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SCAN ME

JON EXCELL

Driving successful innovation

Driving commercially successful innovation and shepherding great ideas across the so -called "valley of commercial death" is no easy feat and a challenge that has bedevilled UK industry for many years. Indeed, for every home-grown engineering and technology success story there are many more also-rans; potentially game-changing technologies which, for a variety of reasons, failed to muster the commercial support required to propel them to success.

Most frustratingly, it's a challenge that's particularly acute in emerging areas of arguably critical importance to our economic and environmental future, where risk-averse investors are scared off by market uncertainty, and where the skills and expertise required to scale rapidly can often be hard to find.

One such area is the vital, fast-moving field of low-carbon mobility and earlier this year – in partnership with the mobility innovation campus Bicester Motion - The Engineer convened a panel of leading experts to explore how we might build on the UK's undoubted expertise in this area and give the sector's diverse pool of innovative disrupters the best possible chance of shaping the future.

Key takeaways from the discussion - covered in detail in this issue (page 28) - include the value of finding a single coherent-voice to articulate concerns to policy-makers, the vital importance of tapping into the full spectrum of the UK's skill base and - above all - the need to create the conditions for effective collaboration.

Collaboration also comes to the fore in this issue's cover story (Star Power, page 20) in which features editor Andrew Wade gives a mind-boggling update on ITER, the giant experimental fusion reactor currently being assembled in Southern France.

Building and assembling what is arguably the most complex machine ever built, capable of generating temperatures ten times hotter than our sun's core, presents a series of unprecedented engineering challenges, and – as we report - they are challenges that can only be solved through concerted and deep collaboration between the various international teams who have invested decades of time and resource into the project. At a time of increasing global volatility, ITER stands as an inspiring example of science diplomacy involving all the world's major powers.

Finally - remaining on the topic of collaboration - there's still time to get your entries in for Collaborate to Innovate (C2I), The Engineer's annual awards competition. Celebrating its tenth anniversary this year, C2I was set up to uncover and champion incredible examples of UK-led engineering collaboration and is open for entries until Friday 12th September. Find out more here: https://awards.theengineer.co.uk/

Jon Excell

EDITOR • JON.EXCELL@MARKALLENGROUP.COM

5 THINGS WE'VE LEARNT THIS ISSUE

1. The steel industry is responsible for eight per cent of global C02 emissions
2. 2025 exam results saw a 56 per cent increase in T-Levels
3. A Scottish space firm has won the UK's first vertical launch license
4. Applications for engineering degrees are up 14 per cent at universities
5. ITER's tokamak will reach temperatures of 150 million degrees Celsius

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E-skin to give human like touch to robots

Robots to go from basic sensing to truly intelligent touch

JASON FORD REPORTS

Work is underway in Cambridge to transform robotic interaction with an advanced next-generation electronic skin (e-skin) for robots.

Inspired by human tactile perception, the advance from Zhuo Chen, a postdoctoral research associate in electronic skins, looks set to advance real-time, high-resolution 3D force and temperature sensing.

One of the biggest technical challenges in replicating human skin is capturing complex tactile information such as the direction and magnitude of forces with high resolution and accuracy.

Most conventional tactile sensors are bulky, low-resolution, and limited to detecting normal forces.

"To address this, we take inspiration from the layered structure of human skin," said Chen. "Our e-skin uses a specially designed multiscale composite architecture that decouples forces in three dimensions. This enables accurate detection of normal and shear forces, allowing robots to sense sliding, texture, surface stiffness, and temperature with greater precision."

He added that through the optimisation of polymer composite formulations and advanced soft electronics fabrication techniques it has been possible to achieve spatial resolution that surpasses human skin and sensitivity.

"This innovation overcomes a major limitation in robotic sensing and paves the way for significantly more dexterous and intelligent robotic systems," he said.

To date, robot bodies and dexterity have not kept pace with the breakthroughs in AI transforming robotic abilities, but AI is helping to address this.

Chen explained that AI is crucial for translating raw sensor signals into meaningful tactile information.

The e-skin produces rich, multi-dimensional data, including pressure magnitude, direction, and temperature, which needs to be rapidly interpreted for decision-making.

"We're exploring spiking neural networks and other neuromorphic approaches that mimic the way the human brain processes touch," said Chen. "This allows low-latency, energy-efficient processing suitable for embedded robotic systems."

He added that beyond responsiveness, AI enables learning-based adaptation, allowing robots to refine their tactile capabilities in dynamic environments where surface properties are constantly changing.

"It further enables the e-skin to adapt to different locations on a robot and meet varied functional requirements," he said. "This is a key step towards moving from basic sensing to truly intelligent touch."

Looking forward, Chen expects the e-skin technology to play a transformative role in equipping robots with human-like touch.

In healthcare, it can enhance the safety and precision of surgical tools by providing real-time force feedback. Furthermore, in prosthetics, combining e-skin with nerve reconstruction and brain-computer interfaces could help restore tactile sensation for users.

In manufacturing and service environments, e-skin will enable robots to sense contact forces, surface texture, stiffness, and friction, adjusting their actions in real time.

Chen is now leading the development and commercialisation of this patent-pending technology, together with a team at Cambridge University. The work has been funded by the by the ARIA Robot Dexterity Programme.

Read more at www.theengineer.co.uk

Read more online

AEROSPACE
- European airports may have to reduce passenger numbers by the 2060s due to rising temperatures caused by climate change.

ARTIFICIAL INTELLIGENCE
- Mass spectrometry and AI have been employed by researchers at McGill University, Canada, to verify the origin of honey and cut fraud.

AUTOMOTIVE
- McMurtry Spéirling defies gravity using fan downforce

COMMUNICATIONS
- MotionBlocks offers accessibility to VR games

DEFENCE & SECURITY
- BAE Systems technology investment delivers major boost to UK munitions production

ENERGY & ENVIRONMENT
- ITER completes superconducting fusion magnet system

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- World's largest electric ferry takes to the water

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Windracers ULTRA drone unlocks Antarctic data

ANDREW WADE REPORTS

The Windracers ULTRA, a UK developed autonomous heavy-lift cargo aircraft, has been helping British Antarctic Survey (BAS) unlock new data in previously uncharted parts of Antarctica.

BAS scientists used the drone for autonomous Beyond Visual Line of Sight (BVLOS) missions to map out remote parts of West Antarctica and investigate how the Earth's crust was created and deformed.

British Antarctic Survey geophysicist Tom Jordan said the project facilitates new ways of collecting data across multiple science areas around Antarctica

During these missions the aircraft – which has a wingspan of 10m, a payload of up to 100kg and a range of up to 1,000km – was operated from the crushed rock airstrip at Rothera Research Station. It was directed by a ground-controller, and routine missions were flown fully autonomously, including take-off and landing.

"Prior to deployment to Antarctica, Windracers conducted

full environmental testing in a large-scale climate chamber," said Stephen Wright, founder and group executive chairman of Windracers. "This allowed us to verify Windracers ULTRA's systems down to -20°C, which is well within the typical summer range in Antarctica of -5°C to 0°C."

Wright continued: "Windracers ULTRA long-distance self-flying cargo aircraft allows us to remove pilots from harm's way and unlock new possibilities for science in Antarctica, and globally."

Carried out as part of the UKRI-funded SWARM project the new research, published in the *Journal of Geophysical Research*, used advanced gravity and magnetic sensors to reveal huge bodies of frozen magma, hidden below the icy sea. Photos of previously unexplored islands, taken at the same time, show how these rocks were deformed as the mountains of the Antarctic Peninsula were pushed up by movement of the Earth's tectonic plates.

Until now, the lack of data from this remote area meant scientists had limited understanding of the region. Using the long-range, heavy-lift capability and autonomous operation of Windracers ULTRA, BAS experts were able to quickly and effectively map out the hidden geology of this inaccessible region.

Later this year, Windracers will also launch a new operational hub in Malawi to support middle-mile delivery of humanitarian aid.

"Windracers ULTRA is a cost-efficient solution for routine missions such as environmental monitoring, mapping inaccessible regions and providing essential supplies to those who need it," said Wright.

LIME BINDER PRODUCTION PROCESS ENABLES CARBON CAPTURE BRICKS

JASON FORD REPORTS

Sustainable materials specialist earth4Earth has created a range of bricks that capture and permanently store carbon dioxide via direct air capture (DAC).

The bricks are made using excavated soil combined with earth4Earth's e4E lime-based binder that enhances their durability and mechanical properties and can be made at room temperature.

Cecilia Pesce, principal research engineer at earth4Earth explained that DAC occurs throughout the service life of the brick via carbonation, which is the chemical reaction between the lime contained in the brick's binder and atmospheric CO2.

"Moreover, no process CO2 is emitted during the transformation of the raw material to binder phase thanks to our novel approach, since the carbon is directly sequestered as a solid by-product," she said.

The company has developed a range of products for different requirements, such as N10, N20 and N30 bricks, which contain 10 per cent, 20 per cent and 30 per cent of the e4E binder. As the percentage of the binder increases, so does the level of carbon absorption.

In terms of lifetime CO2 saturation, Pesce said: "At saturation, N10 and L10 can capture up to 178g of CO2 per brick - with L10 capturing the same amount of CO2 emitted from the raw materials being processed for the production of the commercial lime binder it contains - N20 can capture up to 365g of CO2 per brick, and N30 can capture up to 535g of CO2 per brick."

Pesce added that the performance of the bricks is similar to commonly used bricks.

NEWS IN BRIEF

STRATEGIC INVESTMENT

BAE Systems has invested in Oxford Dynamics, a deep-tech start-up pioneering advances in AI and robotics. The defence giant said the move is part of its drive to identify and harness innovative technologies for rapid deployment. The collaboration will see BAE System combine its defence and security knowledge with Oxford Dynamics' AI driven data expertise to explore ways to deliver next generation advantages across air, land, sea, space and cyber domains.

SUPERSONIC SPACEPLANE

Dawn Aerospace

A space domain awareness (SDA) payload has flown on a sub-orbital spaceplane at supersonic speeds, an advance that could provide an alternative to conventional satellite-based SDA. Scout Space's 'Morning Sparrow' sensor suite flew aboard Dawn Aerospace's Aurora platform, an uncrewed, reuseable rocket-powered aircraft. The mission flew to a maximum altitude of 67,000ft, and maximum speed of Mach 1.03. The sensor suite will next demonstrate tracking and imaging of VLEO objects from below.

CLEAN WATER

Researchers at Glasgow University have used ultrasound to remove the common plastic Bisphenol A (BPA) from water. The system used dual ultrasonic frequencies of 20kHz and 37kHz to trigger acoustic cavitation in the water, where millions of tiny bubbles collapse and create brief localised 'hot spots'. These hot spots are intense enough to break BPA molecules down into harmless substances like carbon dioxide, safely removing the pollutant from the water.

Read more at www.theengineer.co.uk

Sulphate salts boost aqueous battery lifespan

JASON FORD REPORTS


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The lifespan and performance of aqueous batteries could be increased with the addition of sulphate ions that reduce the amount of free water in such cells.

This is the finding of a team from the Center of Excellence for Renewable Energy and Storage Technologies (CREST) at King Abdullah University of Science and Technology (KAUST) in Saudi Arabia.

Their findings, published in *Science Advances*, reveal how water compromises battery life and performance and how the addition of affordable salts – such as zinc sulphate – mitigates this issue, even increasing the battery lifespan by more than ten times.

"We chose sulphate salts because they uniquely stabilise water molecules, preventing the side reactions that typically limit battery lifespan. This makes aqueous batteries more reversible and longer lasting," said Professor Husam Alshareef, chair of CREST at KAUST. "Sulphates are also affordable, abundant, chemically stable, and environmentally friendly. Combined with the safety of water-based systems, this approach aligns perfectly with global needs for low-cost, green, and scalable energy storage — particularly for renewable integration."

One of the key determinants to the lifespan of a battery – aqueous or otherwise – is the anode, which can be degraded by parasitic chemical reactions that compromise battery lifespan.

The new study shows how free water contributes to these parasitic reactions and how zinc sulphate reduces the amount of free water in the battery.

Free water describes water molecules that are not strongly bonded with other molecules. This state allows free water to engage with more molecules than otherwise, triggering unwanted reactions that consume energy and compromise the anode.

Sulphate was found to stabilise the bonds of free water and reduce the number of parasitic reactions.

"One major challenge was understanding the hidden, fast-moving reactions at the metal–electrolyte interface — especially how different anions affect water behaviour," said Prof. Alshareef.

Most of KAUST's experiments were done on batteries using zinc sulphate, but early investigation has shown that sulphate has the same effect on other metal anodes, suggesting the inclusion of sulphate salts into battery design could be a universal solution for lengthening the lifespan of all aqueous batteries.

FIBRE-OPTIC CABLES TO MONITOR INFRASTRUCTURE

European researchers are looking at how existing fibre-optic cables could serve as real-time sensors for damage in infrastructure such as bridges, railways, tunnels and energy pipelines.

Coordinated by Aston University, the €5.1m ECSTATIC project is trialling this approach in a major UK city, using a heavily used Victorian-era railway viaduct as its first live test site.

The goal is to detect subtle structural shifts, stress, and vibrations in real time, using laser light pulses sent through fibre-optic cables.

At the demonstration site researchers will send ultra-precise laser pulses through buried fibre-optic cables. As trains pass overhead, the fibres subtly flex and vibrate. These movements change how the light behaves inside the cable, altering the 'phase' and 'polarisation' of the light, creating an optical 'fingerprint' of the forces acting on the structure.

By measuring these changes and interpreting them using a new dual-microcomb photonic chip and advanced AI signal processing, ECSTATIC aims to pinpoint early warning signs of damage or fatigue. ***JF***

Read more at www.theengineer.co.uk

ON-SITE PERSONALISED MEDICINE PRODUCTION

JASON FORD REPORTS

New legislation will enable the manufacture of personalised medicines and therapies prepared in clinical settings or by mobile manufacturing units.

The change is designed to cut waiting times, help free up NHS beds, and improve access to therapies that were previously out of reach.

Until now, personalised treatments were sent to specialised manufacturing facilities. In some cases, patients became too unwell to receive the therapy in time, or the medicine's short shelf life meant it could not be delivered. Furthermore, hospitals were only able to offer these treatments through complicated, one-off arrangements.

Now, a pathway has been created to carry out the final manufacturing steps for these personalised or time-sensitive treatments on-site, using regulated protocols. A central control site will provide detailed instructions and oversight, while hospitals complete the process closer to the patient.

The legislation also supports the use of mobile manufacturing units, offering a safer alternative for patients too unwell to travel and those with weakened immune systems.

Commenting, Neil Smith, CPG president, Schneider Electric, said: "This landmark legislation positions the UK not only as a pioneer in patient-specific therapies—but also as a regulatory leader across Europe.

"By enabling hospitals, clinics, and even ambulances to produce patient-specific treatments in real time, the UK is setting a precedent that could reshape how medicines are developed, delivered, and regulated globally."

Protium and ULEMCo partner on green HGV hydrogen

ANDREW WADE REPORTS

Welsh hydrogen producer Protium and Liverpool-based hydrogen mobility firm ULEMCo are working together to promote green hydrogen transport.

They have signed a Memorandum of Understanding with the aim of accelerating the use of 'zero-carbon hydrogen fuel for heavy-duty vehicles and non-road mobile machinery'. The immediate focus of the collaboration will be South England and Wales, where Protium's hydrogen production facilities are located.

"We are deploying centralised refuelling hubs, aligned to locations that meet our customer's demand," said Sarah Marshman, operations manager, Protium. "Within the next 18 months we will have deployed up to three refuelling stations for heavy goods vehicles as part of the Hyhaul initiative and have been working with customers looking at localised depot refuelling infrastructure as well; all of these will utilise hydrogen produced by our production sites and transported via tube trailers."

ULEMCo converts heavy duty vehicles to hydrogen power using combustion and fuel cell technologies. The company believes hydrogen is the best solution to decarbonise the nearly half a million heavy duty trucks on the road in the UK. ULEMCo has also worked on specialist utility vehicles including refuse trucks, gritters and sweepers.

ULEMCo CEO Amanda Lyne explained that her company has completed over 100 vehicle conversions but faces infrastructure limitations. The South Wales area is a key target due to upcoming hydrogen production facilities. Feedback from projects with Oxford City Council and South Derbyshire Council indicates the technology works but is hindered by high hydrogen costs.

For its part, green hydrogen producer Protium aims to develop 1GW of hydrogen production assets in the UK by 2030. Its Pioneer 1 facility has been supplying hydrogen to transport trials and other users since coming online in 2023. A second facility in Wales, Pioneer 2, is due to begin operations soon, having been slated to open in 2024.

The new partnership will see Protium and ULEMCo exploring the rollout of green hydrogen to local transport operators and depots, demonstrating hydrogen mobility in real-world environments, and engaging with government bodies to support wider hydrogen adoption and infrastructure rollout.

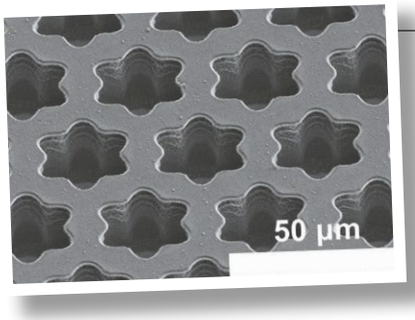
NTU LEADS DEVELOPMENT OF ULTRACOMPACT LASER

JASON FORD REPORT

An international research team has developed a new ultracompact laser that is more energy efficient and consumes less power.

Led by scientists at Nanyang Technological University, Singapore (NTU Singapore), the micrometre-sized laser emits light in the terahertz region and incorporates a design that reduces light leakage, requiring less energy to operate compared to other compact lasers.

"Compared to conventional ridge lasers of similar size, our design achieves roughly 30 per cent higher output power and 20 per cent lower threshold current," said Dr Cui Jieyuan, a research fellow at NTU's School of Electrical and Electronic Engineering. "It also shows much better directionality, with a beam divergence of around 15°, and maintains stable single-mode operation with a side-mode suppression ratio of approximately 25dB."



The new laser prevents light loss using so-called flat bands and a phenomenon called multi-bound states in the continuum (BIC).

Flat bands are energy bands in photonic crystals where light waves have near-zero group velocity, keeping the energy carried by light confined within the horizontal plane of the laser cavity.

Multi-BICs reduce vertical light loss through specific wave patterns that cancel out the parts of light that would normally escape, while still allowing useful light emission.

To implement this, the researchers designed a cavity using a periodic array of daisy-shaped holes in a photonic crystal made from semiconductor material sandwiched between two gold layers.

According to the researchers, this could potentially be the 'ultimate' solution to suppress light leakage from a laser cavity in three dimensions.

MEDICAL MISSION

Skyports Drone Services (Skyports) and healthcare provider AZ Turnhout have launched an on-demand medical drone delivery trial in Kempen, Belgium.

Commencing summer 2025, the service will be using drones to transport urgent medical cargo between the hospital campuses of AZ Turnhout St Jozef and AZ Herentals, using A-kwadraat as a central operational hub.

