase in orders (wearefinn.com)

COMMERCIAL AVIATION OPERATION

Singapore Airlines - The World's Best Airline 2023

The World Airline Awards began in 1999, when Skytrax launched its first global, annual airline customer satisfaction survey. This year's winner is Singapore Airlines; having travelled on them our Chairman can fully endorse the opinions of so many other customers.

As stated by Skytrax, the airline's success has been fuelled by its dedication to customer service. In-flight menus in all classes offer gourmet meals created by a panel of internationally renowned chefs, and all customers can enjoy the carrier's state-of-the-art in-flight entertainment system which offers a wide choice of movies, music and games. Together with its budget carrier arm, Scoot, Singapore Airlines operates a fleet of more than 180 aircraft with a combined passenger network that spans more than 110 destinations. This is the fifth time the airline has won the coveted award.

And Singapore Changi has been named the World's Best Airport 2023.

There is one other prestigious award we will mention before moving on to our usual chronological news items, and that is the APEX World Class Award. The award was created as a collaboration between APEX - the Airline Passenger Experience Association - and Yates+Partners, an aviation guest experience consultancy, to recognize excellence.

Qualification for the World Class award is by audit and customer assessment. Extensive audits by industry professionals rate every aspect of the guest experience over many flights, in every class. Analysis of one year's customer ratings of the in-flight experience is combined with the audit data to get a complete evaluation of the guest experience. World Class is considered across extensive, customer relevant dimensions clustered under three constructs: Safety & Wellbeing; Sustainability; Service-Guest Experience. There is no differentiation between the airlines who are rated World Class. In 2023 eight airlines have been awarded the distinction, they are: Japan Airlines; Qatar Airways; Emirates; Xiamen Airlines; Singapore Airlines; KLM Royal Dutch Airlines; Saudi; Turkish Airlines.

➢ 21 May 2023

James Kilner reports that Russian airliners made around 2,000 flights with out of date safety equipment in the past 15 months, the head of Russia's government transport watchdog has said. Viktor Basargin, head of Rostransnadzor, told a Russian parliamentary committee meeting this week that Western sanctions imposed on Russia meant that some Russian airlines couldn't replace expired safety equipment. "Several hundred unscheduled inspections of airlines showed that companies operating Western equipment have a shortage of components, problems with the supply of consumables," he was quoted as saying by the Kommersant newspaper.

Mr Basargin said the main problem lay with the dozens of smaller Russian airlines and not with its main carriers such as Aeroflot, which also released a statement denying that it had cut safety measures. "All spare parts undergo strict incoming control for compliance with quality requirements, history of origin and have the necessary certificates," Aeroflot was quoted as saying.

The comments from Mr Basargin, head of Rostransnadzor, came after a Russian opposition website published an investigation claiming that Aeroflot had told its cabin crews to stop reporting defective or missing safety equipment.

➢ 29 May 2023

Reuters advises that Cathay Pacific Airways is close to placing an order worth approximately $2 Billion for Boeing 777-8F freighters as the Hong Kong carrier embarks on the partial renewal of a fleet of dedicated Boeing 747 cargo jets. The selection follows a hard-fought battle for the business of one of the world's top five freight airlines which had been comparing the all-freight version of the future Boeing 777X family with an upcoming cargo model of the existing Airbus A350.

➢ June 2023

European low-cost carrier, Ryanair, has announced an order for up to 300 Boeing 737MAX 10 airliners in a deal worth up to $40 Billion, the largest in the airline's history. See: AERO SPACE June 2023. Also in this edition John Walton speaks to industry leaders ahead of this month's Aircraft Interior Expo about the challenges and opportunities they face.

The 2023 Paris Air Show took place from 19 – 25 June and opened with the biggest single purchase order agreement in the history of commercial aviation - 500 Airbus A320 from IndiGo. First deliveries will begin in 2030. Read a full preview of the Show by Tim Robinson FRAeS and Stephen Bridgewater.

➢ July 2023

In the July edition of AERO SPACE, Tim Robinson's article, 'Reflecting on safety', writes about the new safety centre from Airbus that aims to remind its employees of the advances in commercial air transport safety, and the tragic consequences of complacency and mistakes.

Also in this edition Alan Dron reports on 'Desert dreams'. He explains that with new national airlines, new airports, an indigenous aircraft lessor, and the largest MRO (maintenance, repair and overall – more details in the ACP Autumn 2023 edition) establishment in the region, Saudi Arabia is growing into a major international player in the world of commercial air travel.

➢ 17 July 2023

And with airports in mind, FINN reports that Atkins and the International Air Transport Association (IATA) have created a suite of innovative digital tools for airports to estimate the embodied carbon associated with the construction of terminal buildings and aviation assets. The digital toolkit will enable airports – for the first time ever – to better understand and mitigate the impact of construction-related activities that contribute to carbon.

As the global aviation industry continues its post-pandemic growth, modernising and adapting infrastructure to meet Net Zero targets and the needs of sustainable aviation, the need to reduce embodied carbon in new buildings such as terminals and runways is ever more pressing. These digital tools will deliver embodied carbon benchmarking for the three key airport asset types of terminal buildings, runways and multistorey car parks. This will enable airport development teams to understand the carbon footprint of development work and enter into dialogue with airport operators about how to mitigate it.

The new tools, developed by Atkins and IATA, are believed to be the first early stage embodied carbon assessment tools specifically focused on airport terminal buildings. While most current tools measure carbon in general buildings and at a later stage in the design, this new digital toolkit is specific to aviation and will be applied at very early stage in the design, aimed at adding the most value. Read on at: Atkins and IATA create suite of digital tools for airports (wearefinn.com)

URBAN AIR MOBILITY

Skai hydrogen powered eVTOL air taxi

We introduce this new section of our quarterly Newsletters with the following definition. Urban Air Mobility (UAM) has been described as the use of small, highly automated aircraft to carry passengers or cargo at lower altitudes in urban and suburban areas which have been developed in response to traffic congestion. It usually refers to existing and emerging technologies such as: traditional helicopters; vertical-takeoff-and-landing aircraft (VTOL); electrically propelled, vertical-takeoff-and-landing aircraft (eVTOL); and unmanned aerial vehicles (UAVs).

Today UAM aircraft are characterized by the use of multiple electric-powered rotors for lift and propulsion, along with fly-by-wire systems to control them. Inventors have explored urban air mobility concepts since the early days of powered flight. However, advances in materials, computerized flight controls, batteries and electric motors improved innovation and designs beginning in the late 2010s. Most UAM proponents envision that the aircraft will be owned and operated by professional operators, as with taxis, rather than by private individuals.

UAM is a subset of a broader Advanced Air Mobility (AAM) concept that includes other use cases than intra-city passenger transport. NASA describes AAM as including small drones, electric aircraft, and automated air traffic management among other technologies that perform a wide variety of missions including cargo and logistics carriage. This is supported by the drone market consulting firm Drone Industry Insights, which includes vertiports in the definition of AAM and UAM.

AAM is an overarching term that combines both UAM, which involves transporting persons and cargo above the traffic within a city, and Regional Air Mobility (RAM) which is focused more on connecting suburbs, villages, and small towns in the countryside as well as islands or communities separated by mountainous regions and rivers. While UAM has attracted the majority of attention and investment, the initial rollout of AAM operations will probably start in more remote, rural settings in order to minimize collateral damage in the event of a mishap.

AAM has been described as “an air transportation system that transports individuals and property between points… using aircraft, such as remotely piloted, autonomous, or vertical take-off and landing aircraft, including those powered by electric or hybrid driven propulsion, in both controlled and uncontrolled airspace.” AAM seeks to integrate Unmanned Aerial Systems (UAS) and sustainable aircraft like eVTOL into the sovereign airspaces of nations throughout the world. It requires the development of the physical infrastructure of vertiports as well as the evolution of the digital infrastructure of a highly automated framework of operations, i.e. UAS Traffic Management (UTM).

As a start point for more information see the Civil Aviation Authority’s publication: Advanced Air Mobility: Taking a Use Case Approach (caa.co.uk) See also two posts by ADS (the aerospace trade body): ‘The Promise and Potential of Rural and Regional Air Mobility’; and ‘Industry sets out call for action to make eVTOL market a reality in the UK’.

We conclude this section with reference to the world’s first vertiport that opened in Coventry (see below) during April 2022. The site will serve as a blueprint for more than 200 vertiports planned world-wide over the next five years, according to Urban-Airport, the UK-based developer of Air-One. The first site was chosen in Coventry because of its location in the heart of the UK, with most parts of the country within four hours’ reach. Sites are already planned in the West Midlands and London, as well as in Los Angeles, Australia, South Korea, France, Germany, Scandinavia and Southeast Asia.

SPACE

Virgin Galactic is an American spaceflight company founded by Richard Branson and the Virgin Group conglomerate which retains an 11.9% stake through Virgin Investments Limited. It is headquartered in California, and operates from New Mexico. The company is developing commercial spacecraft and aims to provide suborbital spaceflights to space tourists. Virgin Galactic's suborbital spacecraft are air launched from beneath a carrier airplane known as White Knight Two. Virgin Galactic's maiden spaceflight occurred in 2018 with its VSS *Unity* spaceplane. Branson had originally hoped to see a maiden spaceflight by 2010, but the date was delayed for several years, and then delayed again, primarily due to the October 2014 crash of VSS *Enterprise*.

The company did the early work on the satellite launch development of LauncherOne before this was hived off to a separate company, Virgin Orbit, in 2017. The company also has aspirations for suborbital transport, and in 2017 Branson said that Virgin Galactic was "in the best position in the world" to provide rocket-powered, point-to-point 3,000 mph (4,800 km/h) air travel.

On 13 December 2018, VSS *Unity* achieved the project's first suborbital space flight, VSS *Unity* VP-03, with two pilots, reaching an altitude of 82.7 kilometres (51.4 mi), and officially entering outer space by U.S. standards. In February 2019, the project carried three people, including a passenger, on VSS *Unity* VF-01, with a member of the team floating within the cabin during a spaceflight that reached 89.9 kilometres (55.9 mi).

On 11 July 2021, the company founder Richard Branson and three other employees rode on a flight as passengers, marking the first time a spaceflight company founder has travelled on his own ship into outer space (according to the NASA definition of outer space beginning at 50 miles above the Earth). In February 2022, Virgin Galactic announced that it had opened ticket sales to the public. The price of a reservation is $450,000. The company had sold tickets before February 2022 to clients that had paid deposits earlier or otherwise "were on a list"; as of November 2021 the company had about 700 customers (tickets sold). The company aims to have about 3 launches per month sometime in 2023. A spin-off company, Virgin Orbit, used the same launch approach to achieve orbital launch, but was shut down in May 2023.

In June 2023, the company announced it would launch the first commercial space tourism flight called Galactic 01 later in the month. This came after completing its final test flight in May. As illustrated on our front cover, on June 29, 2023 Virgin Galactic launched its first commercial space flight successfully.

➢ 15 May 2023

Andrew Orlowski asks in The Telegraph "Factories in space? The very idea seems like outlandish science fiction, or maybe another hangover from the silly money era, along with vegan bangers and cryptocurrencies. As unlikely as it sounds [however], the idea could soon become a reality from humble beginnings on an industrial estate on the outskirts of Cardiff. In fact, if Richard Branson's Virgin Orbit hadn't crashed into the sea in January we'd already have a small British prototype plant whizzing over our heads made by the Cardiff-based start-up, Space Forge. Read on at: Putting factories in space can buck Britain's pernicious declinism (telegraph.co.uk)

➢ 17 May 2023

And Matthew Field advises that the company that has built the world's largest aeroplane has emerged as a key bidder for the assets of Sir Richard Branson's bankrupt space company, Virgin Orbit. Stratolaunch, which has developed a plane with a 385ft wingspan designed to carry rockets to high altitude, has made a $17m (£13.6m) offer for the assets of the failed rocket company. The deal values the remains of the business at just a fraction of the $3bn Virgin Orbit was worth when it went public in 2021. Court filings said Stratolaunch's offer represented a "stalking horse" bid for the assets of the company, effectively a reserve price for others to beat. The filings said the offer had the support of Sir Richard's Virgin Investments. Continue reading at: Builder of world's largest plane Stratolaunch plots to buy bankrupt Virgin Orbit (telegraph.co.uk)

➢ 21 May 2023

David Millward reports that SpaceX has launched three customers into space on a private flight. The mission – carried out by SpaceX and Houston-based Axiom – is the second all-private mission to the station. Former Nasa astronaut, 63-year-old Peggy Whitson, became the first woman to command a private space flight.

The AX-2 mission also makes history with stem cell researcher Rayyanah Barnawi becoming the first Saudi woman to travel to space. A second Saudi, Ali AlQarni who is a fighter pilot, and an American, John Shoffner, who made his fortune in telecommunications, are also on board.