Flying Beyond Visual Line of Sight (BVLOS) and using a Remote Operations Centre (ROC) to pilot the drones, the project aims to deliver urgent medical cargo faster and more efficiently than the current system of van and bike deliveries.

Skyports will fly RigiTech Eiger and Speedbird DLV-2 platforms for the trial, which began August 1, 2025. ***JF***

Read more at www.theengineer.co.uk

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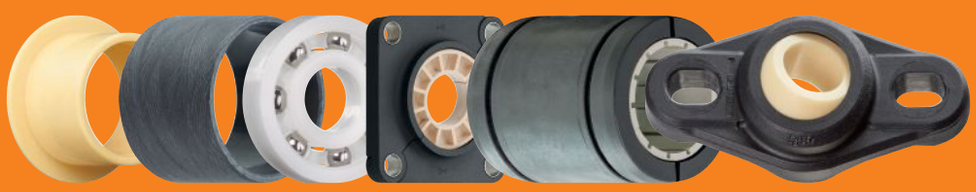

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PeroCycle secures £4m to drive green steel tech

JASON FORD REPORTS

PeroCycle, a start-up aiming to decarbonise steelmaking with its closed-loop carbon recycling process, is opening a £4m seed round to fund a pilot plant and accelerate commercial growth.

The company's process captures CO2 from the top gas in furnaces, with a crystalline perovskite lattice splitting out CO and absorbing the remaining oxygen. The CO can be fed back into the blast furnace, while the absorbed oxygen can be released from the perovskite and used in the basic oxygen furnace to produce steel, regenerating the perovskite material in the process.

"PeroCycle has application for legacy and new DRI [Directly Reduced Iron] units and blast furnaces. Each provides a set of integration challenges," said Grant Budge, who has been appointed CEO of PeroCycle. "For example, by closing the loop on process gases, the steel mills energy balance will be adjusted. The impact of this will depend on the point and extent of integration and for that we are assessing various scenarios to optimise cost and environmental benefit. In addition, the shift in raw materials in the iron making process affects reaction chemistry and mechanics, which requires careful consideration."

Budge added that the company has developed concept solutions around all integration challenges: it is evolving a phased deployment plan scaling onsite reductant supply from 30 per cent up to full deployment; and is looking to establish a mill operator steering committee.

The steel industry is responsible for around eight per cent of global CO2 emissions, with over three gigatonnes produced annually. In the UK, the sector is dealing with rising costs and industrial restructuring. Across Europe, steelmakers face mounting emissions pressure.

"PeroCycle is an elegant solution," said Budge. "That's because it is one of the few decarbonisation solutions that offers significant cost off set opportunity; that can de-risk raw material supply; that can eliminate exposure to legacy CO2 storage liabilities; and that doesn't have to rely on external CCU-product markets to underpin project economics."

SKYRORA WINS VERTICAL LAUNCH LICENCE

Scottish space company Skyrora has been awarded the UK's first vertical launch licence, permitting it to access space from SaxaVord Spaceport in Shetland.

Granted by the UK Civil Aviation Authority, the licence allows up to 16 launches a year for Skyrora's sub-orbital Skylark L rocket.

The 11m tall vehicle is powered by a single-stage 30kN bipropellant engine capable of carrying a 50kg payload beyond the Kármán line.

Initially developed to validate subsystems for Skyrora XL – its planned orbital successor - the prototype has also enabled microgravity research at low cost and opened commercial opportunities for Skyrora.

The licensing decision marks the first time a UK-based company has been given the green light to launch from British soil, with US-based Virgin Orbit and its aircraft-assisted LauncherOne the only previous system to launch from the UK. Virgin Orbit's ill-fated maiden UK-mission from Cornwall ended in failure in 2023, precipitating that company's demise. ***AW***

Read more at www.theengineer.co.uk

PROPOSALS PUT FORWARD FOR THIRD HEATHROW RUNWAY

JASON FORD REPORTS

Proposals have been put forward for a third runway at Heathrow airport with both saying the project would see aircraft flying before or by 2035.

Heathrow Airport Limited's outline submitted to government includes a north-western runway of up to 3,500m, increased capacity to serve up to 756,000 flights and 150 million passengers, and a new terminal 'T5X', expanding Terminal 2 and three new satellite terminals

The investment consists of £21bn for the new runway and airfield infrastructure (up from £14bn in 2018 due to construction inflation), £12bn for new terminal and stand capacity, and £15bn for modernising the current airport through expanding Terminal 2 and eventually closing Terminal 3.

For its part, The Arora Group's proposal comprises a new modernised terminal, Terminal 6, located west of the existing Terminal 5, and a 2,800m runway.

The Arora Group has created a dedicated and wholly owned company, Heathrow West Limited, that will work with delivery partner Bechtel. The company said its proposals could have 'substantial operational benefits and savings' as its focus on efficiency and cost-effectiveness could lead to better performance and lower charges for airlines and passengers.

Commenting, Paul Le Blond, who advises and works with the Aviation Policy Group within CILT UK, said: "As the deadline for submitting plans is now over, I want to urge the government to start moving at pace with the next steps.

"There is a clear need for a third runway, and as global trade and movement rises, Heathrow and the country as whole must keep up."

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SIR JOHN LAZAR

UK can lead the world in AI sustainability

With proper datacentre monitoring, the UK can lead the way in AI sustainability, writes Sir John Lazar CBE FREng, President of the Royal Academy of Engineering.

Debate continues to rage between water providers and local councils about how much water AI data centres will use. The creation of AI Growth Zones which support the establishment of AI infrastructure has accelerated the urgency of understanding how to balance competing demands for finite resources.

This summer Anglian Water opposed plans for an AI data centre in North Lincolnshire over water supply concerns. It's a resource that's also required to meet our housing targets and deliver the industrial strategy. Data centres can also offer potential opportunities like exporting heat waste from data centres to warm buildings (the North Lincolnshire site plan suggests it could include a greenhouse complex for example) and using AI to optimise energy efficiency.

The central problem for those making planning decisions is that we just don't know how much resources these data centres will use. There is limited information available about the current water use or energy demands of AI systems and the data centres that power them, and significant uncertainty regarding future demand for these resources. We see sustainability reports from hyperscalers like Google and Microsoft reporting their water and energy usage, but inconsistent methods of measurement make it difficult to make meaningful comparisons.

This has knock on effects for those trying to forecast and manage demand across the UK. That's why the National Engineering Policy Centre's recent report on sustainable AI called for reporting mandates to standardise data collection and improve everyone's understanding of the environmental impacts of AI systems and services.

We know from data centre operators that there are design, build and use choices that can limit the amount of drinking water required for cooling, such as operating with closed loop air or liquid cooling systems. Many data centre operators take this approach already – such as Microsoft who have begun introducing water-free cooling technologies into their data centres. However, the conservation of water shouldn't be left to chance.

There is a clear role for government to play in setting environmental requirements for data centres to report on. By reducing drinking water usage for all activities and securing commitments to using no drinking water for cooling, government could accelerate the ongoing efforts from data centre operators to reduce their water footprint. Additionally, requirements to report on water usage could play an important role in providing the clarity required to deliver on other planning-related ambitions – such as the UK government's target of getting 1.5 million new homes built over five years.

Taking steps towards reducing the water footprint of data centres doesn't have to disadvantage our economy; in fact, there is a big opportunity for the UK to lead the way in AI sustainability. By working to accelerate ongoing efforts to improve the environmental sustainability of data centres, governments can reduce the environmental cost of AI and maximise its net benefits to the economy and society.

However, reducing the environmental costs of AI will require innovation and action beyond data centres. AI sustainability requires consideration of the environmental impacts of AI hardware, data and algorithms, and interaction and use – as well as IT infrastructures and data centres. The government must lead the way with their investment and encourage proportionality and efficiency at each level, from embedding AI sustainability in procurement guidelines for AI systems to incentivising the use of smaller AI models.

Ultimately, AI Growth Zones will require a 'master plan.' AI Growth Zones must be designed to accommodate a variety of computing workloads to serve the needs of different users across the UK. At the same time, it is crucial that AI Growth Zones do not negatively impact economic growth in other sectors of the economy or harm communities in which they are sited. Balancing these considerations, and delivering maximum value, will require coordination across government departments and industry to locate these AI Growth Zones in areas where there are sufficient resources – as well as opportunities to use waste heat and deliver value to local innovation clusters by improving the availability of super-fast compute power.

Clarity on demand for water, along with suitable incentives and innovations to reduce this demand, is key to supporting that coordination – and ensuring that AI and data centres contribute to a more prosperous and sustainable future. THE ENGINEER

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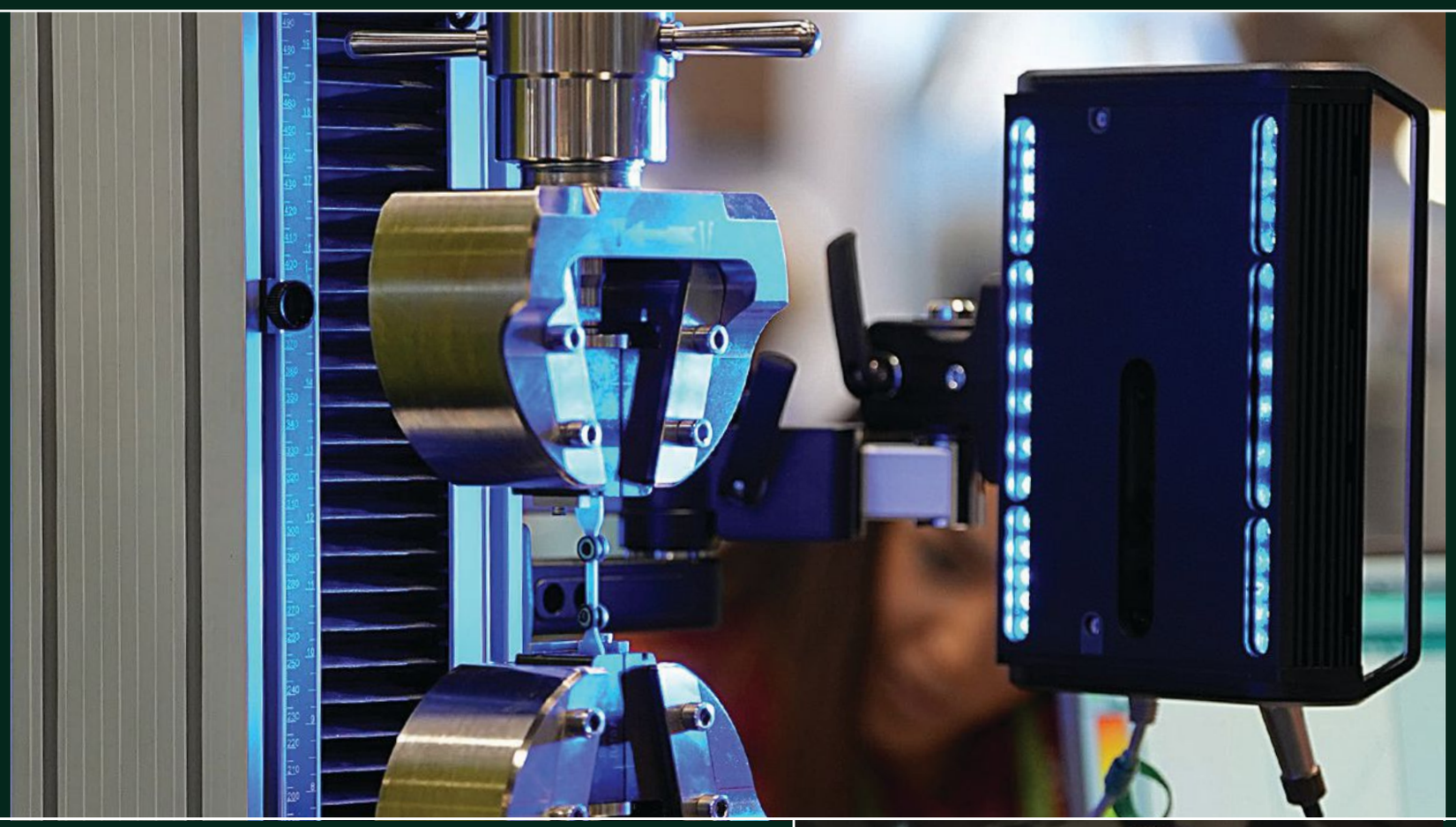

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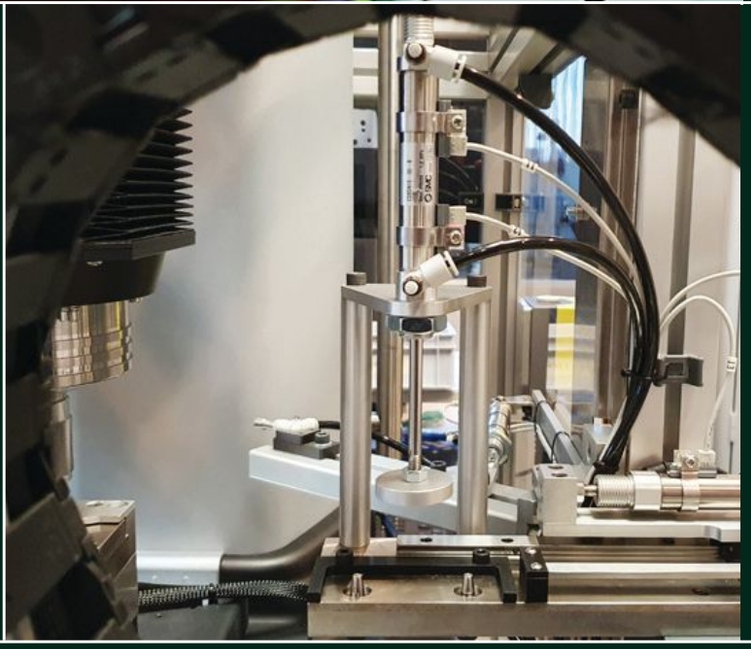

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High labour costs and a shortage of skills have become the major obstacle to growth for the UK manufacturing sector according to a new report from Enginuity

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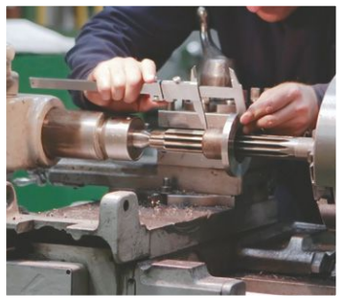


Or... Poor pay and high expectations without any intention of offering training, means companies are struggling to recruit for technical and specialist roles? Maybe pay the people doing the work a decent wage and offer them meaningful training and career progression? You don't hear of a shortage of lawyers, accountants, strategic managers, financial advisors etc
Time Served

The UK apprentice system is poor, From my own experience many school leavers who choose this route are 16-17 year olds who can't cope with further education at an A level standard. Often they are not the best kids on the block with time keeping issues and poor attitudes brought over from school. The old ONC / HNC system was a reliable and good way to get the right skills. some of the apprentice training outlets are not fit for purpose and many fail due to poor OFSTED ratings. Many of the offerings from Tech colleges are not suitable for local employers - Try finding a materials / metals engineering course at this level . With regards to wages it's hard to compete against fast food outlets that offer comparable wages. I offered a job to a bright young lad a few years ago who turned us down for this reason. I invited him to spend an afternoon with us , he saw the light and now has a mech eng HND.
Paul

Strange that premier league football clubs have no problem in recruiting their highly skilled 'staff' - perhaps the £60,000 per week average salary has something to do with it. So when SME employers talk about a 'skills shortage' what they really mean a lack of applicants willing to work at skilled jobs for a small premium above minimum wage - a throwback to 1970s 'differentials' disputes. Inevitably the market will correct this in time, some scenarios being more palatable than others
Trevor

In addition to the (extremely) high salaries, football clubs also recruit and train potential "workers" at a much younger age than any SME employer, and for longer.

Perhaps some of the SME's that are complaining need to look at the training they offer, instead of expecting full trained staff to be available "off the shelf" as some seem to want.
Steve Boyd

Readers responded to an online blog exploring how vehicle to grid technology (V2G) is shaping the future

Nothing will convince me that deep cycling an EV battery every day is anything but detrimental to its longevity or performance. The technology is little different to the Li-ion batteries in every rechargeable small consumer device, just multiplied by a few thousand. And those batteries are invariably - in my experience - the first component to fail
Trevor

This all sounds terrific but what happens in the case of an emergency requirement to use a car linked to the grid that has been drained?
Phil Mortimer

It also assumes that a significant number of vehicles (at least half charged?) will be plugged into chargers. I suspect that the vast majority of EV users drive until the battery is in a low charge state, charge it, disconnect & then continue their journey. This model will only work if owners can be incentivised to leave their cars plugged into their home or workplace chargers while not being driven. It won't be able to use motorway or similar roadside charging stations - the charging queues could be horrendous!
Steve Boyd

I am a relatively new EV owner (since October 2024) and use home charging in my garage. The car is typically plugged in (with a cap at 80% charge unless going on a long trip) the entire time it is at home which amounts to 10-14 hours per day that it is plugged in with a few exceptions. A typical day of driving uses about 30% of the available vehicle range so when I come home it's at about 50% and it gets plugged in and with my level 2 charger takes about 3-5 hours to get from 50% to 80% . I would not allow all my capacity to be available for V2G but would, with the ability to cancel should I need a longer trip on a given day and obviously some financial incentives, allow for the 80% to be taken down to 50% in a V2G scenario. Multiply this by a large number of vehicles in similar situations and this becomes interesting for distributed battery backup.
Jonathan Ingles

Adobe Stock

As the UK basks in its latest summer heatwave, Loughborough University researchers are testing practical, affordable ways to stop homes from overheating.

✉ Would closing the curtains/blinds and keeping a through draught achieve a similar solution? The Loughborough option could fall foul of planning rules. Perhaps we should learn lessons from really hot countries and go for thicker walls (good in winter as well) fewer South facing windows. and designs to induce draughts. The Yemenis were good at this decades ago.
Phil Mortimer

✉ Why the need for this testing? The solution is obvious and has been used for decades in the rest of Europe. Built in external (outside of glass window!) metal roller blinds/wooden shutters..... catch-up UK!
Trish

✉ The French have been doing this for ages - and with considerably more élan ...
Trevor

✉ I live in a house much like the one in the picture. I was going to put an external blind over the centre window only as this is much cheaper and less intrusive. I was hoping to get most of the advantages that Loughborough will be getting.
Clive Davis

Scottish space company Skyrora has been awarded the UK's first vertical launch licence, permitting it to access space from SaxaVord Spaceport in Shetland

✉ This is somewhat larger, though not by a huge margin, than the most successful amateur rocket launches. The 50 kg payload is probably sufficient to launch half-a-dozen mini satellites into a polar orbit: as a commercial proposition this seems somewhat niche to me. With consideration of a failed launch from Shetland, providing the flight path avoids Iceland, the rocket will fall into the sea so the spaceport location ticks that safety box. The phrase 'strategic defence consideration' causes me to raise an eyebrow however, as does the nationality of the CEO. Are they actually developing an inexpensive ballistic missile?
Trevor

✉ Good to see something happening in the UK. Despite a UK establishment lack of interest in launch. Would have been good to hear of some innovative plans for development and a sea change in government policy. The regulators apparent lack of enthusiasm in getting involved in setting up companies to develop and grow is disappointing; though details of what was involved and why it took a long time to get approval would have helped the launch industry no end.
Julian Spence

✉ It's a positive step I suppose but after decades of neglecting the space industry and with a fairly heavy penalty for being well away from the equator it's hard to imagine the UK will ever catch up with SpaceX.
Ekij

✉ I had a similar thought when 'The Engineer' first reported on the Shetland Spaceport. You do indeed get a 1000 mph boost from the Earth's spin by launching at or near the equator. British Guiana or one of the Caribbean British Overseas Territories would the best bet for such a UK spaceport. In the special case of polar orbits an equatorial location has no advantage.
Trevor

UNVEILING SOLUTIONS TO HELP AGGREGATES AND HEAVY INDUSTRIES OPERATORS OVERCOME MOUNTING CHALLENGES

The aggregates industry is important to the UK, playing a crucial part in the fabric of modern life and to the nation's economy. It has a long heritage, with evidence of stone quarrying on the British Isles dating back around 6,000 years.

But the sector doesn't garner much in the way of public recognition and faces mounting challenges. RS's recently launched e-book, The Aggregates Industry: Material Challenges, aims to uncover some of these key challenges in more detail and offer potential solutions. We spoke to RS's industry sector manager (ISM) for original equipment manufacturing (OEM) and heavy manufacturing, Richard Graham, to find out more.

Q. What is your role at RS and what sort of customers are you dealing with in your day-to-day job?

A. I am an industry sector manager within the UK corporate sales team. I am one of six ISMs looking after different industry vertical sectors RS works within. In my role as OEM and heavy manufacturing ISM, I work with discrete manufacturers and heavy industry companies in the aggregates sector. Examples of these are leading brick and block manufacturers, quarrying manufacturers that produce aggregates, and organisations involved in large scale production of quarrying of materials.

Q. Why did RS decide to create this e-book?

A. Working with the customers that we do in this market, we hold specialist knowledge of the arena, and are in a unique position to provide insights for the sector.

This is the first time we have done any activity that speaks directly to this important industry. We recognised the great opportunity to work with customers in this space, to help support and enable them to work to overcome the many challenges they are facing. These include ageing assets, skills shortages, recruitment and retention, rising energy costs and net zero targets. As an energy-intensive sector, rising energy is a particular burden to operators in this space.

We feel it's a worthy mission: we mustn't forget the importance of this sector as both a major contributor to the national economy and a significant employer. The sector has a gross value of £8 billion (statistics as of 2021) and employs 80,000 people directly, while supporting 3.2 million jobs in the supply chain, according to from the Mineral Products Association.

Q. What are the key challenges facing engineers in this sector?

A. Challenges facing engineers and maintainers in this space comes in many guises, but one of the main ones is ageing assets. The assets used on sites today would have been a significant investment when built for the purpose they were but are no longer as suitable for the nature of production they have to handle these days.

A production facility built to create asphalt for the development of the M6 motorway is very different to today's production requirements, which tend to be on a smaller scale production. And so the nature of the assets isn't necessarily fit for purpose anymore. But the initial cost of these would have been very high, so many firms will be maximising the assets. When capital investment is far too great to upgrade, intensive maintenance programmes are needed.

However, companies operating in this space are often quite resource-light and operations are run leanly. Engineers are expected to do a lot in their working day – perhaps even managing element like stores on top of their engineering duties. Skills shortages only exacerbate this issue.

On top of that, there is the recruitment and retention issue. If you can work in an engineering role in a nice warm warehouse, in an innovative logistics business, it's a far more attractive proposition. Compare that with working in a quarry in the middle of the Peak District, and it doesn't take a lot of imagination to work out attracting resource presents real challenges for those in the aggregates and

heavy manufacturing sector, as does keeping skills in the business.

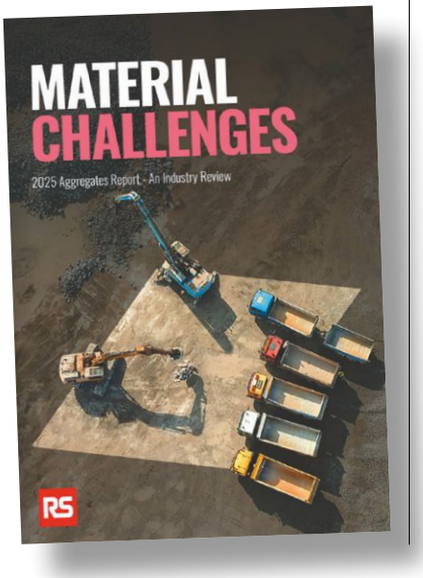
It can also be a very stressful working environment to be in if the business doesn't have mature maintenance programmes, as there'll be a constant fire-fighting approach. This is why addressing maintenance maturity is crucial to alleviating the need for all the resource. Moreover, you'll likely keep talent in the business if they can see it's mature.

Q. What kinds of solutions can really make a difference to the mounting challenges? What tangible results are feasible?

A. It's a very real scenario for an engineer to be involved in non-engineering activities like stores management, to ensure things like maintenance partsare available when needed to prevent downtime. This can be a very time-intensive activity and can take the engineer away from their actual job.

Using vendor-managed inventory is a real solution to this issue. Getting the right products to the right place at the right time is crucial, but can be easily outsourced to ensure engineers can get on with their job. Managing replenishment that is in line with consumption to avoid overstocking, and capital being unnecessarily tied up in stock, removes a huge task from the already full plate of an engineer in this space.

We executed such a solution for one of our customers that was suffering because of poor inventory visibility, and ran real risk of downtime from parts not being available when needed for crucial maintenance tasks. The annual savings we helped them achieve through streamlined processes, elimination of unnecessary orders and engineer time savings were estimated at almost £120,000.



Another key solution for operators in the sector to consider is using maintenance solutions providers for elements like condition monitoring. Working with suppliers that can help provide insights into leading causes of failure and help prevent them, is a lifeline for many businesses. It will help alleviate pressures on stretched resources and avoid costly production downtime.

Q. How important is it to consider solutions like this now? What kinds of issues might there be in the future that engineers/operators in this space should be thinking about now?

A. The recruitment and retention issue is on-going, and operators need to think about the next generation of ambitious engineers and what they will want and expect from an organisation they decide to work with. With ever-evolving technology, operators need to consider how they keep this sector attractive to engineers that might be lured away to more progressive organisations with more cutting-edge technology.

Empowering the engineers of today with the available solutions will create ambassadors for the sector.

If sector operators continue to work in the same way they have always done, in five years' time they will have lost out on significant efficiencies and the all-important competitive advantage.

Working with partners and suppliers that are innovative and forward-thinking allows companies to access the latest technologies. By offering the right products, expertise and solutions, partners like RS can be a real conduit to innovation for businesses working in the aggregates and heavy industries arena.

Download RS e-book
The Aggregates Industry: Material Challenges

STAR POWER

In a giant black box on a hill in France, the world's powers are working together to finally crack fusion energy. Andrew Wade reports from ITER.

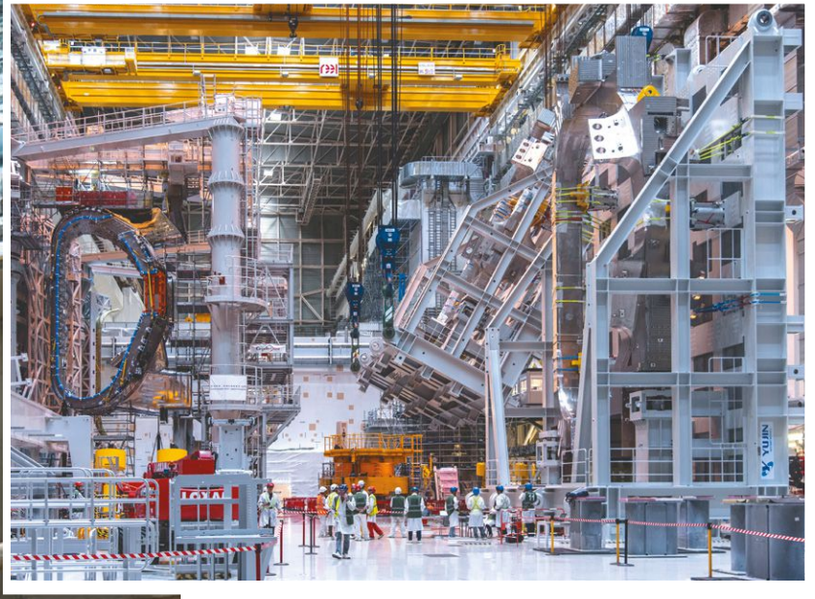
When you're building the most complex machine ever assembled, with profound implications for the future of civilisation, it helps to have the world's superpowers at the table, even if they don't always see eye to eye. Famously discussed by Reagan and Gorbachev at the 1985 Geneva Summit, ITER (International Thermonuclear Experimental Reactor) was conceived as a mission in science diplomacy, a pan-global R&D project bringing old foes together to finally solve fusion energy.

Forty years on, ITER's giant tokamak reactor is now being assembled in southern France. Gorbachev's Soviet Union has long since collapsed, and while the subsequent thaw fostered cooperation, recent events have ramped up tensions to levels not seen since the Cold War. At the time of writing, the US had just manoeuvred two nuclear subs closer to Russia, rhetoric between Washington and Moscow having reached a dangerous pitch. Plus ça change, as they say.

Sited about 60km north of Marseille in Saint Paul-lez-Durance, ITER sits atop a hill, the large black box of the main reactor building casting a somewhat menacing aura over its picturesque Provençal surroundings. The location was chosen in 2005, with ITER's seven member parties (China, the European Union, India, Japan, Russia, South Korea and the United States) formalising agreement in 2006. Initial site preparation was followed by the first buildings appearing in 2010, with tokamak construction getting underway in 2013.

Once upon a time the project's first plasma was predicted for late 2025, but a revamped schedule issued in July 2024 pushed that target back almost a decade. ITER's new goal is for research operations to now begin in 2033/34. A substantial delay, but perhaps an unsurprising one given the megaproject's complexity.

"We are assembling what I call a nuclear Swiss watch," said Alain Bécoulet, ITER's deputy director-general and chief scientist. "We need the precision of the Swiss watch but with the size of nuclear activity."



Inside ITER's giant assembly hall

On paper, we know the science works, the giant ball of fire in the sky providing a daily reminder as it fuses hydrogen atoms to create helium, releasing massive quantities of energy in the process. Replicating the nuclear reaction that takes place inside stars is – you'll be surprised to hear - not a simple endeavour. Stars have the benefit of scale, their immense gravity enabling hydrogen atoms to fuse at around 15 million degrees Celsius in the core of our Sun. On Earth, the absence of those gravitational forces means fusion requires temperatures of around 150 million degrees – ten times hotter than anything else in our solar system.

Amazingly, modern science and engineering has enabled us to achieve these sorts of temperatures, albeit only for relatively brief periods. Where ITER differs from previous fusion reactors is its epic proportions, which in theory will allow it to sustain temperatures and reactions that prove commercial fusion power is attainable.

"You didn't see a tokamak," said Bécoulet, following *The Engineer's* tour of ITER's giant Assembly Hall, where the machine is taking shape. "You saw a plant here. It's the only place around the world you will see a plant...we are covering way more than simply the technology of fusion itself."

Though ITER will not produce electricity, its aim is to advance the science to the point where fusion power plants are the next step. Once completed, the 23,000-tonne machine will be world's largest tokamak, its toroidal vacuum vessel measuring 19.4 metres across the outer diameter, creating an interior volume of 1,400 m^3. The volume of the plasma contained in the centre of the vessel (840 m^3) will be six times larger than that of the largest operating tokamak in the world today, capable of delivering a thermal output of around 500MW.

Controlling the superheated plasma – made up of hydrogen isotopes deuterium and tritium - is key to maintaining temperature. This is the job of ITER's 10,000 tonnes of superconducting magnets, which have a combined stored magnetic energy of 51 Gigajoules. Manufactured from niobium-tin (Nb3Sn) and niobium- ►

titanium (Nb-Ti), the magnets become superconducting when cooled with supercritical helium to temperatures in the region of 4 Kelvin (-269 °C).

"Deuterium and tritium are hydrogen atoms and they are both positively charged, so they don't want to fuse. They don't like each other," explained Sabina Griffith, ITER's lead communications officer, who has worked there since it was founded in 2006.

Tapping her German roots, Griffith used the analogy of pulsing techno in a nightclub to describe the fusion process.

"You come to a discotheque and they have just opened, and there are just a few dancers on the dancefloor, you know, sort of moving their bodies to ambient music, not much is happening," she said.

"And then more and more people enter the stage or the dancefloor, and the DJ turns up the volume and increases the frequency of the music. So we turn from swing to techno. And the more people you have in there on the dancefloor, the more likely it is that they will collide."

In the nightclub analogy, heat is the music, the tokamak's mind-boggling temperatures forcing the atoms to move faster like an irresistible bassline. To further improve the chances of collision, ITER's superconducting magnets will squeeze the superheated hydrogen into a tighter toroidal shape.

"With the magnets, we shrink the dancefloor," said Griffith. "We shrink sort of the volume of the molecules where they cannot escape."

Surrounding both the magnets and the vacuum vessel will be the cryostat. Measuring 29m x 29m, it will be the largest stainless steel vacuum chamber in the world, with an internal volume of 16,000m^3. The 3,850-tonne structure is designed to provide a high-vacuum and thermally insulated environment for the tokamak's superconducting magnets and thermal shields.

The cryostat's base and lower cylinder have already been installed in the tokamak pit, with the two remaining sections (upper cylinder and top lid) stored under protective wrapping until the final stages of assembly. It's a mark of the project's progress, with the majority of components already manufactured and many already on site. However, now the really tricky stuff begins. Building the pieces of the puzzle is hard. Putting them together and making the machine work is a whole new level.

"The critical path is not anymore on the delivery where it has been for very long, now it's on the assembly phase," said chief scientist Bécoulet. "What is really now the core of our activity is machine assembly."

The coming years will see the separate systems including the vacuum vessel, cryostat, toroidal coils and magnets assembled into place with minute precision and tested in isolation. Then comes integrated commission, where Bécoulet and his thousands of ITER colleagues find out if decades of planning and millions of work hours have been worth it, or if they have been chasing a mirage.

"Integrated commission is essentially the moment when all the components of the machine are inside," he said.

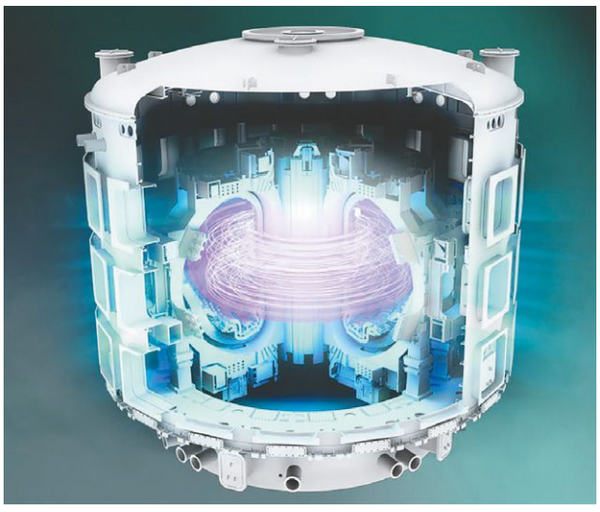
"The cryostat is welded, all is connected, the cryostat is closed, and we go down in temperature and then we start to energise the magnets, which is a very critical and important moment for the tokamak. It is the moment when we know if and when this works or this doesn't work...so by 2033 or something, we will be directly embarking into the scientific aspect of this facility. It's long, but it's short!"

Naturally, precision is paramount. Metrology underpins virtually every aspect of ITER, from manufacture through to assembly and operation. Assembly tolerances are 1-3mm for gigantic components that can weigh several hundred tonnes.

"28 metres diameter (internally), 29 metres high, 23,000 tonnes at the end," said Beatrice Alix, ITER's metrology and reverse engineering coordinator.

"That represents a challenge in metrology because you can imagine, with this sort of weight, everything starts moving...so metrology is actually everywhere throughout the assembly."

"WE ARE DOING THIS ALL TOGETHER IN ORDER TO CREATE SOMETHING THAT NOBODY CAN DO IF THEY DECIDED TO DO IT ALONE"



The project's metrology partner is Hexagon, the Swedish multinational that supplies its geospatial hardware and software to everyone from F1 teams to ITER's pioneering fusion scientists, along with virtually every engineering sector in between.

Accurate measurement has always been a cornerstone of scientific discovery, its demands increasing in step with civilisation's technological ascent. Perhaps no other project on Earth exemplifies this better than ITER. Hexagon's technology touches every corner of the programme, ensuring parts are manufactured to spec and that the machine's multi-tonne components are slotted into place with pinpoint accuracy.

"In terms of metrology instruments, we have a large range," said Alix. "Our key element is a laser tracker with probing system, scanning system, all sorts of accessories. We have these elements called reflectors. These are the targets we place all around the tokamak or the components to be able to measure in 3D."

From near absolute zero for the magnets to the mind-melting heat of the plasma, operating conditions in the tokamak will essentially be as extreme as the laws of physics permit. Add in the weight stresses placed on the reactor building of a 23,000-tonne machine, and you've got a set of engineering and metrology challenges quite unlike anything else encountered before.

"All the components...today at room temperature, will be exposed to the higher temperature or very cold temperature, will react, will deform, will change shape," said Alix. "And we have to make sure that we're keeping clearances and gaps, basically all around the machine."