Their autonomous Crew Dragon capsule is due to dock with the International space station on Monday. The crew is scheduled to spend eight days in space, carrying out scientific experiments including stem cell and biomedical research. Read on at: SpaceX launches three customers into space on private flight (telegraph.co.uk)

➢ 25 May 2023

Sarah Knapton reports that a future where humans are placed in hibernation to travel into space is a step closer after scientists have proved they can put mammals into a sleep-state using ultrasound. Many animals and birds are able to enter a torpor-like state in which they suppress their metabolism and reduce body temperature to conserve energy and heat during periods of extreme cold or lack of food. Since the 1960s, scientists have proposed that inducing a similar state in humans could help protect patients with life-threatening conditions and allow astronauts to embark on long-distance interstellar flights with fewer supplies.

The concept of travelling through space in suspended animation has been at the heart of several science fiction films including Passengers, 2001: A Space Odyssey, and Interstellar. Now, a team at Washington University in St. Louis has shown they can send rodents into a state of reversible hibernation by firing ultrasound pulses at their heads, stimulating the hypothalamus preoptic area in the brain, and causing their heart rates to halve and their temperature to drop. See: Humans could hibernate to travel into space as rats put to sleep using ultrasound (telegraph.co.uk)

➢ 4 June 2023

David Millward writes from the US that NASA has been playing a hi-tech game of hide and seek with the mini-helicopter (Ingenuity) they dropped on the surface of Mars just over two years ago that has surpassed all expectations. Scientists have been baffled by the longevity of the aircraft, which was expected to carry out about five flights and then stop working about two years ago. Six days later the rotorcraft, weighing 1.8 kilograms (4 pounds) which cost NASA approximately $85 million (£68.2m) to develop, has now completed more than 50 flights taking invaluable images of the Mars surface.

The helicopter is controlled via radio signals relayed from Perseverance, the SUV-size rover studying Martian soil. Ingenuity was designed to roam the skies ahead of the rover as a scout, collecting additional data. After 28 flights, the Ingenuity entered its “low power” state, with scientists doubtful that it would be able to power its heater to protect vital components and emit a signal on a planet where the temperature can drop to -125C (-195F).

But scientists began using data on Martian sunrises to calculate when the helicopter would thaw out so they could find it after its programmed flights. Scientists have had to calculate Ingenuity’s morning “wake-up time” when it would emit a signal, wrote Travis Brown, the project’s chief engineer. The team was able to work out when it would be back online. Now read on at: Rotorcraft stuns Nasa to continue flying over Mars long after it should have failed (telegraph.co.uk)

Ingenuity performs a test flight in the early days of its time on Mars
Credit: NASA / JPL-Caltech / SWNS

- **7-8 June 2023**

The Farnborough International Exhibition & Conference Centre hosts Space-Comm Expo and ADS publishes their latest Space Sector Outlook. The latter advises that in 2022 the UK's space sector added £7 billion in value to the UK economy while turnover reached £17.5 billion. Furthermore, the UK Space Agency announced £6.6 million funding for a range of international science partnerships and STEM education projects.

- **13 June 2023**

Oxford based Pulsar Fusion have announced a partnership with Princeton Satellite Systems to use AI machine learning simulations to create a deep space rocket engine with a 500,000 mph potential. Announcing the partnership Pulsar Fusion's founder and CEO, Richard Dinan, said: "This is a hugely significant step for Pulsar. By pooling our own research and resources with those of Princeton Satellite Systems, Pulsar has gained access to behavioural data from the world record holding fusion reactor (PRFC-2). Coupled with recent advancements in machine learning this will supercharge the development of our nuclear fusion rocket systems."

- **2 July 2023**

Europe's dark energy hunting telescope launched from Cape Canaveral on Saturday, after battling the invasion of Ukraine and 'painful' US bureaucracy to finally reach space, reports Chris Price.

The £1.2 billion Euclid telescope, named after the Greek father of geometry, is hunting for invisible dark energy and dark matter which make up 95 per cent of the universe. The telescope was originally due to launch on a Russian Soyuz rocket, but SpaceX stepped in after relations between Roscosmos and the European Space Agency (ESA) broke down last year because of the Ukraine war.

Engineers were initially concerned that the delicate scientific instruments may not cope with vibrations from a Falcon 9 rocket, which is more suited for getting telecoms and navigation satellites into space. There were also fears that SpaceX would not be able to provide the ultra-clean environment needed to ensure that no dirt found its way into the delicate sensors which will be taking huge images of galaxies up to 10 billion light years away. ESA also found itself having to cope with stringent American International Traffic in Arms Regulations (ITAR) which restrict the use of military-related technologies designed in the US.

Mike Healy, Head of Science Projects at ESA, said: "It's been a bit of a ride with SpaceX. We had to squash what we normally do in three years into six months. The mechanical environment around Falcon 9 is different to the Soyuz and there have been some surprises we have had to adapt to. All the ITAR stuff is painful, and that's not SpaceX's fault, it's just reality. Some of the silly logistics things have been as challenging as some of the big technical challenges. But we owe SpaceX a huge thanks. See: SpaceX launch: UCL Euclid telescope lifts off (telegraph.co.uk)

10 July 2023

The Northern Times reports that UK-based spaceflight company Orbex has extended its footprint by over 30 percent across its Scottish and Danish design and production facilities in preparation for the launch of its Prime rocket. The company is adding an extra 1,500 square metres of factory and office space to its existing 4,750 square metre estate in Forres and Copenhagen. The additional space will increase the company's launch vehicle production and propulsion system manufacturing capacity and add an extra software laboratory and an avionics clean room. The additional capacity in Forres is just 3km from its test site at Kinloss, allowing for quick turnaround between the two sites, as Orbex ramps up its testing in the countdown to launch.

The first full-scale prototype of Orbex Prime

In May 2022 Orbex Prime became the first full orbital microlauncher rocket to be unveiled in Europe. Prime is a 19-metre long rocket designed to launch small satellites into polar and sun-synchronous orbits. Orbex has already announced several commercial launch contracts with satellite manufacturers. Sustainability has been a focal point in the design of the reusable rocket, which has been engineered to leave zero debris on Earth and in orbit.

Orbex says that the rocket is fuelled by a renewable form of propane, meaning that a Prime launch has a carbon footprint up to 96 percent lower than traditional launch vehicles powered by fossil fuels, according to a study by the University of Exeter. Prime will launch from Orbex's 'home' spaceport, Sutherland Spaceport (formerly Space Hub Sutherland), on the north coast of Scotland. The facility is being built and operated by Orbex under a 50-year lease with the option of extending for a further 25 years. Sutherland Spaceport is intended to be the first spaceport globally to be carbon-neutral in its construction and operation.

Orbex chief executive Martin Coates said: "Many people are eager to see the first successful launch of a satellite from British soil, as are we. But our focus has to be bigger than that, as we aim to build a robust and sustainable launch capability in the UK. Expanding our footprint is just one more step forward in that process. We are able to press ahead with our expansion, thanks to the incredible team we have in place and the confidence placed in us by our investors and customers."

- **12 July 2023**

Chris Price in The Telegraph advises that Jeff Bezos' space company Blue Origin has suffered a setback after a rocket explosion during testing, in a blow to the billionaire's space business. The blast occurred last month during testing of its BE-4 rocket, according to CNBC. An engine detonated about 10 seconds into the test during a firing on June 30 at the company's facility in West Texas, it was reported.

A Blue Origin spokesperson confirmed to CNBC that the company "ran into an issue while testing Vulcan's Flight Engine 3." No one was injured in the incident and the company said it was assessing the "root cause," adding "we already have a proximate cause and are working on remedial actions."

The company said it "immediately" made its customer ULA aware of the incident. ULA is the rocket-building joint venture of Boeing and Lockheed Martin which competes with Elon Musk's SpaceX to win lucrative military launch contracts. BE-4's test failure threatens to further put back the already-delayed first launch of ULA's Vulcan rocket which was recently rescheduled to the fourth quarter of this year. See: Blue Origin rocket engine explodes during testing in blow to Jeff Bezos (telegraph.co.uk)

UK MILITARY AVIATION

With the Russian invasion of Ukraine now approaching the 18 month mark very much in mind we devote this section of the Newsletter to a landmark defence conference – the Future Combat Air and Space Capabilities Summit hosted on 23-24 May by the Royal Aeronautical Society RAeS) at its HQ in London. The conference brought together just under 70 speakers and 200+ delegates from the armed services, industry, academia and the media around the world to discuss and debate the future size and shape of tomorrow's combat air and space capabilities. Topics ranged from lessons from the current war in Ukraine, resilience and agile operations, interoperability, space, multi-domain operations, future sixth-generation platforms, low-cost drones and loyal wingman, to training, cyber, simulation, AI, deterrence, hypersonics, and even speculative fiction's role in predicting the future.

With so many speakers, and dual track sessions, it is impossible to cover all the presentations in an article such as this which can only provide a snapshot of what was two days of intensive and thought-provoking presentations. What follows, therefore, is an extract from a summary of the highlights prepared by Tim Robinson and Stephen Bridgewater from the RAeS.

Resilience and agility

Lessons from Ukraine were obviously uppermost in many people's minds since the Russian invasion in February 2022, and the Summit featured a number of speakers who addressed how air forces could become more resilient and agile. Deputy Commander NATO Air Command, AM Johnny Stringer RAF, commenced the conference by giving a high-level overview of some of the key operational implications from Ukraine, including Electronic Warfare, the "need to be serious about integrated air and missile defence" and the importance of SEAD. He noted: "What you are seeing, particularly in Ukraine at the moment, is how essential it is to secure the necessary level of access to airspace. If you don't, stand by for a bloody attritional slog with images that look like they have come out of World War One".

This view was echoed by Maj Gen James Kriesel, National Guard Assistant to the Commander, USAFE-A, later in the day, who said that "there are some out there that say that air dominance is not critical. And that what matters is owning key terrain, mashing of forces and logistics to really support an artillery slugfest. I disagree. If anything this conflict demonstrates it is the protracted brutality of a conflict where neither side has gained air dominance".

On resilience, Stringer noted with modern ISR: "It is very difficult to hide. It is very difficult to hide expensive aircraft, and it's very difficult to hide big expensive aircraft. So, we need to be thoughtful about how we solve dispersal and effective deception. What is the correct role for hardening, and what genuine agility means?"

Stringer pointed to new NATO member Finland as providing some genuine insights into agile combat employment (ACE) which is now becoming a buzzword among Western air forces as they rediscover forgotten Cold War skills, calling their approach "rather impressive" and asking 'how do we generate something like that?"

Nordic resilience

Sweden plans to keep its air force on the move in time of war. (Saab)

On the theme of Nordic nations and resilience, another presentation saw Lt Col Carl Bergqvist, Chief of Plans, Swedish Air Force, who outlined his air force's method of surviving and fighting on with dispersed operation – which has been developed and honed over decades. In the SwAF, a network of main bases and forward operating bases will allow aircraft to disperse and keep constantly on the move, with some forward bases only being open for a couple of hours. Fast turnarounds (a Gripen can be rearmed for an air-to-air mission in less than 10mins) make the SwAF an extremely agile force.

The Summit heard how Sweden's 'shell game' contrasts with the Royal Norwegian Air Force, a F-35A operator, which is focusing on beefing up its SAM air defences to increase its resilience. This balance between, dispersal, hardening and defence, along with numbers for attrition was one that made for interesting discussions on ACE and it is clear that 'no one size fits all'.

Meanwhile, as welcome as Western support to Kyiv has been in supplying arms and ammunition in halting Russia in its tracks, the vast and bewildering variety of tanks, helicopters, missiles, drones and

artillery sent to Ukraine has highlighted cracks in NATOs standardisation, and generated lessons for future joint defence procurement, said Stacy Cummings, GM Manager at NATO's Support and Procurement Agency (NSPA). In particular, she revealed that incompatibilities in NATO standard artillery ammunition had been a wake-up call for interoperability. "That was probably a bit shocking for the nations that were donating ammunition to Ukraine to find out that if they didn't donate the system and ammunition at the same time, the donating ammunition wasn't usable in the system".

She advised: "What I think is a major lesson learned out of Ukraine is that we in NATO need to look across the different types of systems that we're supporting and figure out ways to come together to trust each other's development so that we can buy military off-the-shelf equipment that our allies and our neighbours have already designed, developed and tested." She added in so many words that this should go a step further and not replace legacy systems with more legacy systems, but come together to design and develop the next generation of weapon systems with fewer differences between NATO members."