Without wanting to overstate the obvious, ITER is venturing into uncharted territory, learning to fly the proverbial plane as it's being built. The history of tokamaks goes back nearly 75 years, but ITER's mammoth proportions and the step change it is attempting mean the path ahead is ►

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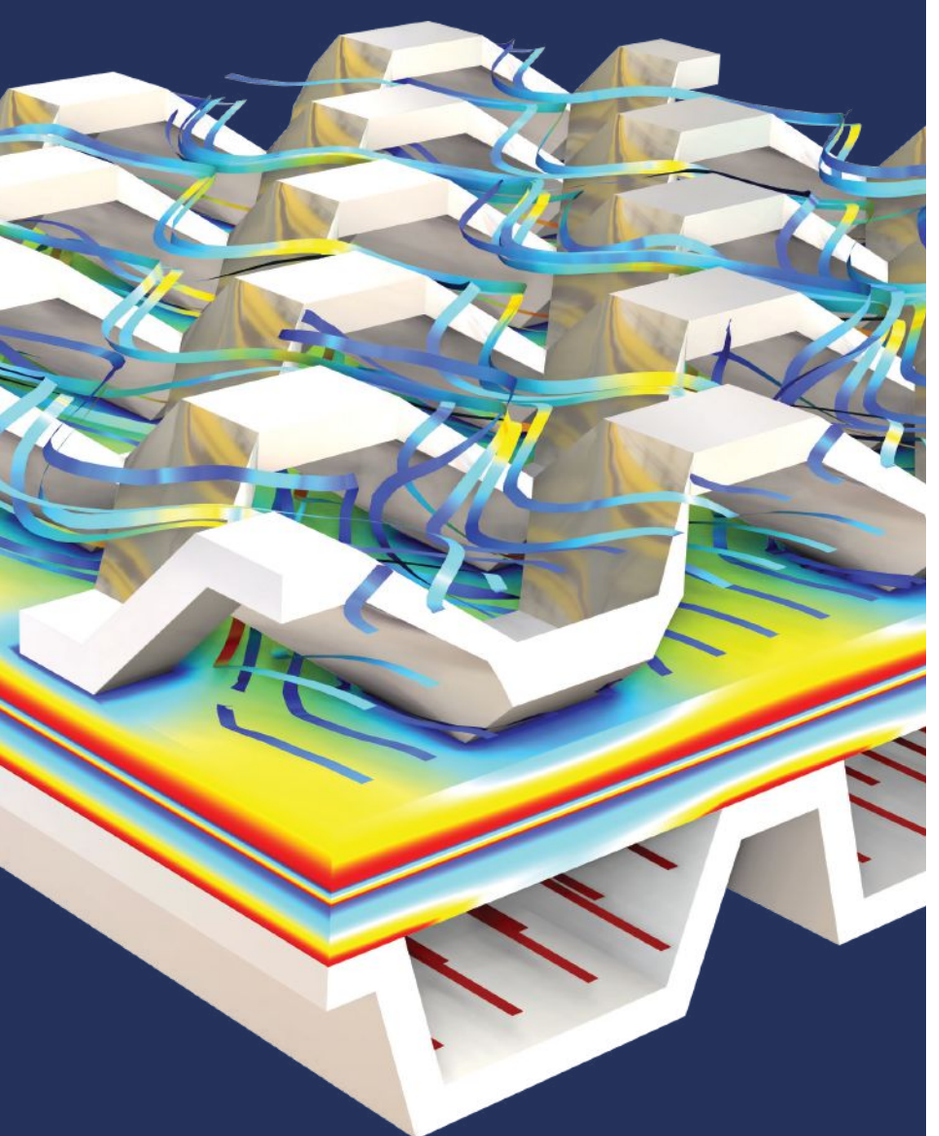

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Above and right: Drone shot of the ITER site; Tokamak assembly underway

somewhat unknowable. Even with the most intensive planning imaginable, commissioning the reactor will be a journey into the dark.

"What you have to understand is that the operation of this device has never happened, nowhere. Nobody knows how to operate this," said Bécoulet.

"We all, myself included, have been trained in the fusion community of bicycles, and we are here driving, building a Ferrari."

There is also pressure to make up for lost time. Manufacturing delays and some significant component failures have already put the project back several years. The enormity of ITER – in every respect – seems to permeate the thoughts of all involved.

"The fact that we are late in the construction [means it] is even more important for us to be ready and operational at the first, on day one, the moment we switch on the machine," said Bécoulet

"The challenge is also...not to be too late for this energy transformation that fusion aims to take part of."

One major source of ITER's delays has been procurement, with components manufactured globally by the various partners. According to Griffith there were several reasons for this, including the huge volume of manufacturing required, as well as a desire to develop a dispersed set of skills and IP across the globe to support commercial fusion in a not-too-distant future.

"This is what maybe slowed us down in the beginning and still causes a lot of headaches, but it's a very noble idea," said Griffith. "Our partners do not transfer money into the ITER accounts, but they all decided to take shares in the manufacturing of the components...the buildings, of course, are all done by Europe, because we are doing this here in Europe."

As for the tokamak itself, fabrication of the vacuum vessel sectors was shared between Europe (5 sectors) and Korea (4 sectors). The central solenoid is a collaboration between the United States and Japan, while India and the US share responsibility for ITER's cooling water systems.

Divertor manufacturing and testing is divided between Europe, Russia and Japan, while the blanket system that lines the inside of the plasma chamber will be produced by China, Europe, Korea, and Russia. Magnet production – a highly prized tender due to its cross-sector spinout potential - has been shared between six ITER members.

"Why do we do this? I mean, this is crazy," said Griffith. "Our project controls office was for many years the largest office within ITER, bigger than the science and engineering!

"You can imagine that producing the same component in Korea and Italy or maybe in India and China requires a lot of control, very tight specifications."

To borrow Bécoulet's analogy, this approach is akin to designing the world's most complex watch but outsourcing the production of each component to suppliers all over the world. Pre-pandemic, teams of people were flying country-to-country to monitor production, checking that everything was aligned. Covid put an end to that, inevitably resulting in divergence and quality control issues that set the project back. According to Griffith, though the process has been painful, the benefits it will reap will be worth it.

"There is a method in our madness," she said. "So the idea is to really establish a fusion industry all around the world, that once we have ITER and ITER says, 'okay, go, we can do it', that this industry is ready to kick in, that we multiply what is learned, that we have people that are trained on the job, that we don't have to start all over again."

Importantly, dispersing production far and wide has kept all players fully engaged, even as the established international order has been crumbling. ITER members can withdraw at any time, but to do so at this point would be folly. As well as being on the hook for financial compensation, the project is so far advanced that participants are essentially 'pot-committed', each having poured enormous sums into equipment and labour over the past two decades. So ITER continues apace against a backdrop of global instability, superpowers old and new side by side, united in pursuit of the ultimate goal.

"You have to understand that we are doing this all together in order to create something that nobody can do at the moment if they decided do it alone," said Bécoulet.

"I've been working in fusion for almost 40 years now and I can tell you that this is the most effective part of this project...this science diplomacy that we are doing.

"Today, we still have more people trying to knock at the door and enter than people leaving the project, which is a good sign!"

On y va, Alain. THE ENGINEER

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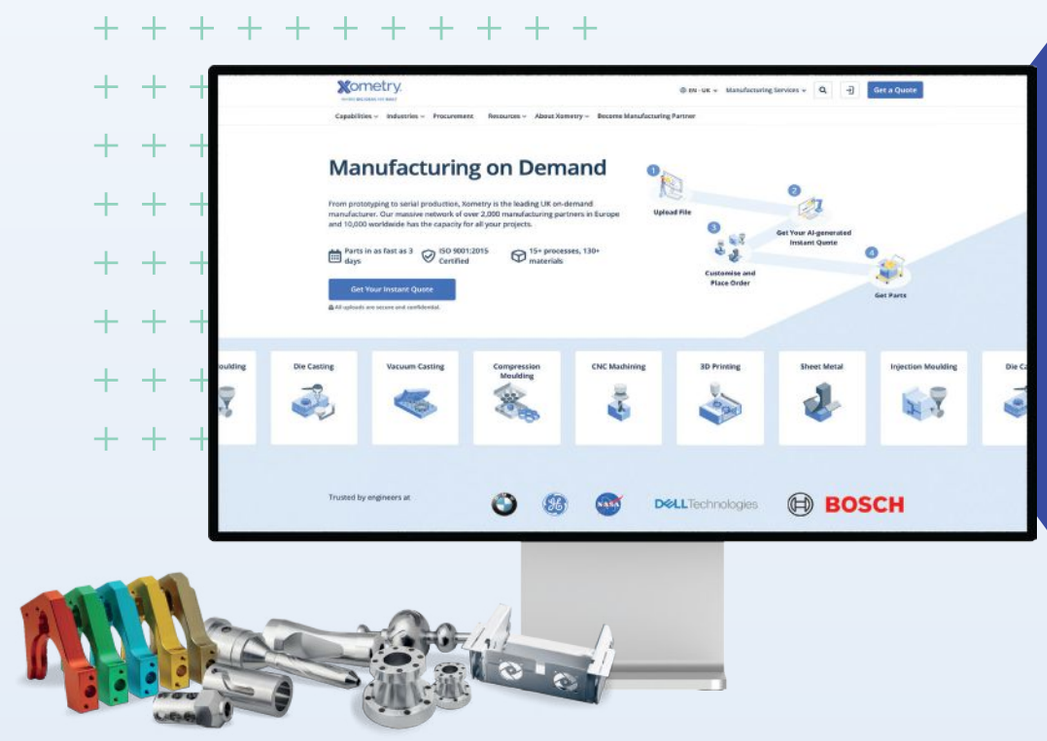

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ACCELERATING SUC INNOVATION IN LOW

JON EXCELL

The global push for greener, cleaner methods of getting from A to B is both a pressing priority and a tremendous opportunity for UK engineering.

Earlier this year The Engineer brought together a panel of experts from across the low carbon mobility sector (see box out below) to highlight the UK's progress in this critical field and discuss the challenges and opportunities presented by the transition to sustainable transportation.

The discussion was held in partnership with Bicester Motion whose vibrant Oxfordshire business campus - home to a diverse mix of young innovators and established incumbents spanning the automotive and aerospace sectors - is at the forefront of this vital dynamic.

Summarised over the following pages, the debate examined UK strengths and weaknesses, explored some of the transformative technologies and pioneering businesses that are shaping low carbon mobility, and asked what measures can be taken (at both a business and policy level) to create a fertile climate for innovation and commercial success in this critical field.

A growing culture of collaboration

Collaboration was identified as a cornerstone of successful innovation in low carbon mobility and whilst the panel agreed that the UK has significant strengths in this area, it also stressed that there's room for improvement.

According to Giacomo Margiotta-Mills - Transportation and Mobility Director at software giant Dassault Systèmes - the current pace of technological change means that collaboration is more important than ever. "With the transition towards electrified, connected and autonomous vehicles, what a car is, is fundamentally transformed," he said. ►

Chris Aylett – CEO, Motorsport Industry Association

"No race has ever been won by inefficient use of energy"

Founder and CEO of the MIA - an organisation that has been banging the drum for the UK's thriving motorsport supply chain for more than 30 years - Chris is a passionate advocate of the role that motorsport plays in driving innovations in efficient mobility.

Ian Constance – CEO, Advanced Propulsion Centre

"Through the projects we've delivered, we can see over 400 million tonnes of carbon dioxide abated."

Ian heads up the APC, a joint venture between UK government and the automotive sector aimed at supporting and growing businesses in the low carbon mobility space.

Dan Geoghegan - Founder & Chief Executive, Bicester Motion

"The vision and mission that we have is to bring together a cluster of disruptors, pioneers, thinkers, in tackling the challenges and opportunities around mobility."

Since purchasing the site from the MOD in 2013, Dan and his team have transformed this former RAF base into a centre of excellence for classic car engineering and - increasingly – low carbon mobility innovation.

Jacqueline Castle – CTO, Aerospace Technology Institute

"Aerospace is growing.... and we believe that the UK can really obtain more of a market share but that growth comes with huge responsibility to hit Net Zero"

The ATI advises government on aerospace and technology needs, and runs a variety of funding programmes. Since its inception it has enabled around £3.6 billion of funding into UK companies.

Shane Davies – Director of Vehicle Battery Systems, Nyobolt

"The fantastic thing I've found since being at Nyobolt is just how collaborative it is"

Cambridge startup Nyobolt is at the forefront of developments in high-power fast-charging battery technology that promise to transform the world of electric vehicles.

Jenny Kavanagh - Independent Aviation Consultant & co-chair of Zero Emissions Flight Infrastructure Group

"We need a long term, cross party industrial strategy that goes beyond the next election"

With 20 years of experience in the aerospace industry - most recently as CSO of a UK SME developing hydrogen fuel cell systems for passenger aircraft – Jenny is a passionate champion for low-carbon aviation .

CESSFUL CARBON MOBILITY

Paddy Lowe – Founder & CEO Zero

"We have evidence that we can get to cost parity with fossil fuel in just 10 years"

One of the most successful Formula One engineers of all time, Paddy is now on a mission to decarbonise transport through his company Zero Petroleum – based at Bicester Motion - which is pioneering the manufacture and deployment of fossil-free synthetic fuels.

Dr James Meredith – Chief Engineer for Sustainable Materials, WMG

"We are very good at working with industry who can then take the good ideas developed in projects and turn them into jobs and money for UK PLC."

A researcher, teacher and engineer specialising materials science and electrification James is also involved in a projects ranging from grid storage batteries through to hydrogen combustion.

Robin Tuluie – Founder of Physics X

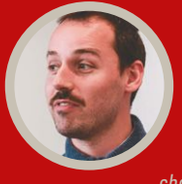
"We seek to accelerate engineering by displacing traditional simulation techniques with deep learning models."

A numerical physicist who went into Formula 1 (he was head of R&D at both Renault (Alpine) F1 and Mercedes F1) Robin is the visionary Founder of PhysicsX, a company at the forefront of deep learning and simulation solutions that redefine engineering and address humanity's most pressing challenges

Giacomo Margiotta-Mills - Transportation & Mobility Industry Director, Northern Europe, Dassault Systemes

"The transition to low carbon transport is a massive driver for our company, and a massive driver for the work that we do with our customers."

Giacomo helps organisations across the transport sector - from startups to major manufacturers - model and simulate the technologies that will help them achieve their sustainability goals.



Edward Russell – Development Lead, Skyports

"We're not a country that likes to fail fast. Ideologically, we have to change that."

Skyports is an Advanced Air Mobility company developing and operating landing infrastructure for the electric air taxi revolution, as well as using drones for a variety of business requirements. The company is currently building the UK's first Vertiport testbed at the Bicester Motion site.

"The OEMs have recognised they can't do this by themselves... even just getting your head around what an electric powertrain means for the design of a car is a whole new way of thinking."

Fortunately, the UK appears to be in a good place in this regard and Ian Constance, CEO of the Advanced Propulsion Centre (APC), highlighted its collaborative culture as a distinct advantage: "In the UK we are good at collaborating. Things like the Automotive Council, where these big companies come together and sit in a room, that does not happen in Germany and it doesn't happen in America, because the competitive tension is just too high."

Encouragingly, he added, this appetite for collaboration appears to be growing. When the APC was established in 2012, there was - he said - reluctance amongst major automotive firms to collaborate for fear of losing competitive edge and the somewhat conservative definition of a collaborative project at that time was for no single "actor" to own more than 75% of a large project. That's now completely changed. "We've gone from that to a situation where, on average, we have between four or five collaborators on every project," he noted.

Shane Davies from fast-charging Cambridge University spin-out Nyobolt agreed with this analysis although added that larger organisations can still learn a thing or two from their smaller, more nimble, industry cousins. In an earlier role at a major automotive OEM the focus was, he said, on "protecting knowledge and keeping everything internal in order to build a competitive edge." But he's found the startup culture to be far more open to this dynamic: "The fantastic thing I've found since being at Nyobolt, working with the APC, and working with different companies, is just how collaborative it is, because you can look at things afresh".

Expanding on this point PhysicsX founder and Formula One veteran Robin Tuluie said that tapping into the flexibility and appetite for collaboration found in the startup sector is key to accelerating innovation. "I think there's an incredibly powerful thing with startups who are by nature very, very fast, where you have to scale fast or die. Combining that with industry and accelerating that interaction model in a very quick way is important."

Cross-sector knowledge transfer

The discussion also emphasised the importance of enabling cross-sector collaboration, and ensuring that the low-carbon lessons learned from relatively fast-moving fields such as automotive are shared elsewhere.

As Jacqueline Castle, CTO of the Aerospace Technology Institute (ATI) noted: "Aerospace is probably a few years behind the change curve of automotive, but actually going through the same issues now where it recognises that it needs to do things differently in order to address emissions. Some of those differences are really radical, and they're not technologies that aerospace is used to. A lot of it comes from automotive."

This cross-pollination extends beyond the obvious sectors. "We shouldn't forget about our strengths in things like pharmaceuticals and drug research," said Dassault Systèmes' Giacomo Margiotta-Mills. "We work with battery cell manufacturers all over the world, but we are able to do that because we've been working with drug manufacturers for years, and manufacturing batteries is much more akin to manufacturing drugs than it is to manufacturing a car."

Robin Tuluie agreed: "I think that is a strength of the UK in particular, because we've got such broad engineering expertise. We bring analogues from other industries - from semiconductor manufacturing, Formula One, aerospace, renewables - and methods of solving problems that haven't been solved that way before. I'd love to understand how we could accelerate that more in the UK."

Meanwhile, Dr James Meredith, Chief Engineer from WMG, reminded the panel of the importance of another key collaborative partner, the UK's lauded academic research base. "R&D is our lifeblood," he said, "We're not in a space where we are very good at commercialising IP, but we are very good at working with industry who can then take the good ideas developed in projects and turn them into jobs and money for UK PLC."

Beyond this - given that low carbon mobility is fundamentally about energy - the panel also identified the importance of collaboration across the wider energy ecosystem.

Referring to her own role as co-chair of the Zero Emissions Flight Infrastructure group - which includes representatives from government, airports, hydrogen producers, and the National Grid – aerospace consultant Jenny Kavanagh said: "Collaboration is absolutely key, because otherwise you're developing technology in a vacuum, and it will never get into commercialisation, because the energy is not there."

The power of clustering

In terms of practical measures that can be taken to drive and stimulate collaboration, the panel identified geographical clustering as a valuable dynamic that can create focus and momentum and help attract inward investment.

ATI's Jacqueline Castle pointed to Boeing's decision to site its first European factory in Sheffield alongside the Advanced Manufacturing Research Centre (AMRC) or the way in which Bristol – a heartland of UK aerospace expertise – is now also home to emerging players, citing Vertical and ZeroAvia as two strong examples of this dynamic at work.

"Business happens more efficiently if you're on a site where people are doing similar things or have similar mindsets," added Bicester Motion CEO Dan Geoghegan.

Reflecting on his own experience of creating and growing Bicester's celebrated

cluster Geoghegan emphasised the importance of having a long-term vision while remaining adaptable. "None of us will slavishly follow the vision, because visions change, and the world and our environment changes, so you have to be adaptable and adapt quickly," he said.

He added that an important element for Bicester Motion has been curation, and ensuring that tenant companies are in tune with the collaborative ethos of the site. "It's about creating an environment that people want to be a part of. You've got to be somewhere that is close to people who want to be where you are."

Whilst celebrating the climate created at Bicester Motion, and the wider significance of Oxfordshire's famed "motorsport valley"

cluster within which it sits. Chris Aylett, CEO of the Motorsport Industry Association (MIA), cautioned that such clusters cannot be easily replicated and was critical of what he termed "artificially inseminated" clusters, arguing that success must build on an existing appetite and enthusiasm rather than being forced at the government level.

Jenny Kavanagh agreed, observing that what all of the most successful pockets of regional excellence have in common is that they build on some existing magic. "With the successful clusters, there is almost a gravitational force in the middle of it, whether that's Formula One, a university, or another anchor institution," she said.

The motorsport mindset

The panel agreed that the expertise found in the UK motorsport sector has a key role to play in accelerating and driving low carbon transport innovation and that more can be done to tap into this globally undisputed hub of excellence.