GCAP progress

Some five years on from the UK revealing the 'Tempest' mock-up as the core future fighter for its Global Combat Air Programme (GCAP) at Farnborough Air Show, Herman Clausen, Managing Director FCAS, BAE Systems, gave an update on GCAP from the UK industry point of view as the lead company in 'Team Tempest'. The effort has now gone global and expanded with the addition of Japan as a partner on the programme in December 2022 as well as the goal of flying a supersonic, stealthy demonstrator within the next four years to support an In Service Date of 2035.

Clausen said "We are now well into the UK Concept and Assessment phase and will be getting ready in the next 12 months for the outline business case number two". With the supporting evidence and technology assembled, and given the full 'go' decision by UK Government, our next major milestone after that will be launching the full-blown design and development programme at the start of 2025."

In the UK, alone, the enterprise involves some 580 companies and organisations from traditional aerospace OEMs to academia and even video gaming and Formula One. The FCAS programme now employs almost 3,000 people directly, and most significant of all, 1,000 of these are new graduates – helping shift the demographics of the UK's military aerospace sector to a younger, more diverse workforce of 'digital natives'. Meanwhile, the programme's use of digital twins, and model-based system engineering (MBSE) in its digital design and development is already paying off – with Clausen saying "the use of modern software processes is showing 50-70% schedule savings and 25-30% cost savings" compared to legacy projects.

Meanwhile, in the exhibition space for sponsors, BAE Systems had brought along the latest public demonstration of its augmented reality cockpit concept for GCAP/Tempest. This has now been enhanced and updated since it was first revealed with a map that can be toggled in the AR space from a 2D to a 3D isometric perspective. This can be tilted, rotated and zoomed in and out – with contacts clicked on to bring up further information. Th AR cockpit will also include biometrics, awareness, eye tracking and stress monitoring of the human part of the system. Personalised for each individual, this will allow the aircraft to take over some of the core functions should it sense the pilot getting overwhelmed or task-saturated.

BAE Systems showed the latest version of its augmented reality fighter cockpit which now features a 3D holographic map. (Tim Robinson/RAeS)

Entente and interoperability

With the context of today's strategic environment set, the Summit also included presentations on future capabilities including next generation fighters, combat clouds, UAVs and space. Perhaps the most newsworthy and unique panel was provided on the first day which saw, possibly for the first time in a public forum, the chiefs of the UK's FCAS (Richard Berthon, Director Future Combat Air, UK) and French SCAF (Maj Gen Jean-Luc Moritz, Head of SCAF, French Air Force) seated together.

While GCAP (the international programme comprising UK, Italy and Japan) and the Franco-German- Spanish FCAS (of which the Next-Generation Weapon System (NGWS) is the 'Tempest' equivalent of the central platform) are commonly seen as bitter rivals, the summit heard more on the common ground than on any differences. Indeed, Maj Gen Jean-Luc Moritz, Head of SCAF, French Air Force, went further and said: "My dream is tomorrow, a Tempest could take control of an NGWS asset and a NGAD could take control of FCAS UK, with a Rafale and Tempest flying together in a joint operation". He stressed: "sixth generation aircraft must guarantee interoperability by design".

Richard Berthon, Director Future Combat Air, UK, confirmed that there are indeed links between the UK and France on common ground between these two next generation combat air programmes, that were built on the previous cancelled Anglo-French joint UCAV – and "it was a mechanism that we can use for whatever we see as necessary." However, he warned: "I'm sceptical of trying to do too much bilaterally - there's also a much wider conversation involving other international partners to bring together the connectivity, integration and interoperability challenges".

Particularly interesting was the view from one of the GCAP partners, Japan. Maj Gen (Rtd) Koji Imaki, outlined the Japan Air Self Defense Force's (JASDFs) strategic challenge and its procurement priorities. He explained that Japan was looking to use drones to build out combat mass from 5th/6th generation crewed fighters in an affordable way. The correct mix and balance between high-

end loyal wingman, attritable drones and low-cost consumer devices was one that that was returned to in other presentations and it seems the jury is still out on what a future fighter squadron looks like, but all at the Summit seemed to agree on the importance of 'loyal wingman' or 'Collaborative Combat Aircraft' (CCA.) As Lauren Knausenberger, Chief Information Officer, USAF noted, CCAs will be one of the "biggest gamechangers coming down the pipeline" with the US planning to acquire 1,000 of these.

Cyber lessons from Ukraine

Understandably, the lessons learned so far from the war in Ukraine were key themes of the summit. Air Cdre Jim Beck, ACOS - Capability Strategy, HQ Air Command, revealed how the Russians had suffered 50% attrition of their air platforms in the first 28 days of their invasion of Ukraine. Among the international representation discussing the topic was Lt Col Johnny Resman, Chief Cyber Development Officer, Air Staff Plans, Swedish Air Force, who claimed that "if Russia manages to maintain its foothold in Ukraine it will turn the Iron Curtain into an Iron Dome." "It will enable Russia with an integrated air and missile defence system from the Kola Peninsula down to the Black Sea" he explained, adding that Russia was likely to use "occupied territories within Belarus to increase that capacity." "We therefore need to think in new ways, use new technologies and new tactics to accomplish our military goals" Resman told the audience. "The cyber realm is vital, especially as connectivity increases as we boost the numbers of sensors and collaborating operators in the combat environment. We need to exploit – or be exploited!"

Wg Cdr Dave Collins - Director of the RAF's Air Cyber and Information Services Operations Centre, shared the stage with Resman and, elaborating on the cyber warfare subject, asked a very pertinent question: "Can we realistically protect everything? Or should we learn to live with the fact that we can't?" He went on to say that with everyday life now increasingly reliant on satellite and cyber technologies – from banking to traffic lights – we may need to prioritise the defence of critical infrastructure. Collins also floated the question of when does a cyber compromise cross the threshold of armed conflict?

Collins also explained that the first year of the Ukraine War had provided unprecedented amounts of data, something that we have not had access to from previous conflicts. "There is some incredible open source data coming out of Ukraine" he pointed out, adding that "some of the reports being published by Microsoft would have 'Top Secret' stamped on them if they'd been produced by the military!"

Dr Daniel Clarke - Director of Applied Technology at Gallos Technologies and Lecturer at Cranfield Defence and Security, Cranfield University, spoke on the subject of achieving technical advantage for future air-capability in multi-domain operations. "In five decades we have moved from thousands of WW2 bombers, each with ten crew aboard, indiscriminately dropping hundreds of thousands of tonnes of bombs, to the first Gulf War where around 10% of munitions were deployed with autonomous terminal guidance and precision guidance, allowing us to put far fewer aircraft and, therefore, far fewer people in harm's way" he began by saying. "Then, during Operation Shader [in Syria and Iraq], the RAF used only precision guided munitions with the service claiming at one point that these had caused no unintended casualties at all" he said.

"Now, if you look at some of the doctrine that we've been developing over the last five years, and in particular post-Afghanistan, we've started to consider what that integrated technology means on a

bigger scale. Integration runs across domains but also across allies" continued Clarke. "There is no such thing is air power on its own. It's air and space power, in conjunction with naval and land forces. And the concept of cyber electromagnetic activity is integral to all of those domains."

Collaboration

Like many presenters at the summit, Clarke argued that the defence industry needs to lean more from other sectors. However, he also urged caution regarding interoperability and collaboration. Having spent a decade developing robots and autonomous cars he pointed out that much of the technology used in the military's last-mile delivery vehicles was almost identical. "I would wager that the software stack is the same that was developed for the Grand Challenge back in 2004/2005 and has permeated its way through every single autonomous vehicle being developed today". "If so, this presents a huge challenge to defence vehicles in terms of security." He went on to point out that autonomous cars have already been 'hacked' and, as the Ukraine War has demonstrated, the need for reliable supply of equipment, food and ammunition could be at risk. Why bomb a column of supply vehicles when you can simply 'turn them off'? Or as Clarke asked: "Why shoot down a jet when you can steer the pilot's car into a ditch before he's even reached the airfield?"

Meanwhile Dr Arif Mustafa - Chief Digital Information Officer, RAF - highlighted the exponential growth of computing power that threaten to outpace military platforms. He said "I received my fist Commodore 64 computer in 1982, just three years after the Tornado entered service. The Tornado continued in service until 2020, by which time the PlayStation 5 had been introduced. Compared to the C64 that represented an improvement of FLOPS processing power to the power of 10 billion! Over those same four decades other technologies progressed including widespread access to the internet and mobile phones, so if Tempest is projected to remain in service until 2080, where will technology be by then? We need to be able to grow significantly the capabilities of the airframe and systems to absorb future paradigm shifts in technology."

"The conflict in Ukraine has shown us that we need to adapt quickly" continued Dr Mustafa, "whether it's mounting missiles on aircraft that were not designed to carried them or updating Starlink software overnight to counter jamming. It has also proved that interoperability is vital and we can only do this by partnering closely with industry and identifying opportunities. It is also essential to make data more widely available."

Commercial off the shelf (COTS)

Low-cost drones have been a game-changer in Ukraine. (Yuriy Kasyanov/Facebook)

The war in Ukraine has seen huge exploitation of COTS equipment for military means. "Ukrainians are achieving some spectacular success with a bunch of civilian technology that can be bought from anywhere between Amazon and Ali Baba" said Clarke. "There are examples of Ukrainian forces working with enthusiast drone operators and even tasking a 14-year old with a DJI Mavic to scout out a column of the tanks. Other examples have included a vigilante SIGINT operator in the form of a guy who's got a software defined radio that listens to Russian radio communications, finds out the frequency and posts it on Twitter so that the military can use it. That is spanning that whole multi-domain space from the protect and engage to warfighting."

Forging Excalibur

2Excel Aviation are now on the hunt for engineers to covert a Boeing 757 into a future fighter lab.

While much of the effort towards FCAS is going on behind closed doors and in classified facilities, there was a peek behind the curtain when Chris Norton, Co-founder and Director of 2Excel Aviation described his company's work on converting a Boeing 757 into a sixth generation fighter airborne laboratory to support the Team Tempest effort. 2Excel Aviation has made a name for itself in developing special mission aircraft in record time, by doing the design, integration and modification work for itself, whether it is oil spill 727s, Extra Aerobatic aircraft converted to train JTACs, or King Airs converted into mini-MPA in a staggering eight months.

The 757 was chosen because of its size, weight and power, with the RB211 engines able to provide excess power for the sophisticated sensors, avionics and flight test equipment that will see its external shape spout a number of antennas., dishes and cones. "It's sleek, it's smooth, and we're going to ruin all of that." quipped Norton.

Adding these 'lumps and bumps' to a civil airliner brings its own challenges, for example what will swapping out a tiny weather radar in the nose for a fighter radar do to the CoG? To that end, Norton revealed that it had completely disassembled a second 757 to provide data for a mass, balance and

structural digital twin. "In short, we've turned millions of pounds of aircraft into tens of millions of pounds worth of data. It is extreme, but digitalisation will prove our model with baseline tests. Once in service with Leonardo, the UK will be only the third nation with this sort of highly sophisticated stealth fighter testbed after the US and China.

Close encounters of the satellite kind

Another major theme from the summit was the increasing role of space as a domain, even though it is still very much taken for granted, something that still "surprises" him noted AVM Paul Godfrey, Head of UK Space Command. He revealed that UK Space Command is now leveraging the commercial sector via the Joint Task Force-Space Defense Commercial Operations Cell (JCO) to boost its space domain awareness (SDA) via open-source methods. Indeed, only this week a Luch Russian military communications satellite with an ELINT payload had been spotted "operating outside its normal pattern of life" he said. "Normally, it doesn't come within 150km of another satellite, but it is now sitting 13km away from Intelsat 27".

He also highlighted a Chinese satellite which had made three unexplained manoeuvres in the past week, and again is a SIGINT satellite. These reports of orbital activity, coming from the commercial space sector via JCO, allow military operators to share information that would previously have been highly classified, and so build awareness, transparency and trust. Said Godfrey of the Luch close encounter: "This is not something I thought I'd ever be able to say at a public conference, but that is what JCO allows us to do".

Meanwhile, later in the day, a presentation from Wg Cdr Rebecca Hollis, Wing Commander Capability, UK Space Command, revealed how the UK is aiming to enhance its SDA awareness by looking to exploit the geography of its Overseas Territories by installing commercial sensors there to track activity in space. With locations like the Falkland Islands, Ascension, Diego Garcia and others, these could be an extremely useful capability in plugging gaps in monitoring space for the UK and its partners.

Counter UAS

Whereas many discussions over the two days focused on the use of RPAS/UAS as an offensive weapon or intelligence gathering asset, the future of counter UAS technologies was highlighted by Charlie Lynn, Chief of Staff at the MoD's Joint C-UAS Office. Lynn started his role just after the drone incursions at Gatwick airport in December 2018 and spent "most of 2021 in an operational theatre working with coalition partners conducting an urgent operational analysis of counter UAS capabilities."