Celebrated Formula One engineer turned sustainable-fuel pioneer Paddy Lowe spoke of the "motorsport valley effect", the unique culture it brings, and how - if channeled correctly - the nimble engineering approaches honed on the race-track can be used to drive innovation across industry. Referring to his own experience establishing Plant Zero (Zero's first fully-featured synthetic fuel plant) Lowe said: "The regular process to deliver that plant with normal EPC (engineering, procurement and construction) would be nine months, and we did it in two months. That's how we work."

Meanwhile, Motorsport Industries Association CEO Chris Aylett asserted that the motorsport supply chain has "never been more healthy - they're pretty inventive. They're facing a whole change in the world of mobility, and they are rising to those challenges." He went on to describe various programs run by the MIA (including motorsport to marine, motorsport to aerospace and motorsport to defence) aimed specifically at enabling this kind of expertise transfer.

Nevertheless, many on the panel expressed frustration that this phenomenon isn't more widespread. Robin Tuluie was particularly critical of the regulatory limitations within Formula One itself that hamper broader technology transfer. "I'm utterly frustrated at the regulatory environment in F1 which prohibits...teams from really leveraging capabilities that exist," he said. "As a technology incubator developer, it's self-defeating to do that."

More generally, WMG's James Meredith argued that the motorsport sector could be doing more to encourage an interest in engineering: "Most of our students are super keen on motorsport, and they love innovation. But I'm just wondering whether maybe ►

industry is missing a trick in terms of teaching them about the manufacturing side of things. Maybe we should spend a bit less time watching Formula One, and a bit more time watching how it's made."

MIA's Chris Aylett agreed that we could be doing more to harness and tap into this enthusiasm: "Here we are with this funny little island with young people motivated by this strange thing called motorsport.... and we don't know what to do with that. We've somehow triggered them with an enthusiasm for engineering. And what we've got to do on the education side is work together to pick up that enthusiasm and make sure we convert it into working practices for those young people."

Engineering talent and skills

Despite concerns about skills shortages, the panel generally agreed that the UK is in a good position, with clustering helping to build and attract the skills base.

As SkyPorts development lead Edward Russell remarked, UK skills are in global demand, a sure sign that we're doing something right. "When I'm working in the Middle East or wherever it is around the world, they're all trying to use tax incentives, whatever it is. They're trying to pull all the workforces to whatever country it is. And for some reason, it just keeps on coming back to the UK."

Ian Constance agreed that while skills present a challenge, the UK is still seen as relatively strong in this regard. "When we talk to people wanting to invest here, it's a lot about the skills," he said.

Robin Tuluie went a step further, and highlighted what he sees as the UK's unique concentration of academic excellence, particularly around the motorsport valley cluster: "We're incredibly fortunate that we're within an hour of half a dozen of the world's top universities when it comes to engineering, machine learning and science. This doesn't exist anywhere in the world - even in America, you don't have a cluster like that. When we look at simulation engineering talent - and we do because we scour the globe - the best engineering simulation talent is in the UK."

Paddy Lowe reinforced this point regarding his company's location decision: "Our decision to come here - I mean, it's fantastic science and we love the site - but actually the larger reason was the pool of recruitment."

The challenge of scaling up

A key - and perhaps all-too-familiar - challenge reported by many of the disruptive UK startups at the forefront of the low carbon vehicle sector is difficulty scaling their operations and turning innovative ideas into commercially sustainable and successful businesses. Here, the panel agreed, despite some bright spots, the UK still has plenty of work to do.

Cambridge fast-charging specialist Nyobolt is a case in point, as Shane Davies explained: "We're scaling up our manufacturing. The problem comes when we then want to actually make something tangible. So we're now ramping up our manufacturing of battery cells, battery modules and we've got to push it out of the country. There's no other way to do it for a startup if we want to stay in business and keep moving."

"Scaling innovative small companies

GETTING GOVERNMENT TO UNDERSTAND WHAT'S GOING ON AND TO GET BEHIND IT IS A REAL CHALLENGE

into medium or large size manufacturing business is a huge problem," agreed APC's Ian Constance. "Many companies are stuck in the 'valley of death', they don't have orders, so they don't get investment." Helping companies scale up in order to attract the necessary investment is - he added - a key area of focus for The APC.

According to Jenny Kavanagh - whose previous role was as CSO for a low carbon aviation firm - part of the problem lies with government not really understanding the issues, or indeed the way that industry works: "You can tell when you're speaking to the government types who are used to the Rolls-Royces, the Airbuses, the GKNs. They kind of almost assume you've already got a factory that you just want to scale up and make bigger. And it's like, no, this is from ground up."

Paddy Lowe agreed, adding that government often fails to understand the opportunities and even when it does, doesn't invest enough to really grow them: "Look at wind and solar. The UK is one of the leading countries in terms of greening up the grid. But where is all that kit coming from? It's not built in Britain. We're not making the solar panels. We're not making those wind turbines. So we're just spending a lot of money building our infrastructure. That's a big miss."

Turning to his own technology, Lowe argued that the UK is not ambitious enough: "Why can't the UK be the leading technologist in the world? It's not about making Britain carbon neutral. It's about Britain making the world carbon neutral. That's the opportunity."

The funding climate

Several panelists identified the UK's risk-averse investment culture as a barrier to scaling innovative companies. Robin Tuluie suggested the UK should learn from the US: "In the US, this works by venture capital - they take the risk and they fund even long-term projects."

Skyport's Edward Russell, whose organisation operates in a number of different countries, agreed: "We're not a country that likes to fail fast - that attitude doesn't exist here, partly because of the capital, because we're not allowed to risk it. Going bust is not seen as a failure. Ideologically, we have to change."

Paddy Lowe added that there appears to be particular problem in emerging areas where there is uncertainty over the market, such as his own field of e-SAF fuel, where despite incredible technological successes, investors remain reticent due to market uncertainty: "We have evidence that we can get to cost parity with fossil fuel in just 10 years, which might sound extraordinary... but we really believe it will happen. But it's getting the world to invest in that."

Lowe also expressed frustration around government funding priorities: "I see things around me that annoy me, a lot of things they spend money on that they shouldn't. It might be things like Drax as an example. They're putting four million a day into Drax to burn wood. I don't get that. I could use a fraction of that for great benefit to the country in the future."

He warned that this failure to take a longer-term view when setting priorities could come back to bite us : "People are now investing in new oil extraction, but I think by the time they extract it, in 20 years' time, they'll go, 'Oh shit, we should have just invested in synthetic' because that will be the thing."

Government and industrial strategy

Leading on from this, the panel also emphasised the importance of long-term policy stability to create confidence in the market. Dassault Systèmes' Margiotta-Mills highlighted China's success in this regard: "Everything that's happened in China now is not a surprise. It was all laid out in their planning documents 15 years ago that was all publicly accessible. They've just executed on it very well."

Edward Russell agreed, pointing to air mobility projects in the UAE as an example of how clear planning drives progress. "If you look at Asia, the Middle East, or wherever, the 5 - 10 year plans are executed very well,"

The panel acknowledged that while such planning might be easier in more autocratic societies, the challenge is finding a way of competing and driving things forward within the UK's democratic framework: "That's what we're competing against," added Russell, "So when you recognise that, we've got to find a middle gap."

Daniel Geoghegan agreed. "Getting government to understand what's going on and get behind it is a real challenge particularly when governments change," he said. "The importance of continuity is something that we should really push up as a message."

In Jenny Kavanagh's view, achieving this requires politicians of different parties to put aside their natural inclination to disagree with each other in order to reach a cross-party long-term strategy that goes beyond the next election. Organisations working in the space can help make that happen by working together to present a coherent voice. She said: "You can't do it without working together and creating one big voice, because otherwise it's lots of little discussions going on trying to say the same thing, but in a slightly different way, and government just gets overwhelmed."

Robin Tuluie echoed this, adding that organisations have a key role to play in showing government the way: "Policy is not necessarily the way to solve it, but rather examples, analogues that we create that are successful," he said, "then others will repeat that and then eventually shape a policy to really accelerate that."

Despite these challenges, there are positive examples of initiatives that have maintained cross-party support. "APC and ATI [Aerospace Technology Institute] really are very good examples of industrial strategy going across parties," commented Ian Constance.

Both organisations were conceived under a Labour government, brought into existence by the coalition government, continued through Conservative governments, and are now being maintained by the current Labour administration.

Constance highlighted their impact: "We've still got the second biggest aero industry in the world and have an auto sector which is getting to low carbon vehicles quicker than anyone else in the world - those are things that show that you can have success if you keep a consistency of policy."

Enabling technologies

The panel also explored how wider advances in technology are being used to help to support and accelerate innovation in low carbon mobility.

Giacomo Margiotta-Mills highlighted advances in modelling and simulation technology, where generative design and other innovations are speeding up the design process

Above and right: Bicester Motion's leafy Oxfordshire campus - built on the site of a former RAF base - is home to an inspiring mix of low cabron innovators and heritage automotive specialists.

and enabling greater complexity: "We are not just modeling and simulating a car door. We're modelling and simulating the cell chemistry, working with battery manufacturers who are defining what parameters they're trying to optimise for, and effectively working with them to define the optimal cell composition."

Robin Tuluie added that the advent of disruptive digital technologies such as machine learning are also transforming the development process: "Products used to be developed using physical testing until simulation took over. Now, a new era of disruption is happening as machine learning comes to the fore - industries that want to stay ahead and want to continue leading or disrupting their fields are demanding that leverage that it brings."

Nevertheless, while the UK has considerable talent for developing these next-generation tools, Tuluie's experience is that it's mainly US customers embracing the technology: "We're great at developing the technology, but not at adopting it, not being the first adopters and really leveraging the business value from that."

For him it's the companies in the middle who face the biggest challenge in this regard: "These are machine learning assets that can operate in real-time in the machine as well as in the design, and getting a company to understand that and to build their infrastructure and capabilities around this new world is really hard."

Giacomo Margiotta-Mills agreed: "The ones who I feel are squeezed are the suppliers that have been around long enough but aren't necessarily at the scale and have to follow the OEMs. These companies face pressure to scale and meet competitive threats but find it difficult to invest in the very technologies that would help them compete and thrive."

According to Nyobolt's Shane Davies part of the solution here is for startups to give careful thought at an early stage on how they're going to integrate these next -generation tools into expanding infrastructure as they scale up.

Ian Constance had the final word on the importance of bringing greater levels of digitalisation and AI into design, development, and manufacturing, and - whilst acknowledging that it can be challenging - sounded a stark warning: "If you don't do it, you won't have an industry in a few years' time!"

BICESTER MOTION: WHERE MOBILITY'S PAST MEETS ITS FUTURE

It's hard to find a pithy two-word description of Bicester Motion that actually does it justice. Business park feels too bland, heritage motorsport hub too niche, and innovation campus too corporate.

Those in the know describe it as something far more unique: an almost collegiate environment - nestled in the heart of the UK's so-called "motorsport valley" - where a friendly community of like-minded enthusiasts and innovators rub shoulders; where the past, present and increasingly the future of mobility technology sit side by side; and where collaboration and knowledge-sharing occurs as naturally as a friendly chat with your neighbour.

Bicester Motion's story began back in 2013 when CEO Dan Geoghegan purchased the 444-acre former RAF bomber training station from the Ministry of Defence.

Geoghegan and his team set about transforming the site, which had had been largely neglected for more than four decades, into a centre of excellence for classic car enthusiasts, dedicated to preserving heritage automotive skills and providing a hub for some of the most innovative and respected small companies operating in this space.

But while classic cars remain a major focus today - and it's only ever a matter of seconds before someone roars past in a vintage Bentley - the site has evolved significantly in recent years to include companies and organisations at the forefront of low-carbon mobility innovation across the automotive and aviation sectors.

Indeed, as well as being home to traditionalists like Bentley racing specialist Kingsbury and the Vintage Car Radiator Company and classic fuels specialists Motor Spirit, the site is now also a base of operations for some of the sector's most exciting disruptors: companies like Mercedes-Benz owned axial flux motor developer, Yasa; Polestar; NEOM Mclaren Electric Racing; sustainable synthetic fuel specialist Zero Petroleum, and EVTOL and drone company Skyports, which is building the UK's first vertiport testbed at the site.

But this transformation has only just begun. While Bicester Motion currently houses 52 businesses across the mobility spectrum, they're occupying just five per cent of the available site, so there's plenty of room for expansion. "We're very much at the beginning of our journey," Geoghegan explained, noting that despite having a waiting list of hundreds of potential tenants, the campus maintains careful curation of its community. "I'd rather have an empty building than somebody who wouldn't fit."

This selective approach reflects an ethos that will likely sit at the heart of Bicester Motion for years to come. The vision extends beyond mere business accommodation to something more holistic, what Geoghegan calls "livability." The goal is creating a place where people can live, work, and even bring their children to the on-site nursery, seeing them at lunchtime.

"A grey shed in the middle of nowhere is not very inspiring for people who are driven by inspiration," said Geogehegan. As Bicester Motion looks ahead, there's a clear determination to preserve the unique culture that has brought it this far – that rare combination of heritage respect, innovation, ambition, and genuine community spirit that makes it so much more than just another business park.

Final reflections

The roundtable highlighted the UK's significant strengths in low carbon mobility innovation, particularly its collaborative culture, world-class skills base, and the unique "motorsport valley effect" that drives rapid development. However, challenges remain in scaling up businesses, securing long-term investment, and establishing consistent government policies that extend beyond electoral cycles.

Success will depend on leveraging cross-sector collaboration, embracing enabling technologies like AI and advanced simulation, creating supportive clusters that nurture talent and innovation, and developing a more ambitious national vision for the UK's role in global decarbonisation.

As Paddy Lowe put it: "It's not about making Britain carbon neutral. It's about Britain making the world carbon neutral. That's the opportunity." THE ENGINEER

CLYDE BUILT

The banks of Glasgow's famous river are no longer the shipbuilding epicentre of yore, but Thales OME is helping to maintain the Clyde's historic naval connections. Andrew Wade reports.

Once said to be the source of around 20 per cent of the global fleet, Glasgow's glory days as the world's shipbuilding capital are long passed, its title usurped by Asia's mega-shipyards during the 20th century. While activity may have ebbed somewhat, the maritime DNA remains, embodied today primarily by naval shipbuilding and the defence sector.

Stephen McCann
Managing Director, Thales OME

The Type 26 frigate programme is the Clyde's current marquee project, spearheaded by BAE Systems from its Govan and Scotstoun shipyards. But nestled between those two locations is a site whose naval heritage dates back more than a century. Sitting on the former Alexander Stephen and Sons shipyard where Billy Connolly famously served an apprenticeship as a welder, Thales OME (Optronics & Missile Electronics) has a long and storied past.

Naval Heritage

The company's history stretches back to 1888 when it was founded by university professors Archibald Barr and William Stroud, from whom it derived its original name. The optical engineering firm worked closely with the Admiralty through both world wars before being absorbed by the Pilkington Group in the 1970s, with Barr & Stroud eventually becoming Thales OME about 25 years ago.

"I was actually born next to this factory, about 500 metres from here," Stephen McCann, Thales OME's Glaswegian MD, told The Engineer.

"Its heritage started out in rangefinders. We've made every periscope for the Royal Navy. So since about 1915/1916, we've made every single periscope. At one point, those periscopes were hull penetrating, but in the last generation of boats that changed to being an electronics mast."

1918 Word War One periscope on display at the Thales Site

The classic submarine trope of slowly scanning for surface danger through 360 degrees is, alas, no longer the reality. Instead, today's submariners are fed digital pictures from optronic masts, the information available on screens throughout the vessel. As well as situational awareness, optronic masts support communications and assist with targeting and navigation.

"Over the last 30 years, you've got more and more digital equipment," said McCann. "The architecture has changed. We've condensed it and made it smaller. And now the objective of the current generation of masts, which you're going to see on Dreadnought in 2030 plus, is they have the same capability but an even smaller footprint." ►

Royal Nacy submarine during winter excercises in Norway. Credit: UK MOD

Crystal Clear

As with all things defence, finer details are kept under wraps. Without going into specifics, McCann confirmed that the masts are equipped with the latest suite of optical and thermal sensors, in ever shrinking packages so that stealth is constantly improving. The sensors sit behind specially cut sapphire crystal, which provides a clear line of sight while protecting the technology from the elements.

"It's a very challenging environment that these boats operate in," McCann continued. "So there's a single crystal of sapphire, which is essentially the window through which the cameras and other devices see. And that's a rather expensive component, a key component. If you use normal glass, you'll get pitting and so forth. And it needs to be the highest quality single crystal sapphire."

As well as packing increasingly more digital technology into smaller masts, Thales has also become a specialist in stabilising the images captured from the surface, compensating for the ocean's often disorienting motions.

"The pitch and roll is extensive," said McCann. "So that sensing and distance and image stabilisation is at our core. We actually deploy that across the Navy, the Army and the airspace.

"It translates into the land environment where you've got tanks that are moving about...we are the eyes of every single one of the UK's armoured fighting vehicles and have been so for 75 years, from Challenger 1 and various vehicles onwards. We've delivered all the sights for the Ajax vehicle. We are in the midst of delivering the first prototype units for Challenger 3, and we also make the remote weapon stations for the Boxer military infantry vehicle."

Local Skills

Skills are of course an ever-present worry for industry at large, but with global geopolitics driving an expansion of the defence sector, talent is at more of a premium than ever in the UK. Shortage is the status quo, with a constant fight to secure the services of the best young people. Despite the challenges, McCann says Thales OME is well served by its locality.

"We've got access to two universities,

Retaining existing skills is a constant struggle. Image: Thales OME

if not more," he said. "Glasgow Strathclyde still educate about 500 engineers a year, and that gives us a unique capability."

Maintaining a healthy talent pipeline is even more important given the company's heritage. Specialising for so long in a relative niche like optronic masts means skills tend to get concentrated in particular departments and individuals. Ensuring those skills aren't lost to the sands of time is a constant battle.

"We (recently) celebrated a long-service event and we had nine people who'd done 40 years," said McCann. "But it's been really important for us to regenerate those skills, because those people, you can't expect them to do 50 (years), although we may ask politely! But regenerating those skills is a key focus.

"There's about 800 people that work on the site. Almost half of them are degree educated engineers. One of our colleagues, she's on her third master's degree, so there's a high concentration of really high value add work here. And we're currently hiring about 50 early careers a year."

This annual intake of around 50 early careers roles at Glasgow is generally split evenly across degree apprenticeships, classic apprenticeships and graduate roles. Several of the degree apprenticeship roles are filled via a programme set up by Thales along with other industry players such as BAE Systems, Leonardo and Rolls Royce, delivered by Strathclyde University. According to Thales, securing the best talent can be something of a 'bun fight', but as hiring has

Challenger 2 tank. Credit: UK MOD

ramped up in line with the sector's recent growth, the influx of new blood is breathing new life into the old Glasgow shipyard.

"As we've seen the proportion of new engineers coming out of universities, both near and far, it's actually added an energy to the business," said McCann.

"It's been really great to see the young people, you know. There's been a buzz and that's been great."

Future Skills

As well as the continuous search for fresh talent to maintain the pipeline and fill the gaps left by retirements, advances in technology are also fuelling demand for entirely new skill sets in the sector. Digitisation – and AI in particular – are creating paradigm shifts in the way that data is absorbed and analysed.