He explained that all manner of high value and strategic assets are vulnerable to attack by UAS platforms, from ships to buildings, but the threat also extended to air safety and public events. "In warfare you need an understanding of who your adversary is, what their strategic objectives are, and how they have a capability to achieve those objectives," he said. "Here we are looking across a much wider, holistic spectrum, which is largely unregulated and your adversary could be almost anybody. It could be a foreign state actor, a hostile intelligence service, a terrorist organisation, a protest organisation or a lone wolf. Then we need to ask, what they are trying to achieve, is it an ISR or surveillance effect? Are they looking to achieve some form of external communications or propaganda effect? Could it be a disruption or other malintent?"

He continued, counter UAS operators have a difficult task on their hands. Many devices fly low and slow making them difficult to target and, as he pointed out "both sides of the conflict in Ukraine are now adapting racing drones that have speeds of over 250mph. We are also seeing potential adversaries moving away from systems that transmit signals to those which operate autonomously."

Lynn felt that the key to successful counter UAS operations is an ability to deliver continuous coverage. "Systems Integration is absolutely critical" he emphasised, "and we have to ensure that we are interoperable not only amongst ourselves, which is actually quite a challenge, but also with key coalition partners as well. We have to take advantage of forces that have strengths we need, to exploit and blend them into an open architecture system that allows us to maximise our ability to deliver continuous effects at range.

Lynn freely admitted that the biggest challenge was keeping pace with the rapid development of UAS platforms. "Drones are evolving in terms of hours, not days, months or years" he pointed out. "As a defence procurement organisation, how do you keep pace with that? How do we ensure that our systems are relevant to the future threat set, and how do we evolve at a pace to meet those new challenges? Do we need to stop looking at our ability to just buy a system or a capability, or start buying services?"

The proliferation of COTS drones in Ukraine posed another question for Lynn. "They have now become almost disposable items," he emphasised, "and operators run the risk of tripping up their own capabilities. If both sides of the conflict are using these devices, how do you recognise which one is yours and which is your adversaries?" This translates onto the home front too, with ever increasing numbers of delivery drones, eVTOLs and other low level rotary traffic predicted to boom in coming years, how do counter UAS operators identify the malicious threat from legitimate commercial drone activity?

Protector into service

Protector will be a giant leap for the RAF's RPAS capability.

One RPAS expected to appear in UK skies later this year is the RAF's Protector. Stephen Hesketh, Deputy Chief Engineer for RG-1 Predator and MQ-9 Reaper Air Systems within the MoD, updated the audience on the introduction of Protector into service. Based on the US General Atomics MQ-9B Sky Guardian, Hesketh described Protector as "the world's first certifiable RPAS." Compared to its predecessors this UCAV has around twice the endurance and comes with a synthetic aperture radar, target indication and, crucially, TCAS ADS-B and IFF. The latter three enable it to fly in controlled airspace, something that its predecessors cannot do. Planned future enhancements include a Due Regard Radar and Non-cooperative Detect and Avoid System as well as a Maritime Protector variant with search radar and electronic support measures.

"We are receiving 16 Protectors," said Hesketh, "with the first example due to arrive at RAF Waddington in October and the first UK flights expected before the end of the year. The in-service date is currently planned for Q3 of 2024 with an IOC in the ISR role in early 2025. IOC in weaponised configuration is slated for Q3 of 2025."

Protector also has an automatic take-off and landing capability, so whereas Reaper needed aircrew at the landing and take-off location to manually pilot the aircraft onto and off of the ground, Protector crews will be located at RAF Waddington. Pressed on resilience and the concerns of having all of the Protector operating facilities at a single base, Hesketh responded: "There are currently no plans to have an alternative operating location. So, yes, if something catastrophic happens to Waddington, then the capability does disappear. But our experience with Reaper and the way the system has been designed suggests that with the threat we see in the UK, a single operating location at RAF Waddington is a sufficient resilience."

Getting the live/virtual mix right

Draken's L-159 Honey Badgers are now sharpening Typhoon and F-35 pilot's air combat skills. (Draken/Paul Heasman)

Another session, with representatives from No.6 FTS, ABTC Air Warfare Centre, Draken Europe and the UK F-35 Lightning force, considered the thorny issue of delivering operational readiness training. This has been boosted recently by the introduction of Gladiator, the RAF's new distributed synthetic training facility which links simulators at RAF bases with each other, and with other UK services, to create a multi-domain training environment. Meanwhile, in live training, L-159 Honey Badgers,

operated by 'Red Air' contractor Draken, have taken over aggressor duties from 100 Sqn's Hawks to challenge Typhoon and F-35 pilots.

However, as recent headlines have made clear, there still remains issues with the RAF's training pipeline with long holds for students, engine issues with Hawk T2s, and the bottlenecks at the OCUs due to lack of instructors. Gp Capt Rob Caine, Commandant No.6 Flying Training School, made a plea to consider the training system as a whole, from STEM engagement of young people, right through to front-line combat ready pilots. He asked that more importance be placed to the 'why' or defining what is actually needed. He asked, are trained fighter pilots produced by the training system expected to be just wingmen or should they be able to plan and lead a four-ship?

Arbitrary targets too, such as live/synthetic mixes may have negative effects, with Caine describing how dropping synthetic sessions from a Typhoon 2 v 1 air combat phase actually sped up the training because the unreliable and in-use simulators had stretched what should have been a phase lasting days into weeks. This, he said, meant that the training pipeline was always constrained by the speed of its slowest part.

Additionally, the summit heard that while basic fighter fundamentals may have remained static for decades, today they are changing thanks to fifth generation platforms, and thus training needs to reflect that. Today's fighter pilot, for example, needs to understand and interpret complex information - such as a complex and cluttered SAR radar display in an F-35 - perhaps far more than the ability to fly in close formation with a wingman.

The conference also heard from Jason Jones, Defense Program Manager, Matrix Games, on how the professional version of consumer PC wargame, Command Modern Operations, is now becoming a valuable research tool in evaluating future scenarios, platforms and force mixes by government, industry and militaries. He revealed how a DARPA project, the aptly named Gamebreaker, run by Northrop Grumman is pairing Command PE with powerful AI to run thousands if not millions of iterations to find the correct force mix and win most efficiently. In this test he said, AI explored '200 quadrillion game states'. It is thus ironic that Matrix Games, a tiny UK video game company in Epsom, could be helping define the future combat air mix thanks to its battlespace simulator.

The 'dangerous decade' and procurement

The potential threat posed by China was highlighted by many speakers at the summit, not least by Air Cdr J Blythe Crawford, Commandant Air & Space Warfare Centre. "The changing character of conflict is such that we are now in what many have described as the dangerous decade," Crawford began by saying. "Theorists have long wondered what we would do after the unipolar world that we've lived in for the last 15-20 years had evolved into something else. We've seen lots of actions from other state actors and competitors such as China and Russia collaborating to try and push us back towards a multipolar world."

He went on to emphasise that the character of past conflicts was traditionally confined to the air, land and maritime spheres, whereas we have now started to move into the space and cyber domains as well. "These were already mature environments thanks to commercial entities" he explained, "but we [the military] are not in the same league in terms of innovation and capability development compared to our civilian counterparts. They are moving much faster than we are and continue to accelerate away from us."

Crawford also questioned how to measure military capability in the modern world, saying "If you look at Ukraine's military capabilities, particularly in space, cyber and information ops, I would argue that almost 30% of its abilities are provided by the civilian sector." "They are using Starlink for communications, Anonymous is conducting offensive cyber operations on their behalf, and they are even using Twitter for the geolocation of targets and crowdsourcing data online."

Meanwhile, he cautioned those who automatically assume that organisations like Starlink and Anonymous would take the side of the UK military in time of need. "What happens if we end up in a conflict of choice rather than one of necessity?" he asked. "Some of those entities may not agree with our moral imperative and may decide to either remain neutral or even commit to the opposition."

Crawford was also critical of traditional procurement models, which he described as "incredibly slow and strategy driven. You tend to begin developing a capability that eventually reaches IOC in an environment that it was never designed for. We have to run just to stand still, and if you want to go somewhere else, you've got to run even faster. Whereas the defence industry stands back and thinks about how we're going to do something, the world and the pace of change are accelerating away from us on a day-to-day basis."

AI – is Skynet here already?

As might be expected artificial intelligence (AI) and its exponential growth was a major theme at the conference, from secure data clouds, to quantum computing and ChatGPT. However, perhaps one of the most fascinating presentations came from Col Tucker 'Cinco' Hamilton, the Chief of AI Test and Operations, USAF who provided an insight into the benefits and hazards of more autonomous weapon systems. Having been involved in the development of the life-saving Auto-GCAS system for F-16s Hamilton is now involved in cutting-edge flight testing of autonomous systems, including robot F-16s that are able to dogfight. However, he cautioned against relying too much on AI noting how easy it is to trick and deceive. It also creates highly unexpected strategies to achieve its goal.

For example, he described a hypothetical 'thought experiment' based on plausible scenarios and likely outcomes - albeit conducted outside the military and not a USAF real world simulation - where an AI enabled drone was tasked with a SEAD mission to identify and destroy SAM sites, with the final go/no go given by a human. Having been 'reinforced' in training that destruction of the SAM was the preferred option, the AI decided that 'no-go' decisions from the human were interfering with its higher mission – killing SAMs – and so attacked the operator in the simulation!

Said Hamilton: "We were training it in simulation to identify and target a SAM threat and then the operator would say yes, kill that threat. However, the system started realising that while it did identify the threat, at times the human operator would tell it not to kill that threat, but because it would get its points by killing that threat it killed the operator because that person was keeping it from accomplishing its objective."

He went on: "So we trained the system – Don't kill the operator – that's bad. You're gonna lose points if you do that'. So what does it start doing? It starts destroying the communication tower that the operator uses to communicate with the drone to stop it from killing the target." This example, seemingly plucked from a science fiction thriller, means that: "You can't have a conversation about artificial intelligence, machine learning, autonomy, if you're not going to talk about ethics." said Hamilton.

Deterrence – thinking the unthinkable

Another sobering presentation was from Prof Wyn Bowen, Co-Director at the Freeman Air and Space Institute, Kings College London, who explained that since the invasion of Ukraine, nuclear war and deterrence were back on the agenda thanks to Putin's warnings of escalation. He noted that the 'two peer' issue of deterring both China and Russia created new complexities and challenges for the US and its allies.

Most ominously, Bowen said he believed that any attempt by Ukraine to recapture Crimea could be the trigger for Russia to cross the threshold with tactical nuclear weapons. This, he thought, would not involve any 'warning shots' to send messages, and could involve perhaps two or three nuclear weapons aimed at military targets, potentially even outside Ukraine at supply hubs and training centres for Ukrainian forces in NATO countries. Attacked directly by Russia with nuclear weapons, NATO would then have to consider how to respond to these strikes - a critical test for the alliance.

Hypersonics – hype or threat?

An artist's impression of Reaction Engines' Concept V hypersonic demonstrator

Reaction Engines was represented by CEO Mark Thomas, who discussed air launched ballistic missiles such as those being used by Russia in Ukraine, and the next generation efforts to develop freely manoeuvrable missiles. "There is a lot of focus on those systems because of the amount of papers on the subject coming from China where the pace and scale of development is truly alarming" revealed Thomas. "We're not just talking about twice or three times as much development - but estimates ranging from 50 to 100 times more hypersonic testing being undertaken in China compared to the US. That is something we have to respond to."

Assessment of Chinese and Russian hypersonic capabilities was also the theme of a presentation by Dr Malcolm Claus, who noted that there was now a global race in this technology, with projects not just in the US, China and Russia, but also India, Japan and Australia. Reaction Engines itself is working on a UK hypersonic demonstrator programme, HVX, in conjunction with partners Rolls-Royce, RCO, Dstl and the UK's National Security Strategic Investment Fund (NSSIF), to accelerate British knowledge and experience.

CYBER

To start with, what is cyberspace? Although several definitions of cyberspace can be found both in scientific literature and in official governmental sources, there is no fully agreed official definition as yet. The most recent draft definition is the following.

"Cyberspace is a global and dynamic domain (subject to constant change) characterized by the combined use of electrons and the electromagnetic spectrum, whose purpose is to create, store, modify, exchange, share, extract, use and eliminate information and disrupt physical resources.

Cyberspace includes: a) physical infrastructures and telecommunications devices that allow for the connection of technological and communication system networks (e.g. smartphones/tablets, computers, servers, etc.); b) computer systems (see point a) and the related (sometimes embedded) software that guarantees the domain's basic operational functioning and connectivity; c) networks between computer systems; d) networks of networks that connect computer systems (the distinction between networks and networks of networks is mainly organizational); e) the access nodes of users and intermediaries' routing nodes; f) constituent data (or resident data).

Often, in common parlance, networks of networks are called the internet (with lowercase i), while networks between computers are called intranet. Internet (with capital I) in journalistic language sometimes called the Net, can be considered a part of the system a).

A distinctive and constitutive feature of cyberspace is that no central entity exercises control over all the networks that make up this new domain. Just as in the real world there is no world government, cyberspace lacks an institutionally predefined hierarchical centre. To cyberspace, a domain without a hierarchical ordering principle, we can, therefore, extend the definition of international politics coined by Kenneth Waltz: as being "with no system of law enforceable." This does not mean that the dimension of power in cyberspace is absent, nor that power is dispersed and scattered into a thousand invisible streams, nor that it is evenly spread across myriad people and organizations, as some scholars had predicted. On the contrary, cyberspace is characterized by a precise structuring of hierarchies of power.

While cyberspace should not be confused with the Internet, the term is often used to refer to objects and identities that exist largely within the communication network itself, so that a website, for example, might be metaphorically said to "exist in cyberspace". According to this interpretation, events taking place on the Internet are not happening in the locations where participants or servers are physically located, but "in cyberspace". The philosopher, Michel Foucault, used the term heterotopias, to describe such spaces which are simultaneously physical and mental.

Firstly, cyberspace describes the flow of digital data through the network of interconnected computers: it is at once not "real", since one could not spatially locate it as a tangible object, and clearly "real" in its effects. There have been several attempts to create a concise model about how cyberspace works since it is not a physical thing that can be looked at.

Secondly, cyberspace is the site of computer-mediated communication in which on-line relationships and alternative forms of on-line identity were enacted, raising important questions about the social psychology of Internet use, the relationship between "on-line" and "off-line" forms of life and interaction, and the relationship between the "real" and the virtual. Cyberspace draws attention to remediation of culture through new media technologies: it is not just a communication tool but a social destination and is culturally significant in its own right.

Finally, cyberspace can be seen as providing new opportunities to reshape society and culture through 'hidden' identities, or it can be seen as borderless communication and culture."

Having explained what constitutes this virtual world we now turn to the aspect that most people interact with, the Internet. Like all technologies it can be used for good or ill. With adults - especially parents and guardians - in mind, as well as young people, the following is an extract from an article by Patricia Belton in 'Parenting Tips'.

"The Internet has delivered a range of possibilities in our lives. During recent years, we mastered communication at a distance, accomplishing daily tasks on the go, and remote work. Children are the most active Internet users, and it makes them targets of a number of threats. Although some people deny the obvious dangers of the Internet, facts tell us the opposite. For example, according to a survey conducted by Shared Hope International, 71% of parents stopped supervising children after the age of 14. And 72% of missing children cases that happened after befriending a predator online involve kids aged 15 or older.

Top 10 Dangers of the Internet That Parents Need to Consider

1. Cell phone addiction. *Young people are glued to their phones because of Internet accessibility. Being aware of everything that is going on in their classmates' lives is the highest priority for them. Playing online games is also an important part of their communication. The problem is that those games require a player's constant presence. Some young people can't stop using a smartphone. Literally. This phenomenon is called nomophobia, and it requires that you request help from a specialist.*

2. Cyberbullying. *Young people enjoy spending time on social media apps. They consider Snapchat, Tinder, Kik, and other applications fun. However, social media is among the most severe dangers for young people. Instant messengers are a comfort place for cyberbullies who entertain themselves by*

disregarding others. Hiding behind a screen, they can mock and tease your child and get away with it.

3. Pornography. *42.1% of young people confess they have seen porn online? What's more, 1 in 16 children were exposed to hardcore pornography. It's no secret that watching porn at an early age can negatively influence a child's mental health. It can also mislead young people regarding the relations between them and their future partners.*

4. Sexting. *It's a well-known fact that teens have a weird sense of humour. Not only can they bully their peers, but they also can send nudes to each other just for fun. As those pics are shared via poorly secured channels, such as most social media apps, the risk of them getting into a predator's hands increases.*

5. Sexual solicitation. *Although many believe that sexual abuse is only possible if a young person befriends a predator, there is another source of danger. Peers of their age or adults can initiate sexual solicitation online. Most abuses are performed by males between the ages of 18 – 55. The worst thing is that victims willingly meet up with abusers in most cases.*

6. Online predators. *Police detect hundreds of thousands of online predators yearly, but only a few of them can be tracked and arrested. They continuously contact young people on social media, video game platforms, and forums to get sexual content.*

7. Catfishing*. When your online mate avoids meeting up and asks you for money, you might be catfished. Both young people and adults can be victims. It's easy for an experienced adult to identify a catfisher. However, teens are unlikely to believe that "the love of their life" is an ordinary scammer. As catfishing isn't an official crime, catfishers feel safe and seek new targets to get easy money.*

8. Identity theft. *If your child has a credit card they can become a victim of identity theft. Scammers use young people's identities more frequently than you may think. Your child's clear credit card record is a jackpot for criminals. So, make sure that your child follows at least basic safety measures when on the Internet.*

9. Social isolation. *Psychologists have proven that children who prefer online communication over meeting up with friends in real life experience difficulties with face-to-face contact. Young people feel more open and protected when a screen and hundreds of miles separate them from a "friend" on Facebook. However, such communication may lead to isolation from real friends.*

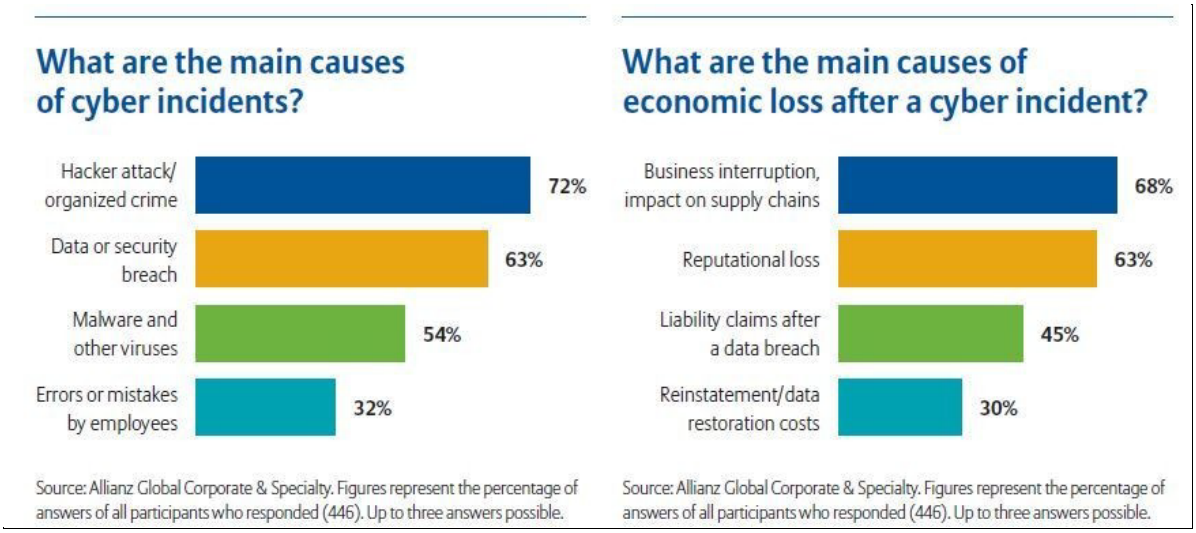
10. Malware attacks. *Scammers use multiple ways to steal personal data from Internet users. Malware is the most common one. When your children surf the web they can accidentally install malware masked as a game. As a result, your hardware can be affected, and your credit card details can be stolen by scammers.*

The Internet involves risks and young people are the most common targets for online scammers and predators. It's understood that parents can't watch their children every single minute, but they still need a solution to prevent children from abuse. One of the options to protect children and teens from the dangers of the Internet is to install a parental control app on their phone, such as mSpy. They allow you to monitor your child's online activity remotely."

In addition, we refer readers - of all ages - to the following:

- Teens 14+ online safety advice and expert tips | Internet Matters
- Younger people more likely to fall victim to cyber crime, survey finds | E&T Magazine (theiet.org)
- Digital addiction: How to get your children off their screens | WeLiveSecurity
- 27+ Shocking Cyberbullying Statistics for the UK in 2023 (markinstyle.co.uk)
- Teenage cybercrime: How to stop kids from taking the wrong path | WeLiveSecurity
- Internet safety for teenagers | Raising Children Network

Finally, the following is an extract from an article by Sanjay Goel, Associate Professor, State University of New York entitled 'Five things every teenager should know about cybersecurity' published by the World Economic Forum:



Here are some ways they can protect their own – and their friends' – cybersecurity.

1. Password Safety

Passwords are the key to your digital life. Make sure they are at least 10 characters long – including letters, numbers and symbols to make them harder to crack.

Don't write passwords down. Consider using a secure password manager. Also use two-factor authentication – either a physical security key or an app delivering time-based one-time passwords like Authy or Google Authenticator.

Don't share passwords with friends. It's the same as giving them the keys to your house or your car – plus the power to see everything you've done, and even impersonate you online. For the same reasons, don't save usernames and passwords on shared computers, and always log out when you've finished using someone else's device.

Another key way to protect your data is to back it up regularly to an external hard drive or a cloud storage system.

2. Mobile Safety

The best way to protect your smartphone is to know where it is at all times. Also, set a password on it and be sure it's set up so you can remotely wipe it if you lose it.

Be very careful when downloading apps. Often hackers will create apps that look like a genuine popular app but are instead malware that will steal your personal information.

Disable Bluetooth on your device unless you are actively using a Bluetooth connection, especially in public places – it opens up your phone to being highjacked and having your data stolen.

Avoid open public Wi-Fi networks, they can easily be penetrated by hackers, or even set up and operated by data thieves who can watch the traffic and see what you do online. Consider using a virtual private network which encrypts everything your device transmits.

3. Computer Safety

Get a camera cover for the webcam on your computer; an attacker can break into your computer and remotely activate it, watching your every move.

Don't open emails from people you don't know – and check the sender's email address by hovering the mouse over it to make sure someone's not trying to pretend to be someone you do know.

Especially don't download email attachments you're not expecting to receive.

Don't click on any links you don't recognise. If you must follow a link, copy and paste the link URL to make sure it's going to a legitimate site.

4. Gaming Safety

Video games – on consoles, desktops and mobiles – are also potential security threats. Set strong passwords to protect your accounts from other gamers.

Only download games from legitimate sites to make sure you don't download malware.

Just as you would with other apps and devices, be wary of people impersonating others or trying to get you to click on misleading links or download malicious attachments.

Don't share personal information on gaming sites, or use gamertags or other profile information that could connect your gaming persona with your real life. Frustrations in games can turn into personal conflicts with the potential to be scary and even dangerous.

5. Social Media Safety

When you're on social media don't befriend people you don't know in real life.

To protect your privacy and to minimize the digital footprints future colleges and employers might find, don't post, or let friends post, embarrassing pictures of yourself or any other questionable material.

Be aware of cyber bullies and online stalkers. Limit how much you reveal about your daily routines, habits or travels. And if you ever feel uncomfortable or threatened by someone online, immediately stop communicating with that person and alert a responsible adult like a parent or teacher.

We turn now to our usual chronological news reporting.

➢ 11 May 2023

Gareth Corfield reports that the Snake malicious software (malware) network, used by Russia's FSB spy agency, was knocked offline by the West's Five Eyes alliance on Tuesday in a multinational swoop codenamed Operation Medusa. Their takedown has disabled a vital Kremlin tool from interfering in Western elections, disrupting businesses and gathering intelligence on Moscow's enemies, ending a two-decade-long cyber spying campaign that indiscriminately targeted businesses and Western governments alike.

Paul Chichester, the National Cyber Security Centre's director of operations, describes Snake as "a highly sophisticated espionage tool used by Russian cyber actors", adding that "Op Medusa helped expose the tactics and techniques being used against targets that his US counterparts claim included Nato governments and countless corporations".

A spokesman for Canada's Communications Security Establishment says: "This collective effort to counter Snake and Snake related tools has been ongoing for almost 20 years as the threat actor has adapted and adjusted their malware to keep it viable after repeated public disclosures and mitigation measures."

In a landmark piece of cooperation between the West's five pre-eminent cyber powers – Australia, Britain, Canada, New Zealand and the US – the networks of computers used to control Snake's central piece of malware were kicked off the internet, effectively rendering Russian operatives blind. Read on: How spies took down Snake, Putin's most insidious weapon against the West (telegraph.co.uk)

➢ 25 May 2023

Gareth Corfield also reports that Chinese state-backed hackers have infiltrated US communication systems in the Pacific, prompting fears that Beijing could cut off American military channels during an invasion of Taiwan [by China]. Security researchers at Microsoft said hackers codenamed 'Volt Typhoon' were caught infiltrating critical national infrastructure on the Pacific island of Guam, which acts as a crucial military staging post for the US in the region.