"Previously, all of our systems were designed specifically...to be processed by the human brain. That is going to change," said Stewart Macpherson, head of Digital Strategy at Thales OME UK.

"We're on the edge of quite a large change, where it will be software that will be processing those images...and that opens up a whole new area for us, where we can develop smart algorithms that complement the crew and the systems, and operate a digital crew that would work alongside the physical crew."

For as long as ships and subs continue to exist, there will still be a place for the hard engineering skills needed to design and build them. But according to Macpherson, the future will see a convergence with software skills, as digitisation becomes ever more prominent.

"Obviously we'll continue to grow in areas of traditional engineering and manufacturing skills, but we'll also have to look into where the crossover lies between software, algorithms, firmware and hardware," he said.

"These are digital engineering skills but they kind of mix together as we move into this future where we will have software-defined, hardware-enabled systems."

It's a far cry from Billy Connolly's boilermaking days, but the Clyde's maritime story continues to roll. THE ENGINEER

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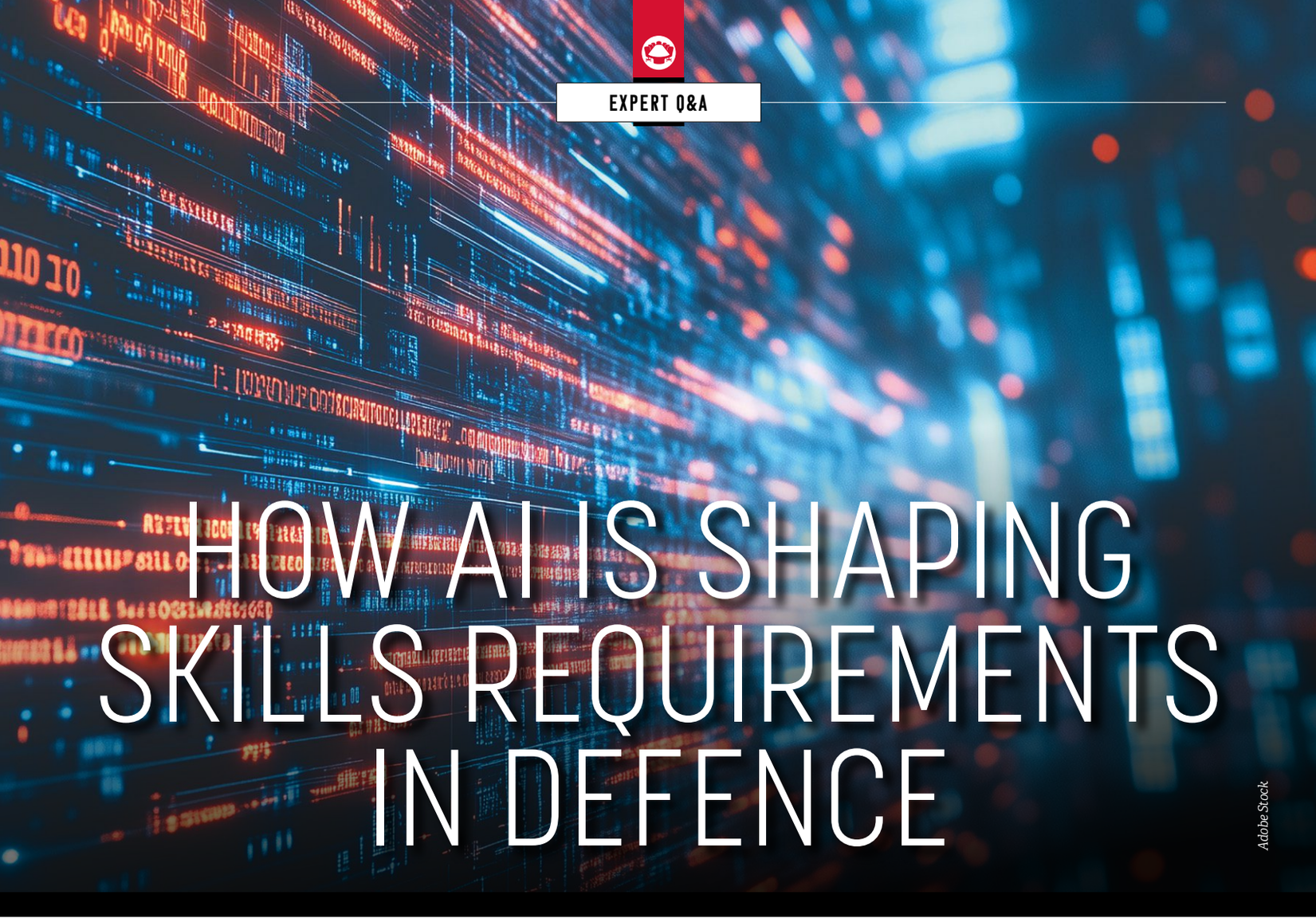

HOW AI IS SHAPING SKILLS REQUIREMENTS IN DEFENCE

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JON EXCELL REPORTS

Babcock's Donna Sinnick and Raytheon's Alex Rose-Parfitt explore the impact of AI on the defence sector's skills requirements and explain how their organisations are rising to the challenge.

How is AI affecting your business and how is this influencing your skills requirements?

DS: AI is presenting incredible opportunities across our entire business ranging from making our internal processes and activities more effective and efficient, through to improving productivity for our technical product development and services implementation. AI is also opening up new opportunities for innovative product lines, new ways of working and allows us to access innovative methods for creative design.

The impact on skills requirements is significant. Almost everyone in our business will require enhanced awareness of how to work with AI tools, including most importantly, how to identify, understand and manage risks appropriately. Two of the most important risks are ensuring our input data is protected (commercially, security and privacy) and the output data is of the appropriate integrity for its purpose. Critical thinking, data governance and data quality management and technical assurance skills are therefore increasingly important skillsets. These skills are required for all AI use contexts ranging from use of tools like CoPilot to do administrative tasks through to using bespoke and highly sophisticated AI tools to perform complex military operations for our customers.

The biggest risk of all though would be to ignore the impact AI will have on us commercially and on our customers' ability to compete with peer adversaries. If we don't train our workforce now to make effective use of AI, and teach them how to build AI-driven systems, both our commercial competitors and our customers' geopolitical adversaries will have a massive advantage over us in the near future.

ARP: AI is enhancing our business by streamlining operations, accelerating research, and advancing complex design workflows. To fully realise its potential, we need professionals who blend domain expertise with a strong grasp of AI tools and responsible deployment practices. This evolution is reshaping our skills requirements, investing in our teams to build awareness and the ability to critically evaluate AI outputs for bias, error, and reliability. For me, maintaining a multidisciplinary approach is essential, ensuring that technical, safety, and strategic perspectives are integrated as we adopt AI across the business.

What technical competencies are you finding most difficult to recruit for and what AI capabilities do you see as most critical to maintain your competitive and operational edge in the next 3–5 years?

DS: There is a shortage of AI engineers worldwide who are skilled in the application of emerging tools. Part of this is due to the speed of technology development. As there are very few people who have been using these tools for a significant period of time, there just aren't enough experienced AI engineers out there. To overcome this challenge, we need to teach our engineers to be able to constantly retrain themselves to adapt to continuously improving tools and techniques.

The technical competencies associated with identifying, understanding and managing risk associated with AI use is one of the most difficult to recruit for. Many users of AI do not have a technical background and so have not worked with algorithms before. There needs to be a certain level of data literacy (i.e. understanding the algorithms) along with an awareness of the risks that can happen if the outputs are erroneous and if high quality input data is not tested and assured for accuracy and integrity.

The users of AI who will benefit the most in years to come will be the ones who both identify the opportunities to give competitive edge and who also identify, understand and manage the associated risks appropriately.

ARP: Integrating AI into business and customer workflows demands a shift in the technical competencies we seek. Software engineering with AI agents introduces new challenges, particularly around code maintainability, verification, and trust.

Engineers must be able to assess when and how to apply AI effectively, and when not, as traditional methods remain appropriate. In manufacturing, AI-driven efficiency and insight require a more advanced approach to data analytics, moving beyond legacy tools. This is a key topic of discussion among UK manufacturing leaders.

As AI tools evolve, the most critical capability as with any new tool, is adaptability. Learning quickly, understanding limitations and identifying risks to ensure responsible and effective use.

What are you doing to upskill your existing workforce in AI -related competencies?

DS: We are launching AI awareness and skills courses, and we require AI use cases to be subjected to a governance and assurance process to ensure the opportunities associated with AI are realised, rather than the risks.

We are training the next generation of software, data, and AI engineers to incorporate AI tools into their workflows in a way that allows us to create cutting edge systems at pace and with a very robust assurance process. This assurance process has relied on our long history of engineering excellence, now applied to the emerging technologies in the AI space.

We are sharing the knowledge of how to apply AI systems and techniques, using our core AI, data, and software engineering teams to spread learnings across all engineering disciplines.

ARP: We are fortunate in that we have long invested in a skilled data science team, which has shaped our thinking and raised awareness around AI. While we are still early in our adoption journey, we are focused on expanding AI literacy across Raytheon UK. This includes formal introductions to AI tools and capabilities, supported by our internal AI research team. Their role is critical, not only in explaining the underlying technologies, but also in helping teams understand model-specific risks, such as hallucinations or lack of domain context in LLM outputs. For example, they're currently working with our training teams to convert large volumes of technical data into usable content, while ensuring accuracy and trust.

This means our data and platform engineers work together ingesting data and running algorithms, in order to drive further operational benefits from the technology.

We recognise that different AI systems, like computer vision or language models, require tailored skills and risk awareness. As mentioned earlier, our goal is to build a multidisciplinary, adaptive workforce that can responsibly and effectively integrate AI into our workflows.

Donna Sinnick, Babcock

Alex Rose-Parfitt, Raytheon

MEET THE EXPERTS:

- Donna Sinnick - Chief Delivery Officer, Babcock International Group
- Alex Rose-Parfitt - Director of Engineering, Raytheon UK

How do you anticipate AI reshaping your workforce and skills requirements five to ten years from now?

DS: Given the foundations we are laying now, and the significant investment into digital skills, our workforce will have significantly enhanced AI awareness, AI management and assurance-related skills and enhanced critical thinking capabilities.

Our technical workforce will increasingly need AI, data, and software engineering capabilities. Importantly, we will need to continuously train and then retain people who are deep subject matter experts, as we will need the capability to develop, train, test, explain, modify, oversee AI related systems and processes.

ARP: AI is rapidly evolving from a niche capability to a foundational technology embedded in everyday tools. While public focus often centres on commodity AI tools, like chatbots and LLMs, I hope AI's broader role will be as decision support systems, automating routine tasks, and enabling humans to focus on higher-value outcomes.

Much like calculators transformed bookkeeping into spreadsheet modelling, AI will reshape skillsets, moving from manual execution to model training, validation, and strategic application.

Over the next 5 years, we anticipate growing demand for professionals who can interpret AI outputs, manage risks, and understand domain-specific limitations. Our workforce will also need to engage with emerging concepts like meta-AI systems that validate and monitor other AI models. As trust and regulation evolve, AI will extend further into our autonomous systems across land, sea, and air, with more ability to adapt, learn, and critically assess. THE ENGINEER

ABB expands large industrial robot portfolio

ABB Robotics has expanded its large robot portfolio with the launch of the IRB 6730S, IRB 6750S and IRB 6760. The company claims that the introduction of these new robots, alongside the wider portfolio of next generation robots launched since 2022, means it is able to offer customers the most comprehensive lineup of industrial robots and variants on the market.

The IRB 6730S and IRB 6750S are both shelf-mounted robots and have been designed to support an increase in robot density in the production line. Capable of handling industry-leading payloads of up to 350 kg, the shelf robots can be installed at a height (or on a second floor) and can work with floor-mounted robots to maximize productivity. In addition, the robots provide excellent full vertical and horizontal motion to increase downward reach, making them ideal to optimize the space for die casting, injection molding, and spot welding for use in automotive, foundry, construction, and general manufacturing industries.

ABB claims to offer the most comprehensive line-up of industrial robots on the market

Meanwhile, the IRB 6760, a member of ABB's latest generation of press tending robots, is the highest performance solution to date for mid-sized press lines. When combined with ABB's carbon-fiber tooling boom, it can boost production output to a market-leading rate of up to 15 strokes per minute or 900 parts per hour. The IRB 6760 press tending robot is recommended for automotive, electronics and general manufacturing industries.

All three new robots are powered by OmniCore, ABB's advanced controllers for automation, which is claimed to deliver a 20% reduction in energy consumption.

"The launch of our new robots supports our vision that 'versatility' will be the defining factor for robotics in 2025," said Marc Segura, President - Robotics Division at ABB. "This market-leading range of industrial robots and variants, coupled with our comprehensive portfolio of mechatronic platforms, cobots, and AMRs, ensures we are ideally placed to support our customers as we enter a new world of increased productivity and flexibility."

Simulation platform to drive deployment of robots in offshore wind

A simulation platform that harnesses live environmental data could help fast track the deployment of robotics and autonomous systems for offshore wind.

Developed by engineers at the UK's Offshore Renewable Energy (ORE) Catapult, VDARE (Virtual Demonstration and Assessment for Robotic Environments) - claimed to be the first system of its kind for the offshore wind sector - allows companies to test, validate and accelerate the deployment of robotics in offshore wind environments including floating platforms, fixed bottom wind turbines, and harbour and dockside operations.

The technology realistically simulates wind, wave and sea conditions, environmental parameters such as wind speed and wave height, and a multi-robot communications system. As well as offering a variety of UK locations, it can also replicate international locations..

Dr Cristina Garcia-Duffy, Director of Research and Technical Capabilities at ORE Catapult said: "By creating accurate real world offshore environments to put innovative robotics through their paces, we can help fast track their progression to commercialisation and gain valuable learning on how to overcome various technical challenges for the sector."

ORE's new platform creates accurate offshore simulations for testing robots

Delivered with funding from Innovate UK and the Net Zero Technology Centre, the technology is located within ORE Catapult's DARE (Digital, Autonomous and Robotics Centre of Excellence) at the National Renewable Energy Centre in Blyth, Northumberland.

Showcasing VDARE's capabilities, ORE Catapult teamed up with USV (unmanned surface vessel) company Acua Ocean to simulate deployment of the company's hydrogen-powered equipment. The demonstration involved deploying an Unmanned Aerial Vehicle (UAV) from the Acua Ocean USV, where it successfully followed the USV autonomously and collected vital data.

Mike Tinmouth, Chief Operating Officer at Acua Ocean, said: "Working with ORE Catapult we have been able to develop a concept of operations in an operational environment such as an offshore wind farm or subsea data cables and simulate the deployment of payloads from USV PIONEER in different sea states and weather conditions.

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AtkinsRéalis and Kinova extend partnership in nuclear robotics

A renewed long running collaboration between Engineering services company AtkinsRéalis and Canadian robotic developer Kinova is expected to will help advance the integration of cutting-edge robotic technology in the nuclear sector, building on the successful deployment of Kinova's robotic arm within the patented AtkinsRéalis Remote Glovebox Operation (ARGO) system in the United Kingdom.

The ARGO system was recently used in a world-first deployment at the UK's Sellafield site, retrofitting a nuclear glovebox with a robotic arm in a successful demonstrator project that proves viability to use at scale across nuclear decommissioning sites.

The next phase of the partnership will focus on further refining and expanding the technology for use in nuclear world-wide to improve safety and unlock efficiencies, including the use of Kinova's Gen3 robotic arm for remote glovebox operations and decommissioning using ARGO at selected nuclear licensed sites. Plans include the development of additional tools and functionalities, enabling the system to perform a wider range of tasks for remote handling and treatment of hazardous materials in gloveboxes across the nuclear sector.

Christian Pilon, Head of Nuclear Robotics at AtkinsRéalis, said: "Robotic and automation technology is already improving safety and speed of delivery in the nuclear sector but the full extent of its potential is still to be realized. Our work with Kinova is proving how commercial technology used successfully in other sectors can be integrated into nuclear systems through close collaboration and combining engineering expertise and industry knowledge."

The ARGO system was deployed for the first time at the UK's Sellafield site

igus introduces new humanoid robot

Motion plastics specialist, igus has introduced a low cost humanoid robot aimed at supporting industrial production, transportation and service applications.

Costing just over £40,000, Iggy Rob is about 1.7m (5'6") tall and can operate for eight hours on just one battery charge, greeting colleagues with a smile, two ReBeL cobot arms and two bionic hands.

Equipped with a LIDAR sensor and 3D cameras for object detection, it navigates its surroundings easily, using the proprietary igus Robot Control for control. The robot is approved for fleet management in accordance with VDE 5050 and has CE certification. Supported by an ROS2 interface, Iggy Rob meets the requirements of modern robotics.

At the core of Iggy Rob is igus' ReBel Move autonomous mobile robot (AMR). With a load capacity of 50 kilograms and a payload of 100 kilograms, ReBeL Move creates the conditions for workstation-independent movement.

According to igus, Iggy Rob could be deployed as a service robot at company receptions, provide transport and delivery tasks in factories, or simply clear cutlery in the canteen. igus itself plans to use Iggy Rob when inserting components into the company's injection moulding machines. "We believe that humanoid robots will be of high interest for industrial purposes," said Adam Sanjurgo, Low-Cost Automation Manager at igus in Northampton.

To ensure customers are confident in their decision to purchase, the company is offering a "test before invest" model for potential buyers to trial the robot for their specific application.

Based on igus' ReBel Move robot Iggy Rob is 1.7m tall and has a load capacity of 50Kg

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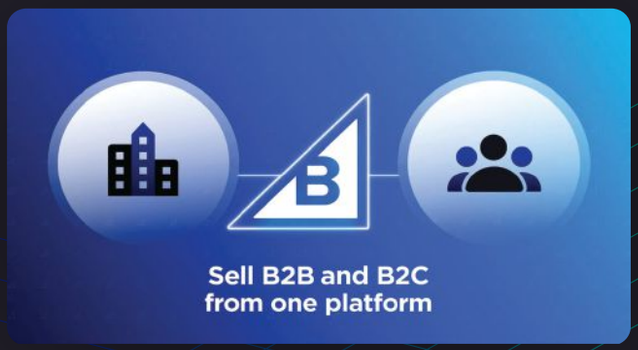

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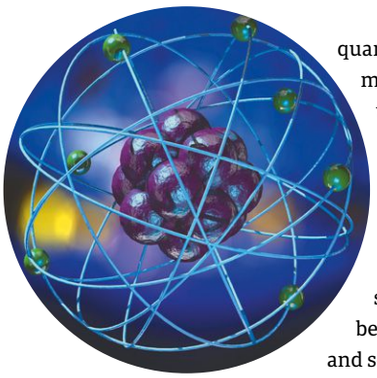
NPL ballistic electron sensing shows quantum promise

Researchers at NPL have discovered a new high-speed charge sensing technique for ballistic electrons, a potentially useful technique in the fields of electron quantum optics, quantum electrical metrology, flying qubit technology, and signal sensing.