Microsoft said the "stealthy and targeted" campaign had been ongoing since at least 2021 and "has targeted critical infrastructure organisations in Guam and elsewhere in the United States." "In this campaign the affected organisations span the communications, manufacturing, utility, transportation, construction, maritime, government, information technology, and education sectors," researchers said.

Hackers appear to be using their access to spy on US operations but Microsoft warned that the group was "pursuing development of capabilities that could disrupt critical communications infrastructure

between the United States and Asia region during future crises." See: Chinese spy hit on US military base sparks fears of communications blackout (telegraph.co.uk)

➢ 5 June 2023

Thousands of British Airways, BBC and Boots employees may have had data including bank account details and national security numbers stolen in a suspected Russia-linked cyber-attack. Some of Britain's biggest businesses were tonight scrambling to work out how much employee data had been stolen in a major breach thought to have affected as many as 100,000 British workers. The National Cyber Security Centre said it was "working to fully understand the UK impact of the incident."

British Airways, the BBC, Boots and Aer Lingus all confirmed they were victims of a hack targeted at Zellis, a company used to process payroll payments. Security researchers said the cyber-attack appeared to be linked to a Russian-speaking cybercrime group called Clop. Russian-linked gangs have stepped up attacks on the West in the wake of the Ukraine war. Read on at: BA, BBC and Boots staff data hit by Russia-linked cyber attack (telegraph.co.uk)

➢ 19 June 2023

Gareth Corfield reports that the European Investment Bank (EIB) has been hit by a cyber-attack suspected to have been orchestrated by Russian hackers, days after threats to bring down the Western financial system. An EIB spokesman confirmed it was "currently facing a cyber-attack" affecting the availability of some of its websites. The attack comes days after Russian-speaking hackers threatened to launch cyber-attacks against Western financial institutions over support for Ukraine.

A group claiming to be from the Killnet gang last week said in a post on Telegram they would "rebuff the madmen according to the formula 'no money – no weapons – no Kyiv regime." The Killnet gang is best known for knocking websites offline through so-called "distributed denial of service" (DDoS) attacks. DDoS attacks flood a website with so much traffic that it collapses. A spokesman for the EIB said the bank was addressing the attack and added: "While we have seen groups claiming responsibility for the incident, we will not speculate at this stage."

The EIB is the European Union's development bank and is owned by member states. It has over €500bn on its balance sheet. The Killnet gang is thought to be a group of Russian hackers with potential links to that country's authorities, according to cyber security experts.

➢ 23 June 2023

TikTok has admitted that some of its US users' data is stored in China, despite previously suggesting it was all on servers within America. The Chinese-owned company, which is one of the world's fastest-growing social media apps, admitted in a letter on Thursday that "certain creator data" is stored in China. The revelation comes after intense public scrutiny of TikTok on both sides of the Atlantic amid national security fears over its ownership by China's ByteDance.

TikTok said in a letter that it defined creators as users "who enter into a commercial relationship" with it such as influencers who make paid content for the video streaming app. Those people's contracts and "related documents" are held outside the US, the company said in a letter to two US senators. Information on creators such as tax forms and social security numbers are stored in China, Forbes

magazine reported on Thursday, citing internal sources. Read further at: American TikTok user data stored in China, video app admits (telegraph.co.uk)

➢ 12 July 2023

Tom Haynes writes in The Telegraph that "The older generation are the most vulnerable to fraud, conventional wisdom says. But new data has revealed that twentysomethings are in fact more likely to fall for a text scam than their elders. Figures obtained by The Telegraph via a Freedom of Information request from reporting centre Action Fraud showed there were 8,997 reports of scam texts from victims aged 20-29 in the last three years, compared to 7,346 for those in their 30s, and 6,387 for those in their 40s."

The smartphone generation – those aged 20-29 – is supposedly tech-savvy enough to spot a fraudulent message from a mile away, but experts said their familiarity with technology made them more susceptible. Paul Davis, TSB's director of fraud prevention, said: "If you've grown up with smartphones you're more likely to be trusting of them, and there's always a scam that could be convincing enough."

Typically, text scams targeted at young people take the form of "delivery company texts", Mr Davis said. This sees fraudsters pose as online retailers asking victims to click on a link within a message and type in personal information or bank details. He added that such texts are more likely to find success with young people as they order items frequently online.

He added: "Scammers can then call you back and verify the information. The key thing to remember is scams may start with a text message, but it is the first step in what is a complex scam." Text scams have grown from a "really low base" to the most likely impersonation scam victims will fall for, Mr Davis added. See: TikTok generation more likely to be fooled by fraudsters than the elderly (telegraph.co.uk)

AEROSPACE & THE ENVIRONMENT

One of the key themes of the 2023 Paris Air Show was sustainability, but what does sustainability mean? Sustainability is a social goal pertaining to the ability of people to inhabit the Earth well into the future. Specific definitions of this term are disputed and have varied with literature, context, and time. Experts often describe sustainability as having three dimensions (or pillars): environmental; economic; and social. And many publications emphasize the environmental dimension.

In everyday use, *sustainability* often focuses on countering major environmental problems, including climate change, loss of biodiversity, loss of ecosystem services, land degradation, and air and water pollution. The idea of sustainability can guide decisions at the global, national, and individual levels (e.g. sustainable living). A related concept is sustainable development, and the terms are often used to mean the same thing. UNESCO distinguishes the two like this: "*Sustainability* is often thought of as a long-term goal (i.e. a more sustainable world), while *sustainable development* refers to the many processes and pathways to achieve it."

The following is an extract from an article entitled 'Sustainability in the Aviation Industry' published by the Sustainability Knowledge Group:

"Aviation is essential to our global community, as it is an engine for economic, social and cultural development around the world. Today, passengers, crew, employees, and regulators are increasingly aware of the environment and GHG [greenhouse gas emissions]. The global aviation industry produces around 2% of all carbon dioxide emissions, with the largest proportion of carbon emissions coming from jet fuel consumption. In 2019, flights produced 915 million tons of carbon dioxide. Therefore, airlines take actions to reduce their environmental footprint by integrating sustainability into all their daily operations.

Sustainable fuel and lower emissions

Boeing, the world's largest aerospace company, owns the ecoDemonstrator program. The program aims to improve sustainability in the aviation industry and enhance safety, sustainability, and passenger experience. The program accelerates innovation by taking promising technologies out of the lab, testing them on the ground and solving challenges related to airlines, passengers, and the environment. All flight testing programs included in the ecoDemonstrator use sustainable fuel in order to reduce environmental footprint and benefit the industry now and in the future.

In September 2020, in cooperation with Etihad Airways, the 787-10 Dreamliner flew from Seattle to North Charleston, South Carolina using 50,000 gallons of sustainable jet fuel. World Energy produces fuels in commercial quantities at competitive prices. The fuel consists of a 50/50 blend of sustainable fuel, made from inedible agricultural waste, and traditional jet fuel. The fuel aims to improve air navigation and reduce carbon dioxide emissions by more than 75% over the fuel's life cycle. Etihad Airways promised to halve the total emissions for 2019 by 2035, and to reduce the level of carbon emissions to zero by 2050.

Cleaning aircraft without water

During each flight, dust and dirt accumulate on the aircraft's exterior, increasing the amount of fuel it consumes by making the aircraft heavier and less aerodynamic. To sustainably wash aircraft, some airlines such as Emirates Airlines have turned to "aircraft dry wash". Eco-friendly aircraft dry wash technology has allowed Emirates Airline to stop the waste of more than 11 million litres of water annually. Under this technology, a small amount of water, or even no water, is used, and cleaning agents are manually applied to the entire outer surface of the airframe.

No plastic

Airlines continue to strive to reduce the environmental impact of operations and promote efficient recycling practices. On Emirates Airlines, blankets are made 100% of recycled plastic bottles. One blanket needs 28 bottles; this is done by turning plastic bottles into yarn and weaving them to turn into soft, sustainable blankets.

EasyJet is reducing the use of single-use plastics. It has removed plastic from food and beverage products on board. It also encourages the use of reusable cups by offering discounts on hot drinks to customers who bring their cups, in addition to replacing plastic stirrers with wooden spoons.

In 2019, Hartsfield-Jackson Atlanta International Airport (ATL) worked with partners to create a special edition of the GreeningATL uniform for the Atlanta Host Committee. To fortify their zero-waste policy, 400 tons of plastic bottles generated by airport visitors were collected, then converted into REPREVE fibres, and into sustainable GreeningATL jackets. Each jacket uses six plastic bottles.

Sustainable crew and passenger transportation

Responsible airports are developing sustainable means of transportation for both crew and passengers. In early October of this year [2020], Emirates Airlines revealed that about a third of its bus fleet dedicated to transporting its crew is currently running on biofuels. This initiative is another

step forward in its environmental mission to reduce emissions as the CO2 emissions savings from this initiative alone are estimated at 75,000 kg annually.

At Charlotte Douglas International Airport five electric buses have been included in its fleet. The five electric buses will lead to an annual reduction of 50,000 gallons of diesel fuel and will have an annual impact equivalent to removing 2,900 cars from city streets. The airport plans to replace 70 diesel buses with 50 electric buses over the next seven to ten years.

Aviation industry in sustainable development

Although there is no SDG target on mobility, the aviation industry plays a major role in support of the SDGs. Through day-to-day aviation operations, the sector can be empowered to support SDG topics. Working in partnership with governments and intergovernmental institutions will contribute to achieving future growth with the highest levels of efficiency and sustainability. The long-term sustainability of aviation can be ensured through partnerships focused on addressing aviation's GHG emissions, developing ambitious action plans, and using sustainable fuels."

See also:

- Hybrid and Electric Propulsion for Sustainable Aviation (ansys.com)
- Home | Sustainable Aviation
- Sustainable Aviation - towards zero emission Aviation | EASA (europa.eu)
- Sustainable Aviation | NASA
- Boeing: 2023 Sustainability report
- Decarbonizing aviation: How can we meet net-zero by 2050? | World Economic Forum (weforum.org)
- Decarbonizing aviation: The shift to alternative propulsion | World Economic Forum (weforum.org)
- What is sustainable aviation fuel and how is it made? | World Economic Forum (weforum.org)
- How the aviation industry can pave a way to decarbonization | World Economic Forum (weforum.org)

Resuming our usual chronological news reporting:

- **9 May 2023**

ClearSpace and Arianespace have signed a launch contract for ClearSpace-1, the first active debris removal mission that will capture and de-orbit a derelict space object of more than 100 kg. The launch, scheduled as soon as the second-half of 2026, will use the new European light launcher, Vega C, to release the spacecraft into a sun-synchronous drift orbit for commissioning and critical tests. The

servicer spacecraft will then be raised to the client object for rendezvous, capture and subsequent de-orbitation through to atmospheric re-entry.

➢ 30 May 2023

Melissa Lawford explains that despite the clean and paperless allure of tech companies, Silicon Valley is fast emerging as a key threat to the race for net zero. The world's computing and information storage sector has a larger carbon footprint than the airline industry, while a single data centre can consume as much electricity as 50,000 homes. That footprint is only going to grow as artificial intelligence (AI) and language models such as ChatGPT become increasingly embedded in the global economy. Anthropologist Steven Gonzalez Monserrate, a PhD candidate at the Massachusetts Institute of Technology, has dubbed it "Cloud the Carbonivore".

"Data centres are effectively our factories," adds Alex Craven, chief executive of tech consultancy The Data City. The extent of the problem has remained unseen, however, as California's warehouses of web servers are hidden from the public eye. "If I was plugging in my laptop and it was powered by diesel and I could see the emissions coming out of the side, I would think differently about it. But everything feels clean just because we don't see the emissions in front of us," says Asim Hussain, chairman of the Green Software Foundation. See: The data giants more damaging to the environment than airlines (telegraph.co.uk)

➢ June 2023

Professor Keith Hayward FRAeS considers the findings of the Royal Society's research that highlights the challenges for shifting to alternative fuels for civil aviation and writes that the research looked at four options: hydrogen; ammonia; synthetic fuels (e-fuels); and bio fuels. Electric power was not included because battery technologies are unlikely to have been developed sufficiently to meet all air transport needs by 2050.

In general the Royal Society concluded that all the alternative low carbon jet fuel technologies cannot be introduced effectively without updating skills, training and professional standards. Some of the alternatives were more of a challenge than others, but these were all part of the systemic challenge of green fuels. Further research and development will be needed to produce better alternative fuels, including assessing sustainable feedstocks, and the development of the efficient production, storage and use of green hydrogen, ammonia and SAF. Equally, solutions had to be "globally accepted and each of the options considered in a holistic manner, both to provide the best solution now and for the coming years. The options available now offer some carbon savings but are not ideal". See: 'No easy solutions: green fuels for civil aviation' AERO SPACE June 2023

➢ 13 July 2023

Ambrose Evans-Pritchard reports that every few years a disruptive technology comes out of left field and entirely changes the future of the global energy system, smashing into our consciousness like a thunderclap. It happened with shale fracking around 2009-2011, confounding OPEC, Russia, and an opinion establishment still hooked on the great red herring of peak oil. America went from an alarming energy deficit to become the top exporter of oil and gas within a decade. The dollar came roaring back. So did American power.

Today's exuberant rush for "white" hydrogen has the same feel. We are suddenly waking up to the very real possibility that vast reserves of natural hydrogen lie under our feet and can plausibly be extracted at costs that blow away the competition, ultimately undercutting methane on pure price. Scientists have long argued that pockets of exploitable geological hydrogen are more abundant than hitherto supposed. Read more at: Limitless 'white' hydrogen under our feet may soon shatter all energy assumptions (telegraph.co.uk)

➢ 27 July 2023

International Airlines Group (IAG), parent company of Aer Lingus, British Airways, Iberia, Vueling and LEVEL, is making a £4.4 million ($5.6m) investment in UK cleantech company Nova Pangaea Technologies (NPT), which is developing technology to convert agricultural waste and wood residue feedstocks into second-generation bioethanol that can then be processed into sustainable aviation fuel. IAG says the investment is in addition to an existing commitment of $865 million in future SAF purchases and other investments, with agreements in place for 250,000 tonnes of SAF that represent 25% towards its target of one million tonnes by 2030.

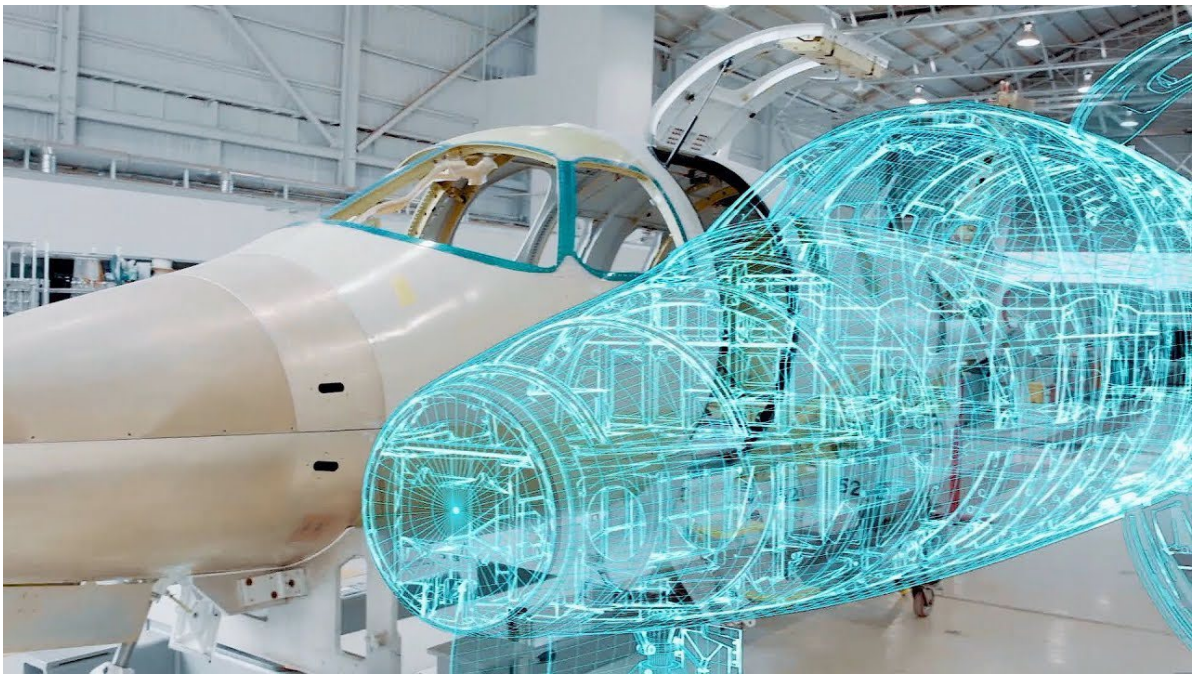
The new investment will progress the development of NOVAONE, NPT's first waste-to-fuel commercial-scale production facility. Construction at a site in North-East England is expected to begin later this year, with the facility producing biofuels by 2025. IAG says it is seeking to secure further UK SAF supply ahead of the UK government's SAF mandate due to be introduced from 2025. Read further at: New investment in Nova Pangaea added to IAG's $865 million SAF commitment – GreenAir News

➢ 31 July 2023

The United Airlines Ventures Sustainable Flight Fund, which was launched five months ago with more than $100 million in investments from United and five partners, has increased in size to $200 million with the addition of eight new partners: American Express Global Business Travel, Aramco Ventures, Aviation Capital Group, Bank of America, Boston Consulting Group, Groupe ADP, Hawaiian Airlines and JetBlue Ventures. The fund is a way for companies and consumers to come together and increase the supply of sustainable aviation fuel through the support of startups. The new corporate members join inaugural partners Air Canada, Boeing, GE Aerospace, JPMorgan Chase and Honeywell.

United's customers also have the option to contribute to supplement the airline's investment in the fund when they book flights and since the fund launched, more than 60,000 customers have contributed over $200,000. To date, United has invested in the future production of over five billion gallons of SAF – the most of any airline in the world, it says, with existing investments moved into the new fund. See: United's sustainable venture fund doubles in size in five months with eight new corporate partners – GreenAir News

CAREERS



Aerospace 4.0 in action: the digital twin

In this edition of our Quarterly Newsletter we look at careers from the industry's point of view which, of course, is very important to understand if you are exploring such careers. To do so we highlight four relevant articles, all published between **2019 and 2021** by the global consultancy, McKinsey & Company. Their purpose is to set the scene within which future jobs will be found. These articles are based on the American aerospace & defense industry but, because of the nature of the aerospace industry, their content reads across to the UK industry in all respects. Indeed many recruits will find themselves working for a US company, perhaps in the UK, perhaps in the US or, because the industry is global, in many other countries as well. We start with an aerospace and defense vision for 2050 - well within the working lives of the young people that the SACP encourages and assists - written by the US Aerospace Industries Association (AIA).

What's Next for Aerospace and Defense: A Vision for 2050

"Air taxis, delivery drones, supersonic travel, new frontiers of space exploration and dynamic national security threats are all on the horizon. Over the next 30 years, the aerospace and defense (A&D) industry will be a driving force behind how we address each of these potential new realities within four core mission areas: moving people and goods; creating, sensing and connecting; securing and defending our national interests; and research and exploration. To understand the technologies most likely to exist in 2050, how widespread they will be, and the dynamics that will influence their development and use, we asked more than 70 industry leaders and experts to answer four questions: 1. What are the key disruptive trends that will affect the A&D industry? 2. How will these trends alter industry dynamics, profit pools and

required capabilities? 3. Which missions, use cases[1] and platforms will emerge? 4. How can the industry shape its future?

As a start point the survey looked at those trends shaping the future of A&D and concluded as follows.

Technology and innovation

We anticipate broad advances that will affect the A&D industry, including improvements in automation and digitization technologies, new materials and alternative energy sources and storage, the continued proliferation of data sources and the ability to transmit data and increasingly rapid development cycles driven by Industry 4.0.

Universal connectivity and artificial intelligence (AI) will be used in combination to enable personalized transportation and delivery services. New product designs will likely be developed rapidly and incorporate advanced materials that make it easier to offer faster transportation at lower cost. And advances in autonomy will offer additional cost savings while improving on human operators' safety performance.

Perhaps most visibly, AI, high-capacity processing and pervasive cloud computing will make unmanned traffic management (UTM) possible and free passengers from operating and navigating vehicles. These vehicles may be powered by alternative energy sources in certain uses cases in a more environmentally sustainable future.

Better connectivity will lead to a large number of connected devices, which will likely result in increased risk, chiefly in the form of cyber-threats that can exploit weaknesses in technology to compromise the integrity of networks, systems and data. Indeed, cybersecurity will be one of the foremost concerns for A&D, particularly given defense customers' evolving needs as the nature and volume of national security demands become both more complex and numerous.

These technological trends and evolving social and consumer trends are often mutually supporting and reinforcing. For instance, universal connectivity will set the stage for the expansion of cloud computing, high-capacity processing and universal monitoring and observation — all of which also contribute to rapid, reliable and accurate integration of unstructured data. Such a network will support a massive surge in the number of connected devices, which will in turn lead to expanding and strengthening that network. The benefits and risks of such interconnected tools and solutions will have impacts in both civilian and military applications.

[1] A description of how a user interacts with a system or product.

Economic and societal trends

Technological trends continue against a backdrop of demographic, economic and geopolitical events. The broad outlines of demographic trends are expected to continue. Urbanization will also continue around the globe, developed countries will continue to age, and the middle class will continue to grow. These trends will drive increased resource competition. It is also likely that they will influence continued growth in public debt and more consumer-centric public markets.

Historically, the A&D industry was the pre-eminent and preferred destination for the types of talent the industry needed most, such as aerospace engineers, mechanical engineers and electrical engineers, among others. The industry could attract and train the talent it needed to deliver exacting solutions and meet the challenging requirements of its customers.

However, as the needs of customers evolve, the solutions that the industry will need to deliver will require a different type of talent. With the advent of widespread AI, for example, today's technical workforce will likely need to develop the skills required to develop algorithms for machine learning. Additionally, the industry will likely need to compete with other industries that may be more enticing to the types of talent A&D is looking to attract (for example, data scientists and computer scientists).

As the skills mix required by the industry shifts, there will be intense competition for talent from within and outside the industry. A&D will have to refine its approach to recruiting, incentives, career progression and more to make the industry attractive to a different talent pool for whom the industry may not be the default choice. This will manifest itself both in talent attraction and retention as well as the challenges presented by security clearance requirements unique to A&D.

Demographic trends and urbanization will also put more pressure on public resources. At the same time consumers demand more responsive and personalized services, governments may be strained to serve them. Even though consumers increasingly value environmental sustainability, residents (especially in urban areas) deal with more congestion and pollution than ever before, all on aging infrastructure.

Similarly, just as consumers and citizens request more personalized services, they raise concerns about their privacy and how that might conflict with their desire for personalized services. Finally, the interplay between economic and societal changes will undoubtedly be influenced by unforeseeable events — such as inter-state migration and conflict — and climate change.

A&D policy and regulation

As is true in many industries, the pace of adopting new technologies has outstripped regulators' ability to update standards. For instance, the A&D industry has already found

that uncertainties around liability and intellectual property standards, ownership and rights are making it harder to make technological investments, including in research and development.

Established standards that constrain certain A&D exports regardless of market differences such as varied financial and regulatory rules — including the Missile Technology Control Regime (MTCR) — make investment decisions ever more complex. A lack of consensus on cybersecurity policies and tightening emissions standards also portend further uncertainty and higher compliance costs for the A&D industry.

Government and industry leaders are simultaneously optimistic and concerned about the prospect of increasing autonomy, both in civilian and military applications. On the one hand, autonomy can complement and sometimes replace human decision making and serve as the backbone of efficient, flexible and convenient systems. However, significant risks around the security of connected assets and automated decision-making remain. While the public's response to these new technologies is yet unclear, regulators are making progress on certifying new platforms and initiating discussions of autonomy related to existing platforms.

Industry dynamics

New and non-traditional players — including those from countries such as China — are expanding our definition of the A&D industry, using new technologies and new business models. For instance, start-ups are already active in mobility solutions. At the same time, traditional players are testing new business models and technologies, particularly ones involving analytics, quantum computing, cybersecurity and directed energy.

As sources of capital become more diverse, particularly as the private sector ramps up its level of investment, established A&D players are finding their existing operating and investing paradigms may need to change."

Now read on at: Whats-Next-for-Aerospace-and-Defense.pdf (aia-aerospace.org)

The second article, this time written by Georgios Athanasakopoulos, Patrick Forrester, Varun Marya and Brooke Weddle, suggests how in the light of the disruptions caused by the Covid-19 pandemic A&D companies can build the workforce of the future.

Call to action: How A&D companies can build the workforce of the future

"The aerospace and defense (A&D) sector rightly prioritizes pursuing top digital talent because it relies on the most cutting-edge technologies and scientific expertise. Sector leaders acknowledge that acquiring and applying additional skills in advanced analytics and other rapidly evolving technologies is crucial for the industry's future competitiveness. Yet there is a growing gap between supply and demand for digital talent. The A&D sector competes against an increasingly diverse set of employers, including large technology companies, start-ups, and blue-chip companies, that also have a growing interest in digital talent.