The study reveals that the presence of a single ballistic electron can be revealed by tracking the path of another fast-moving "sensing" electron. By steering the paths of these electrons close to each other, the tiny repulsion between them can redirect the sensing electron, like a train switching tracks or cars diverting off a freeway.

When charge sensors are used as in quantum devices they are measured continuously, with each sample long enough to resolve a signal from the noise. The NPL sensing system leverages synchronisation between the detector and sensing electrons to achieve extreme time selectivity, only sampling within a minuscule time window and detecting interactions that occur in just 1-2 picoseconds.



The technique could be used to drive a number of quantum technologies

To put this in some context, there are various quantum technology platforms in various stages of development, competing to determine which is the most practical for applications. NPL's work highlights a key feature of the platform based on ballistic electrons in semiconductors. These systems, which somewhat mimic quantum optical systems, have intrinsically fast time scales of operation. Sensing schemes are one ingredient to build complex single-electron circuits and unlock new quantum technologies.

"All conductors feature ballistic single electron physics at the atomic scale on very short time scales, but it's unusual to be able to detect this this at the single electron level, let alone have direct control," said Jonathan Fletcher, senior scientist at NPL.

"This control and detection is exactly what our system gives you. It's exciting for me because control of electricity at nanometer and picosecond scales is a fundamental tool for metrology and also a pathway to other quantum-enabled capabilities."

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Skanska and Hexagon team on world's longest underwater road tunnel

Hexagon is supplying its metrology tools to construction multinational Skanska for Project Rogfast, a 27km subsea tunnel connecting municipalities in Norway.

The project is claimed to be the world's longest and deepest road tunnel under construction. Running 392 metres below sea level, the Boknafjord tunnel will connect the cities of Stavanger, Haugesund, and Bergen, helping to cut travel time by 50 per cent and strengthening economic links across the region.

Project Rogfast poses a host of extreme engineering challenges, including tunnelling from both ends to meet within a 5-centimetre margin of error, with even a minor misalignment potentially leading to massive rework and waste.

"In a project like this, even a millimetre of misalignment can trigger cascading risks," said Trond Valleur, vice president, Skanska.

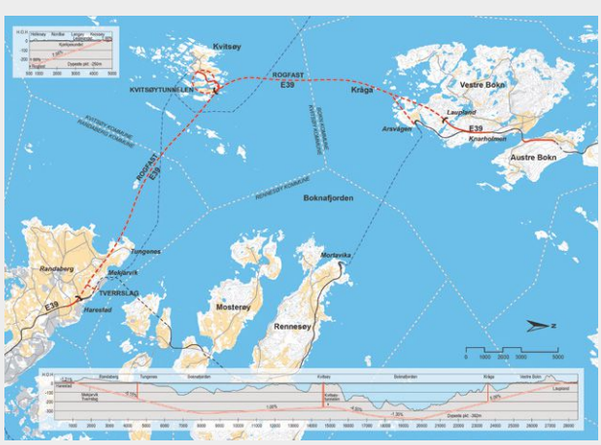
"Hexagon's technology gives our teams the confidence to move forward with accuracy, efficiency, and safety. That precision, and our shared drive to push boundaries, is what makes this partnership so powerful."

Hexagon's portfolio of Leica Geosystems solutions enables surveyors, excavators, and drill operators to work with high-confidence accuracy, allowing the project to proceed without interruption. Measurable impacts across Rogfast include enabling precise alignment with total stations, GPS, multistations, and laser scanners; reducing rework, emissions, and cost through real-time data capture and validation; and powering safe operations under extreme conditions 392 metres below sea level.

"This project is a milestone for infrastructure and a testament to how measurement technologies are reshaping what's possible," said Burkhard Boeckem, CTO, Hexagon. "We're proud to support Skanska with solutions that enable their teams to work smarter and safer with accuracy."

Skanska teams use a wide array of Hexagon tools, including the Leica RTC360, Leica MS60 MultiStation, Leica AP20 AutoPole, and Leica TS60, claimed to be the world's most accurate total station.

The world's deepest and longest road tunnel, Rogfast presents a series of extreme engineering challenges



New report predicts big growth for 3D metrology software market

A new report from HTF Market Intelligence estimates that the global 3D metrology software market will experience a CAGR (compound annual growth rate) of 7.5 per cent over the next five years.

According to HTF, growing adoption of Industry 4.0, smart manufacturing and additive manufacturing are making 3D metrology software a cornerstone for automated quality assurance and real-time monitoring, driving much of the growth in the market. Metrology software is becoming integral for ensuring product accuracy, compliance with international quality standards, and faster prototyping in industries such as aerospace, automotive, electronics, energy, and medical devices.

The report highlights some of the major players in the space such as 3D Systems, FARO, BuildIT, EMS, InnovMetric Software Inc., Metrologic, Hexagon Manufacturing Intelligence, East Coast Metrology, and Creaform. Market trends that these companies are tapping into include integration with digital twins and Industry 4.0 ecosystems; use of AI and machine learning for predictive defect detection; rising adoption of cloud-based and SaaS platforms; demand for portable and real-time 3D metrology solutions; and enhanced AR/VR.

The market is expected to grow by 7.5 per cent over the next five years

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The HTF report also identifies some key challenges for the market. These include a relatively high cost of implementation and training, compatibility issues with legacy hardware and CAD systems, and a shortage of skilled professionals in metrology software use.

While North America currently dominates the market, Asia Pacific is the fastest growing region for 3d metrology software.

LK Metrology makes industrial CT play with ProCon X-Ray acquisition

Castle Donington-based LK Metrology has announced the acquisition of ProCon X-Ray GmbH, a specialist German manufacturer of computed tomography (CT) systems.

Previously known for its coordinate measuring machines (CMMs) and more recently laser scanning sensors, the new purchase now puts LK Metrology into high-precision inspection solutions that include industrial CT imaging, strengthening its metrology portfolio.

"With the acquisition of ProCon X-Ray, we are strengthening our position as a leading, full-service provider in metrology" said Angelo Muscarella, CEO of LK Metrology. "Industrial CT imaging perfectly complements our existing CMM and scanning technologies."

Founded in 2003 and based in Sarstedt, Germany, ProCon X-Ray develops and manufactures modular CT and X-ray inspection equipment for industrial and scientific applications. Its systems are renowned for high-resolution focus X-ray technology, as well as customisable hardware and software. They are used worldwide in the automotive, aerospace, electronics, medical, and materials research sectors.

The acquisition means that LK Metrology now offers a wider range of products

Through the acquisition, LK Metrology can now offer its customers a wider range of products for inspection and measurement from a single source, from traditional CMMs, portable measuring arms and laser scanners to high-resolution X-ray equipment and CT analysis. The two companies will work together to further develop existing CT systems as well as deliver new, flexible, integrated metrology solutions of the highest precision to customers worldwide.

"We are pleased to become part of the international LK Group and, through its outstanding global presence, to make our market-leading products accessible to a significantly wider customer base," said Nikolas Westphal, managing director of ProCon X-Ray GmbH.

LK Metrology

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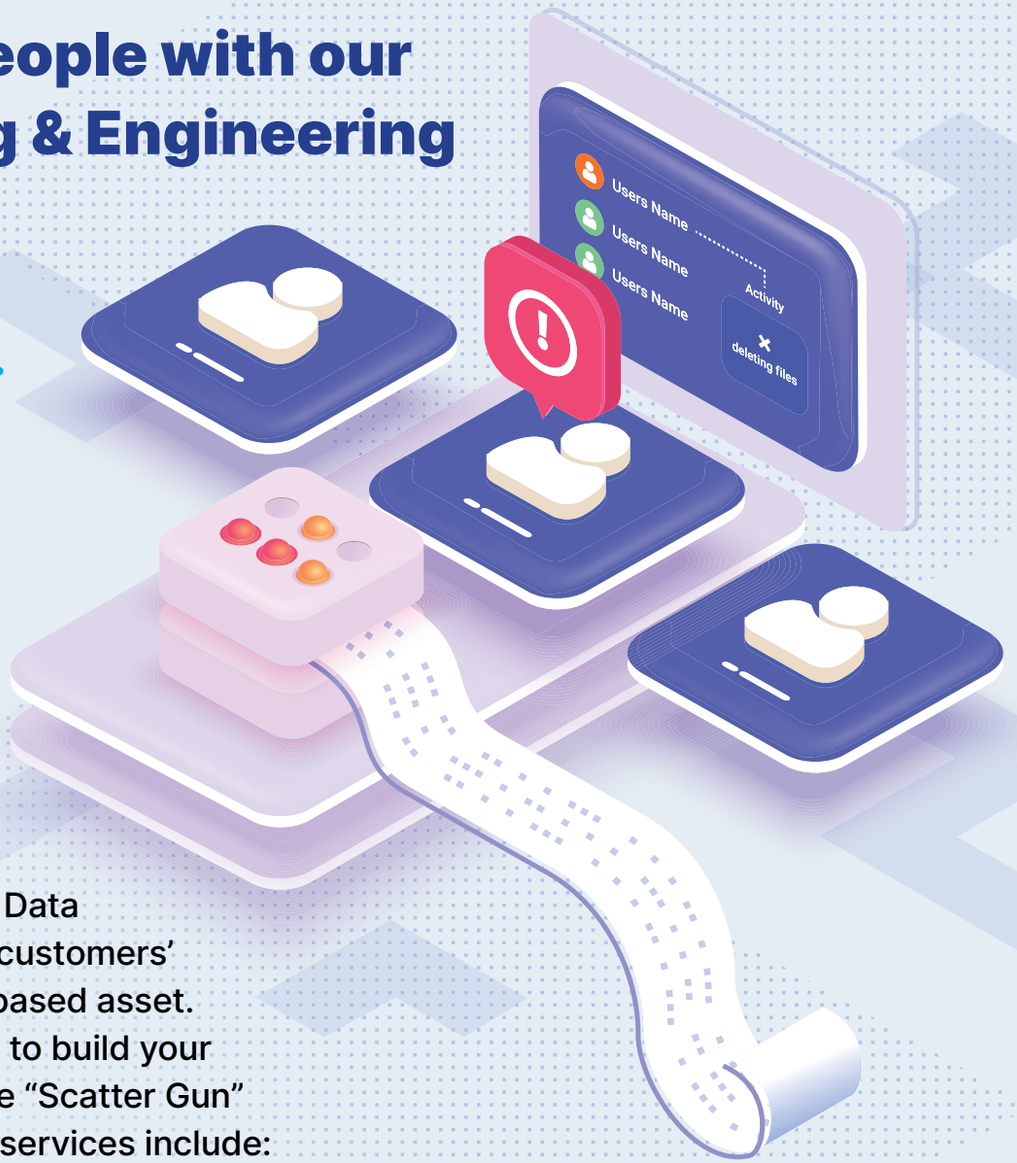

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MEET THE INNOVATORS, ACCESS THE FUTURE: REGISTER FOR EDS TODAY!

Running from 8 – 9th October at the Coventry Building Society Arena, this year's Engineering Design Show (EDS) promises to be the biggest edition yet

FREE registration is now open for the Engineering Design Show (EDS), taking place on 8–9 October 2025 at the Coventry Building Society Arena. Following last year's successful event, EDS 2025 is gearing up to welcome more than 4,800 mechanical, electronic and embedded design professionals, making it the biggest edition yet.

Building on its reputation as the UK's leading event for the engineering design community, the show continues to attract innovators, decision-makers and technical specialists looking to explore the latest technology and trends shaping product development. Across two days, visitors can meet 220+ exhibitors spanning product design, 3D printing, embedded systems, PCB manufacturing, motors, sensors, robotics and more.

Industry-leading Suppliers

EDS 2025 will bring together more than 220 suppliers under one roof, representing industries including electronics, embedded systems, robotics, motors, sensors, materials and product design.

Headline sponsors Würth Elektronik and Solsta highlight the breadth of expertise on offer. Würth Elektronik continues to expand its global reach with a comprehensive portfolio, including the recently added IQD Frequency products, alongside full design-in support and delivery. Solsta, formerly Solid State Supplies, focuses on semiconductors, embedded modules, communications, power management, LED lighting, relays, switches and optoelectronics, offering both technical guidance and commercial support.

Visitors will also be able to explore products from suppliers including Maxon Motor, Telonic Instruments, Yokogawa Test & Measurement, Peli Products, Hitek Electronic Materials, TTI, Robafoam, Smallfry Industrial Design and The Peak Group, reflecting the wide breadth of industries represented at EDS.

Conference Programme - Ideas That Shape Tomorrow

The 2025 conference programme is tailored for design engineers across all market sectors. From aerospace and automotive to electronics and consumer products, it delivers insights and practical knowledge for real-world challenges. Attendees will hear case studies

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on transformative technologies such as Artificial Intelligence and Quantum Computing, helping them stay ahead in a rapidly evolving landscape.

In addition, sessions will provide strategies for embedding sustainability into product development, expert guidance on patent protection, and career-focused insights on skills for the next generation of design challenges.

Alongside keynote talks, the programme will feature panel debates, interactive Q&A sessions, and more. Giving attendees the chance to put questions directly to speakers and gain practical guidance on the issues affecting their projects today.

Highlights of the 2025 programme include:

- Don't Forget Me! A human-centred approach to simulation and digital twins – Claire Palmer, Loughborough University
- Breaking the Reactive Cycle: Strategic Approaches to Component Obsolescence Management – Dunstan Power, CEO, ByteSnap Design
- Panel discussions hosted by Angela Lamont on supply chain resilience, security, and career opportunities in defence
- Pass EMC the First Time: Design It Right, From the Start – Min Zhang and Telonic

Work in Defence

New for 2025, EDS will debut a Work in Defence feature, delivered in partnership with The Engineer. With the UK defence sector facing an urgent need to attract skilled professionals with transferable expertise, this initiative will provide a dedicated platform for connection and collaboration.

Attendees will have the chance to meet leading defence organisations and take part in the Work in Defence Roundtable, hosted by The Engineer's editor Jon Excell, exploring opportunities, skills pathways and career routes into this vital sector.

What's On in 2025? Innovation in Action!

The EDS exhibition floor will once again showcase engineering creativity, giving visitors the chance to experience innovation in action.

A highlight will be the Dynium Robot, an autonomous agricultural vehicle designed for precision tasks in environments such as orchards and polytunnels. With OxDrive's compact, high-torque electric hubs, it demonstrates the potential of smart robotics to enhance productivity in off-highway applications.

KUKA Robotics will present its next-generation range of Autonomous Mobile Robots (AMRs). From flexible AMRs to fleet management software and no-code programming tools, KUKA's showcase will reveal how advanced automation can be integrated into existing operations.

Visitors looking for something competitive can try the Rollapaluza cycling challenge, supplied by Modnyco. Using rigs fitted with Condor track bikes, participants race head-to-head in high-speed sprints, with progress tracked on a giant display, and prizes to be won!

The show will once again feature the Nottingham Trent University (NTU) student showcase, giving the next generation of product designers a platform to present their work.

A notable return this year is Joshua Dennis, who first appeared at the NTU student showcase and now brings his business, Dennistries, to the Innovation Zone. He will unveil the NextGen line of humanoid robots, including the newly announced NextGen LEO.

It's a great example of how EDS provides a platform for new talent to grow, giving students a first step into the industry, and then welcoming them back as innovators in their own right.

Also within the Innovation Zone, Creative Hubb Ltd will showcase their bomb disposal suit, demonstrating how innovative textiles and engineering can create life-saving protective equipment.

These live experiences capture the spirit of EDS, celebrating creativity from heavy-duty robotics to human-focused design. Visitors can see the technologies up close, meet the teams behind them, and experience the engineering breakthroughs shaping the future.

Networking and Community

Hands-on learning remains a core feature of EDS, with practical workshops running across two dedicated theatres. These sessions will equip engineers with new tools, techniques and fresh thinking to apply back at the design bench.

Networking is supported in the Chill & Charge Zone, a relaxed environment to recharge, catch up with colleagues or reset before diving back into the action.

At the end of day one, attendees are invited to the EDS Party in the Dhillons Lounge at the Coventry Building Society Arena. With a cocktail bar, live band and raffle prizes, it's a lively way to unwind after day one on the exhibition floor.

See you there? It's free!

So, what are you waiting for? The UK's biggest engineering design show is just around the corner... and registration is completely free. Don't miss your chance to see the latest innovations, meet industry experts, and be part of the future of engineering.

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HENRY MAUDSLAY: MASTER OF MACHINE TOOLS

One of the great architects of the Industrial Revolution, Henry Maudslay was fuelled by an unrelenting drive to standardise machines and refine the mechanical processes of the time.

WRITTEN BY NICK SMITH

For anyone caring to examine 'the machinery of our modern engineering workshops' wrote Samuel Smiles in *Industrial Biography: Iron Workers and Tool Makers* (1884), 'he will find in all of them the strongly-marked features of Maudslay's parent machine, the slide rest and slide system – whether it be a planing machine, a slotting machine, a slide-lathe, or any other of the wonderful tools which are now enabling us to accomplish so much in mechanism'. Perhaps unusually for Smiles, a historian somewhat prone to conjecture and over-excitement, in this instance he was as unfailingly accurate as the machines that have made Henry Maudslay one of the great names in the history of the Industrial Revolution.

More than two centuries after developing the first practical screw-cutting lathe, Maudslay is still thought of as the founding father of machine tool technology. As one commentator puts it, he was the 'most esteemed machine tool designer of the modern era, famous not only for his inventions, but for training many of the next generation of tool designers and inventors.' At the peak of his career, Maudslay's south London engineering business formed the epicentre of a pre-digital technology cluster that wielded such influence and

HENRY MAUDSLAY 1771-1831

innovation that it is now referred to as the Silicon Valley of the Georgian age. In his superb *Iron Men: How One London Factory Powered the Industrial Revolution and Shaped the Modern World* David Waller describes how Maudslay, 'an engineer from a humble background, opened a factory in Westminster Bridge Road, a stone's throw from the Thames. His workshop became in its day the equivalent of Google and Apple combined, attracting the country's best in engineering talent... helping Great Britain become the workshop of the world.'

Henry Maudsley was born on August 22, 1771, in Woolwich which is now in southeast London, but at the time was part of Kent. His father, also Henry, had been a wheelwright in the Royal Engineers and, after being heavily wounded in action, became an 'artificer' at the Royal Arsenal. When he died in 1780, the Maudslays were left in reduced financial circumstances, with the result that the 12-year-old Henry was forced into the dangerous employment of 'powder monkey' at the Arsenal. While manually filling cartridges with explosive was a low-skilled job, the exposure to large-scale industrial production awakened in Maudslay an interest in machinery, which led him to the Royal Foundry where he acquired knowledge in metalworking, tools and lathe operation. His natural talent for engineering was such that by the time Maudslay was eighteen, the inventor and locksmith Joseph Bramah – who was struggling to find experienced precision engineers – had taken him on at his Denmark Street premises.