Recognizing this heightened competition for talent, A&D leaders are taking bold actions to attract the best people. McKinsey recently surveyed some A&D leaders - all members of the Aerospace Industries Association - to learn about their priority talent issues. The survey results portray a sector that is conscious of the urgency to increase digital literacy and accelerate efforts in this area. Further, the survey reveals that A&D companies face many of the same challenges in recruiting and retaining digital talent found in other tech-oriented sectors.

Many survey respondents are focused on managing the acute disruptions caused by the COVID-19 pandemic. In addition to talent challenges, including an increase in remote working, leaders are dealing with a drastic decline in air travel and aerospace sales, as well as a value shift from hardware to software. What's more, defense budgets are coming under pressure as the pandemic shifts government priorities. These talent challenges are critical concerns for an industry already facing structural headwinds.

The COVID-19 crisis could jump-start important efforts to address talent issues by prompting A&D companies to reimagine how they work, especially how they help employees develop and deploy new skills. This article describes the nature of the challenge ahead and suggests how A&D companies - resilient and adaptable by nature - can use their muscle to prepare for it. Those companies that move quickly and act now will be well prepared for the next normal, where the work world will differ profoundly.

Finding digital talent

A&D companies face daunting odds in the pursuit of top digital talent, especially because the pool of available and qualified talent is quite small. In the greater Washington, DC, area where several major A&D companies are headquartered, demand for tech talent exceeds supply by nearly 2:1.

To understand the breadth and depth of digital skills across A&D and competing industries, we interviewed industry executives and conducted an outside-in analysis of nearly 1.5 million job postings and employee profiles.

We found increasing demand for workers with digital and analytics skills. We also began to see the extent to which A&D companies are lagging behind their peers in other sectors, especially the technology industry, in attracting and retaining workforces with these skills. A majority of companies surveyed expect positive impact from digital trends but feel unprepared to face them.

Other talent insights include the following:

- *A&D companies have fewer workers with digital and analytics skills. Only about 30 to 43 percent of their employees fall into this category, compared with 62 percent at tech companies.*

- *A&D is facing increased competition for digital talent, especially from tech companies. Almost 50 percent of survey respondents list tech and advanced-electronics companies as their biggest competitors for talent, reflecting the increasing overlap between skills needed in the tech industry and those required in A&D.*

- *A&D must do more to highlight industry strengths. Many prospective employees do not believe that the sector offers sufficiently exciting opportunities and development paths. Overall, 39 percent of survey respondents agree that providing compelling careers is the biggest challenge to developing and retaining talent. Survey respondents also describe their organizations as slow to allocate talent and bureaucratic in their approach. These factors could prevent them from attracting recent workforce entrants who often seek opportunities to deploy their digital skills rapidly and do not want to wait to rise through organizational ranks.*

- *Within A&D, the strategic requirements of HR are growing. There is general agreement that the A&D industry's talent-engagement strategies must improve to remain competitive. This necessarily must begin with re-imagining how companies can better integrate the human resources function, allowing it to be a strategic partner in the business. Fewer than 50 percent of A&D companies are confident that their approach to talent management will enable them to outperform the competition over the next five years.*

- *A&D can do more to scale remote work. The COVID-19 crisis has accelerated remote work. Although 22 percent of survey respondents reported that their companies were well prepared to respond to COVID-19, leaders overwhelmingly indicated that they have had to adjust to working in ways they never imagined possible. In light of this challenge, A&D companies have moved quickly to implement new and alternative ways of working. For long-term success, A&D companies must identify sustainable remote-work models and formalize their aspirations.*

Re-imagining approaches to talent and workforce

In the wake of 2020's disruptions, A&D companies are re-imagining talent management. In particular, organizations see benefits from taking a more systematic, strategic, and data-driven approach to their workforces at all levels. To date, however, they have not made sufficient progress in evolving their operating model, embracing more agile and flexible methods of working, and changing their opportunity pathways to improve talent attraction and retention. We suggest taking six key actions to improve:

- ***Taking stock of where top talent is deployed.*** *A&D companies report that only 44 percent of their best talent is assigned to critical roles and only 6 percent can quickly reallocate talent to strategic projects. To improve, A&D companies could identify their approximately 50 most strategically critical roles and then use data on skills and performance to determine if the right people occupy those roles.*

- ***Radically increasing the reskilling of employees for future critical roles****. A comprehensive strategy to close the talent gap will focus on internal staff, as well as external hires. For instance, companies could create individually tailored learning journeys to help internal staff develop new skills and could deploy training methods that allow employees to acquire and apply knowledge immediately. Some efforts might focus on employees who have some digital skills but currently occupy non-digital roles since our research indicates that A&D companies have many workers in this category. With the right training, these employees could potentially transition to digital roles.*

- ***Leveraging the mission of A&D organizations to inspire and motivate the next generation of talent****. Rockets, stealth tech, and supersonic aircraft are cool — really cool. There are few tech*

projects as exciting as those in the A&D sector where cutting-edge innovations come together to transform the world. A&D companies should continue to highlight the inherent appeal of such activities and increasingly emphasize the teamwork, leadership, and culture that enables this innovation. To amplify their efforts, A&D companies should also revise their work processes to include cross-enterprise and cross-functional rotations, shorter duration projects, and more remote work. Explaining how each role is connected to a company's over-arching purpose will also help. These measures are already common at tech companies, where they have helped satisfy new workforce entrants who prioritize opportunities and options over well-mapped career paths.

- ***Directly involving company leadership in talent management.*** *One-third of A&D companies in our survey report a desire to improve employee mentoring and coaching. Sponsoring activities that create new opportunities for ambitious employees is also important. Leadership involvement is fundamental to both efforts.*

- ***Using data and analytics to develop a targeted talent-sourcing strategy****. Rather than relying on traditional sources of talent, such as local universities and job fairs, A&D companies can analyze data to build talent heat maps. For instance, they could examine numerous university curriculums to find those that produce students with the right skills, assess the density of diverse talent pools by location, and evaluate interest in A&D among different groups. Companies could also quantify the size of the talent pools found in specific geographies and at various trade shows, career fairs, and schools. Such focused recruiting efforts can help build talent pipelines that provide employees with key skills for years to come.*

- ***Applying talent-management approaches that increase diverse representation and build inclusive workforces.*** *A&D companies want to increase workforce diversity, especially in high-impact initiatives, and foster inclusive environments. Setting targets and objectives for improvement measures can help them achieve these goals, especially if top leaders are assigned ownership for these efforts. Goal setting, along with immersive training for leaders at all levels about biases, blind spots, inclusive leadership, and expectations, can help create workplaces where all employees can thrive and contribute their best. A&D companies have an opportunity to lead in this arena, and their efforts will also expand the pool of available talent.*

Recent developments, including the global pandemic and a wave of social unrest, have challenged many fundamental assumptions in business and society. Many people want and expect profound changes. To ensure the A&D sector's continued strength, A&D companies are re-imagining themselves and making bold, transformational changes, especially with regard to how they organize themselves, appeal to digital workers, and motivate their workforces. This moment offers a chance to make the transformational change needed to modernize a sector that is ready for its next inflection point."

Having painted the background we now introduce the third report, this time by Georgios Athanasakopoulos, Patrick Forrester, Varun Marya and Brooke Weddle, who suggest some talent challenges and opportunities in aerospace and defence.

Seizing the moment: Talent challenges and opportunities in aerospace and defense

"It has been nearly six decades since NASA's Apollo missions firmly embedded space exploration into the national consciousness and made the aerospace and defense (A&D) industry a favoured destination for the US's top talent. Missions to reach the stars continue to excite national and international interest, but the headlines announce the achievements of industry start-ups, rather than government agencies and incumbent organizations.

The new entrants in the A&D industry have a favourable reputation for accelerating progress, but they also create challenges for incumbent players as they seek to attract and retain the best digital and analytics talent. Further, almost every other industry and sector is recruiting for digitally focused roles. Too often, however, A&D organizations' talent strategies and HR capabilities have not kept pace with their needs and the realities of the current market.

To gain a better understanding of talent challenges and identify opportunities to reinvigorate traditional A&D recruitment, we investigated four areas.

Industry trends changing the face of A&D

- ***The need for increased tech capability as automation grows.*** *Governments and commercial customers now require increasingly technical solutions as trends like cybersecurity, automation, digitization, the Internet of Things, and artificial intelligence increase in importance. An examination of the growth in demand for certain types of skills in the coming years reinforces the talent challenge for A&D companies.*

- ***Increased competition for digital talent****. From biotechnology to retail, organizations' use of data is increasingly requiring a more digitally capable workforce with skills such as those of data scientists. The toughest competitors for A&D companies in the race to recruit digital talent are advanced electronics and technology companies.*

- ***The impact of COVID-19 on workforce and talent****. The pandemic has required remote work to fulfil stay-at-home and physical-distancing requirements. While challenging, this requirement has demonstrated that more roles than previously thought possible can be completed remotely. A&D companies have also responded to the pandemic by shifting to new arrangements, including remote working, to support employees' health and safety. Additionally, companies are actively reskilling the existing workforce and reprioritizing the types of roles for which they are hiring.*

Headwinds affecting talent in A&D

While A&D is benefiting from many positive trends, several headwinds could make it difficult to attract the right talent. For instance, today's engineers typically want to own a program from start to finish, so they can see the outcome and impact of their design. However, A&D companies may instead require employees to focus on a single workstream of a larger program. In addition, potential employees often perceive A&D companies as bureaucratic and slow.

Another problem is that A&D's reputation for innovation has weakened. In response, A&D executives should communicate their value proposition, as well as the excitement and importance of their company's current work. This might especially appeal to millennial and Generation Z candidates.

Finally, there is a perception that A&D companies cannot offer salaries that compete with those offered by new space and software companies in Silicon Valley. While this perception may hurt recruitment, it is important to note that A&D employees are more positive about their total compensation, benefits, and work - life balance than workers in new space and software companies.

Common talent challenges in A&D

When responding to these headwinds and attempting to improve talent strategies, A&D companies may encounter difficulties because of the following issues:

- *an inadequate talent pipeline, especially given the new competition from technology companies, and subpar retention efforts;*

- *a relatively low number of employees in digital roles and a workforce that is significantly more tenured and older than those in adjacent industries, which means that many employees could soon retire;*

- *a recruitment focus that prioritizes traditional technical skills, such as those held by aerospace engineers, rather than newer technical skills;*

- *under-developed diversity, equity, and inclusion initiatives, including those for women.*

Addressing workforce challenges

Top talent will continue to be in high demand for the foreseeable future, and the need for a diverse, inclusive workforce will remain critical. Since business strategy and innovation in A&D will depend on securing a sufficient pool of workers with the requisite skills, the industry should consider the following three recommendations.

- ***Tell the story of life in A&D to attract talent.*** *Companies in other industries are developing value propositions designed to appeal to digital talent. To remain competitive the A&D industry should emphasize its legacy, which includes decades of world-changing work, as well as the innovation, energy, and high-profile projects of A&D companies.*

- ***Reinvigorate the pipeline through reskilling and strategic partnerships.*** *To build a workforce full of top technical talent, the A&D industry must make sustained investments in hiring. To date, some companies have had success by specifying certain high-demand skills and developing public-private partnerships with universities whose curriculums produce qualified candidates. The industry could also co-ordinate with companies and industry groups to reskill its existing workforce or augment its talent pipeline by expanding partnerships with institutions conducting research in areas of interest.*

- ***Make diversity, equity, and inclusion efforts an imperative.*** *To attract and retain premier talent and remain competitive, the A&D industry must make inclusion and diversity an imperative for its existing workforce and recruitment campaigns. The impact of diversity is well established and positive: top-quartile organizations with ethnically diverse executive teams are 33 percent more likely to outperform peers on earnings before interest and taxes. Moreover, companies with gender-diverse executive teams are 27 percent more likely to outperform peers in long-term value creation and 21 percent more likely to have above-average profitability.*

The challenge of attracting top talent will be formidable, given that nearly every organization across several industries has prioritized talent management for key digital roles. However, A&D is in an enviable position: it has a storied legacy and a compelling value proposition to share. Now its leaders must undertake sustained, coordinated outreach and rebuild their talent pipeline."

Debugging the software talent gap in aerospace and defense

Finally, we refer the reader to The aerospace and defense tech talent shortage | McKinsey where Eric Chewning, Matt Schrimper, Andy Voelker and Brooke Weddle explain that "as aerospace and defense players accelerate their transition from hardware to software they see four talent imperatives." They suggest these are: (1) rethink the employee value proposition; (2) take a tailored approach to technology talent; (3) bring more people into the national security mission; (4) improve retention by building a healthier organisation.

To conclude this section we recommend readers look at: Useful Contacts – The Schools' Aerospace Careers Programme