In the 1971 Science Museum pamphlet *Henry Maudslay: Machine Builder*, K.R. Gilbert details eyewitness accounts of how the young engineer worked with 'several curious machines, for forming parts of the locks, with a systematic perfection of workmanship, which was at that time unknown in similar mechanical arts.' This testimony dates to 1849 and is from one John Farey, who had known Bramah, and who was also adamant that these machines 'had been constructed by the late Mr. Maudslay, with his own hands, while he was Mr. Bramah's chief workman.' These

Images: Alamy

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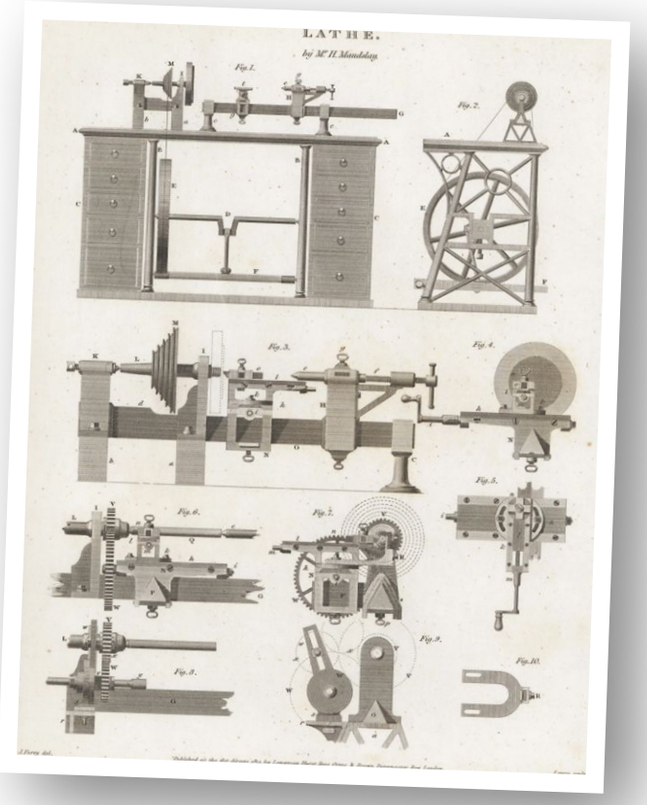
tools included a high-precision screw-cutting lathe capable of creating threads of standardised pitch and depth. It was a device that marked the first steps toward mass production of components and mechanical interchangeability, and is noted as a watershed in the history of industrialised machinery.

While working for Bramah, Maudslay upgraded the design of his employer's patented hydraulic press that was defective due to the fundamental malfunction of water leaking past the piston. As Gilbert explains: 'Maudslay again came to the rescue with his self-tightening leather collar.' Despite his apparent willingness to help Bramah out of a tight corner, when it came to protecting his own intellectual property, according to Smiles, Maudslay held a radically different attitude: 'although Mr. Maudslay was an unceasing inventor he troubled himself very little about patenting his inventions. He considered the superiority of his tools, and the excellence of his work were his surest protection.'

If Maudslay had been expecting gratitude or generosity from Bramah, he was soon to be disappointed. In 1793, following his marriage to Bramah's housekeeper Sarah Tindale, with eight years of loyal service under his belt and a rapidly growing family to feed, Maudslay petitioned his boss for an increase to his salary of 30 shillings per week. Gilbert confirms that 'Bramah curtly refused', presumably on the grounds that this was already a competitive compensation for a skilled worker in the metropolis. Maudslay responded by spinning on his heel and leaving Bramah to establish his own business, eventually settling in Lambeth on the south bank of the River Thames where he set about refining his screw-cutting lathe.

By the early 1800s, Maudslay had turned his attention to marine steam engines. Naval and commercial shipping were shifting from sail to steam power, and Maudslay's designs offered compact, reliable engines well suited for ships. He developed improved high-pressure engines and was a key supplier to the Royal Navy. One notable commission was the engine for *Victory*; a warship fitted with Maudslay's compact engine that demonstrated the viability of steam



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HENRY MAUDSLAY (1771-1831)

propulsion in military vessels. This would culminate in larger projects in the later part of his career, but his work in the 1810s and 1820s was all about building his reputation as a leading innovator in maritime engineering.

As Waller describes in *Iron Men*, one of Maudslay's most celebrated career highlights was his role in the development of automated block-making machinery for the British Royal Navy, a project begun in 1802 in collaboration with Marc Brunel (father of Isambard) and Samuel Bentham. The challenge was to mechanise the production of pulley blocks; essential wooden parts used in rigging sailing ships. Despite each Royal Navy ship requiring thousands of blocks in different sizes, production to date had been manual, time-consuming and inconsistent. Working from Brunel's designs, Maudslay built and refined over 40 machines for the Portsmouth Block Mills, delivering a complete system capable of producing up to 130,000 pulley blocks per year. Put into operation in 1808, it combined precision engineering, automation and interchangeable parts in a way that anticipated assembly-line manufacturing of the twentieth century. The machinery remained in use for over 100 years.

In 1810, Maudslay went into partnership with his assistant Joshua Field, to found Maudslay & Field, later reorganised as Maudslay, Sons and Field that would become famous for building the steam-powered mill used in the 1852 re-cutting of the Koh-i-Noor diamond. Their business rapidly grew to employ over 300 men by the 1820s with the firm taking on complex commissions for both government clients and commercial markets driven by Britain's global trade and military interests. With the limitations of sail increasingly evident, Royal Navy and commercial shipbuilders began investing in marine engines capable of long-distance, high-power operation. Although Maudsley would not live to see it in service, a notable application of the company's marine engine was the *Dee*, a Royal Navy steam ship launched in 1832, and one of the first warships equipped with a purpose-built steam engine. The factory also built engines for the *S.S. Great Western*'s Atlantic crossing of 1838.

In his final decade, Maudslay's focus shifted to ever more detailed levels of measurement and mechanical calibration, in the process becoming one of the first engineers to systematically integrate metrology into workshop practice. He developed surface plates; flat cast iron blocks used to check the flatness of machined components, and encouraged the use of standardised gauges. The advent of gauge blocks enabled his workers to verify the size of components without needing to rely on subjective judgment or manual fitting. These instruments were a landmark in engineering standards that paved the way for Maudslay's vision of engineering as a repeatable, scientific discipline rather than an artisan skill.

Maudslay died in 1831 on the cusp of massive industrial and socioeconomic change. He never got to see the full effect of his tools and methods on the expansion of railways, steamships or automated manufacturing lines. But along with the other great engineers who worked with him in Lambeth – Richard Roberts, David Napier, Joseph Clement, Joseph Whitworth, James Nasmyth and Joshua Field – he'd led the charge for excellence in engineering. As Smiles wrote of him: 'One of the things in which Mr. Maudslay took just pride was in the excellence of his work. In designing and executing it, his main object was to do it in the best possible style and finish.' THE ENGINEER

SEPTEMBER 1960

Streaks ahead

Seemingly doomed to failure, the Blue Streak rocket programme proved its worth in space

WRITTEN BY JASON FORD

Throughout the history of Britain's post-war defence projects it is often the most ambitious and eye catching that get the most attention, and this is particularly true of those that fail.

Examples include the TSR2 (Tactical Strike/Reconnaissance) aircraft that was cancelled 1965, the Blue Water shortrange ballistic missile for the British Army that was cancelled 1962, and the Fairey Delta 3, a proposed Mach2+ interceptor, that was cancelled in its early design stages. The list goes on.

Another seemingly notable failure was the Blue Streak missile program, the UK's 1950s project to develop an intermediate-range ballistic missile (IRBM) as part of its nuclear deterrent.

Powered by liquid-fuel engines developed by Rolls-Royce, it had a range of about 2,300 miles and was intended to be launched from hardened underground silos.

The Blue Streak missile program was officially cancelled in April 1960 but by September 1960, RAF Spadeadam - the intended UK test and launch site for the Blue Streak missile - was still in the construction phase for reasons that will become clear.

In that same month in early autumn, The Engineer filed a report on progress at Blue Streak's site in Cumbria, which was more formally referred to as the Spadeadam Rocket Establishment.

"Construction commenced in January 1957 and is still not complete; two facilities, however, are working: a component test area and an engine test area," said The Engineer. "There is also a missile test area in which there are under construction two test stands with mobile servicing towers, irresistibly evocative of those seen on launchers for ordinary missiles.

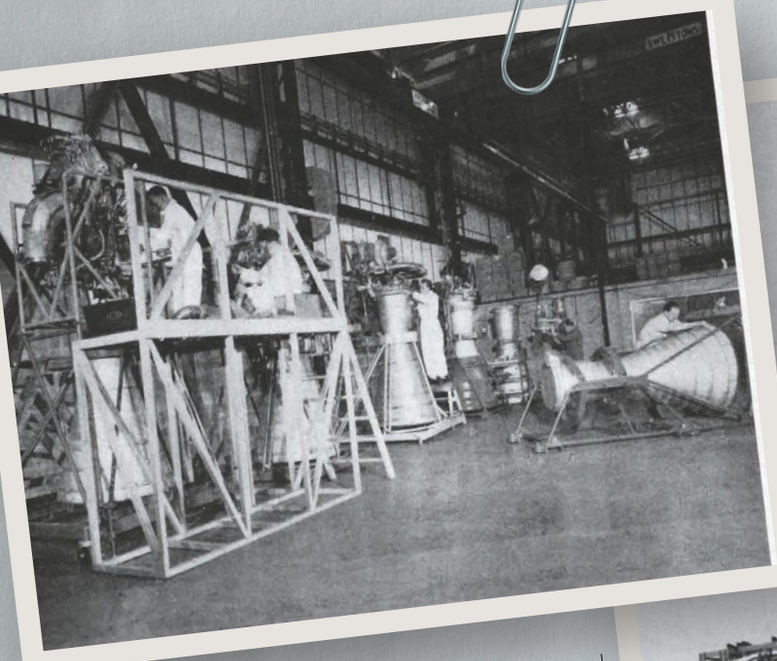
"The establishment exists to test liquid oxygen engines, and an air condensing and distilling plant has been installed by British Oxygen Engineering, Ltd; the oxygen consumption is too low to justify a tonnage oxygen plant, and a pair of reciprocating plants of 50 tons per day output each was built."

According to our report, the far end of the component test area housed a pair of stands for testing pump-turbine assemblies; one was equipped for pumps handling fuel and water only, but in the other fuel and liquid oxygen (lox) could be pumped and returned to the tanks in the upper storeys.

"The incomplete building...is also devoted to pump and gas generator development, and the fuel-rich exhaust of a generator can be seen burning in the air," said The Engineer. "The two tall stacks... carry the exhaust gases from a pair of R-R Avon RA-7 engines which have been installed with power take-off from the turbine, making available several thousand shaft horsepower for the testing of pumps; the power is fed into transmission dynamometers and must of course pass through speed-increasing gears before use in realistic pumps.

"In this area also is a facility considered to be unique and useful, a High Flow Water Test building in which pumps, valves, flowmeters, nozzles, etc, can be tested; three pumps make available flows up to 2000 gallons per minute at 950lb per square inch or 6000 gallons per minute at 300lb per square inch."

Our reporter noted that the engine test area had four stands, one of which was built 'merely to allow engines installed in a vehicle to be tested pending completion of



Images: l-Test chamber and r-Test stand

the missile test area'. The fourth stand, still incomplete at the time of the report, was expected to prove the cheapest as it was being built of prestressed concrete.

"The remaining two are, like the engines, closely based on North American practice, and the valves, solenoids, microswitches and other equipment on them are principally of United States origin," said The Engineer. "The stands are 250ft apart; to avoid the risk of the whole area being burnt out by failure of a missile under test, only one tank of a missile is filled at a time, the other propellant being pumped from the site storage tanks."

Our reporter continued: "The engine test stands proper have their own tanks installed. Each test stand has a flame deflector cooled by water injected in large quantities through holes in the impingement face; the water is in a closed circuit with a 1,000,000-gallon reservoir and, although the site is not merely isolated but enclosed, elaborate provisions are made to remove from the water dirt as well as unburnt fuel."

Not to be disappointed, a 'Blue Streak' could be seen in the engine test stand built to house it.

There are several reasons why the Blue Streak missile programme was cancelled, but it wasn't in fact a complete failure; the facilities under construction would eventually support the missile's transition into the civilian Europa space launcher program under the European Launcher Development Organisation (ELDO). Although Europa failed as an operational launcher, the experience - rooted in Blue Streak - laid the groundwork for the Ariane program in the late 1970s, which became Europe's longterm launcher family.

And what of the other projects mentioned earlier that were doomed to failure?

Much of TSR2's avionics, terrain following radar, and airframe research influenced later strike aircraft such as the Panavia Tornado, and Blue Water's missile guidance and solidfuel work informed later Polaris support infrastructure. Fairey Delta 3's influence was not so obvious, given that it wasn't built. However, its design work is said to have helped sustain Britain's supersonic research momentum, which influenced military (including the TSR-2) and civil highspeed aircraft in Europe. THE ENGINEER

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DR HILARY LEEVERS

Reasons to be cheerful

Engineering UK's CEO Dr Hilary Leevers on what the 2025 exam results reveal about the future workforce.

As students return to classrooms this September, the engineering and technology sector has much to reflect on, and cautiously celebrate, following the release of the 2025 exam results and university admissions data. Together they paint a promising picture of a generation increasingly drawn to engineering and technology careers and to studying the subjects on pathways into them.

STEM uptake signals momentum

STEM A levels offer a vital stepping stone into careers in engineering and technology, so I was really pleased to see that, while overall entries fell slightly, some key subjects have grown. This includes maths (+4.4%), physics (+4.3%), and further maths (+7.2%). Design and Technology (D&T) entries were broadly stable (+0.3), although unfortunately computing is down (-2.8%).

A similar broadly positive pattern was evident in Scottish Higher results – with increases in maths (+6.6%), physics (+6.1%), and computing science (+5.7%). Although design and manufacture was down (-3.2%).

Even more encouraging is the fact that the growth in physics was driven by a 7.9% increase in entries from young women. Although young men still made up almost three quarters of physics entries. Female participation in D&T and computing also rose—by 3.3% and 3.5% respectively. These figures matter. Women remain underrepresented in engineering and technology, making up just 16.9% of the workforce. While there's still much more to do to increase the uptake of STEM subjects among girls and young women, the results show things are moving in the right direction. Gender equity will remain a key area of focus for EngineeringUK – including through our Gender Pathways partnership.

T Levels take off

T Levels in engineering and technology, which are still in the early years of roll-out and growth, saw a dramatic 56.2% increase in entries. This takes the total up to 5,643 students. The proportion of female entrants rose from 9% to 12%, which is a modest but meaningful shift.

T Levels, which blend classroom learning with industry placements, are an important pathway into the sector. Students gain hands-on experience and real-world insight – meaning they are learning the most sought-after skills in today's job market. These qualifications also benefit employers who can engage early with future talent and build a diverse pipeline.

Industry and policy makers alike are keen to expand uptake of vocational and technical pathways into engineering and technology. So this year's results demonstrate another positive shift in the right direction.

University demand surges

University admissions data adds another layer of optimism. UCAS data released earlier in the year showed there had been a 14% uptick in *applications* for engineering and technology degrees. However, there were concerns as to whether universities would have the capacity to meet this increased demand. It's fantastic to see that they could – with accepted applicants for engineering and technology degrees rising by a similar 13%. This takes the total number of students from 26,680 in 2024 to 30,020 in 2025.

Industry takeaways

This surge in positive growth and a reducing gender gap suggests that collective outreach efforts to attract more young people into the sector from more diverse backgrounds are paying off. I think it also reflects a growing interest in engineering and technology and a recognition of their relevance to society and young people's futures — from climate change to digital transformation.

For employers, the message is clear: the pipeline is strengthening, but continued investment in quality STEM outreach, workforce diversity, and accessible pathways is essential. The sector must be ready to meet rising demand with inclusive opportunities and clear progression routes.

For the engineering and technology sector, the 2025 exam results and admissions data are more than just numbers. They're a sign of real progress. Let's keep the momentum going. THE ENGINEER

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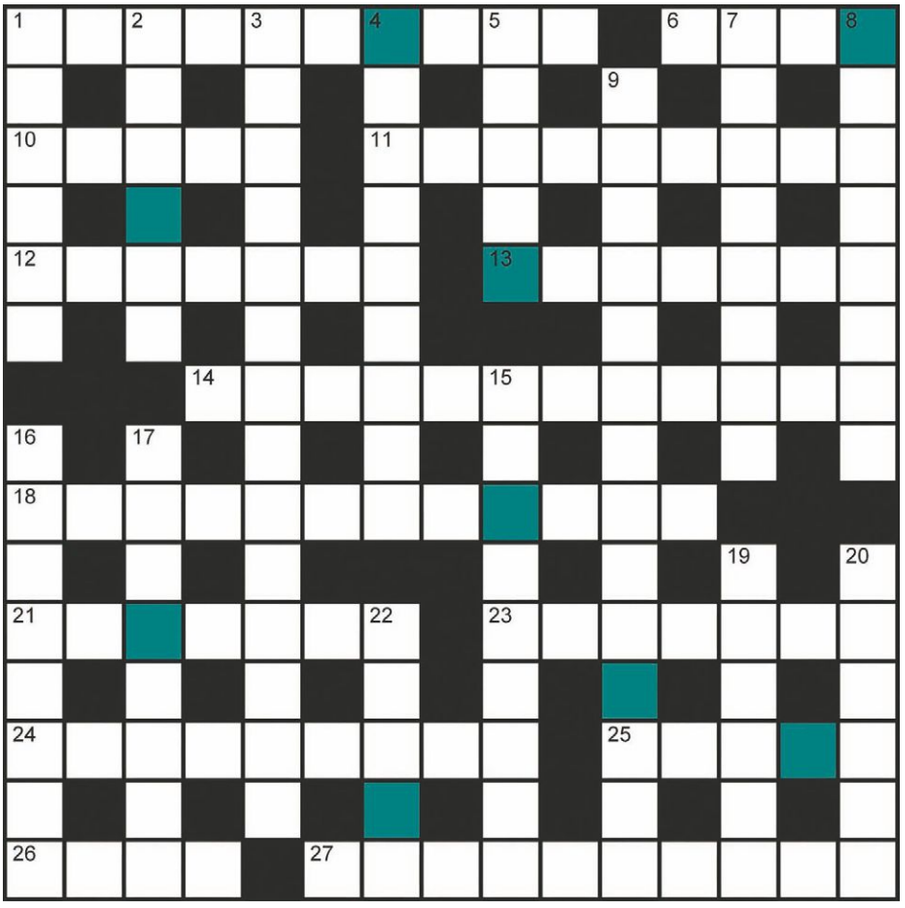

Across

1 An effort that is inconvenient (10)
6 Basic level of a subject taken in school (4)
10 Henry and Jane, the Hollywood stars (5)
11 Analog computer used for rapid calculations (5,4)
12 One who habitually doubts accepted beliefs (7)
13 Pouring in torrents (7)
14 Batteries (7,5)
18 Problem affecting the sight (3,9)
21 Vehicles that use road (7)
23 Remove with a cleaning agent (4,3)
24 Substance that readily transfers electricity or heat (9)
25 Sound of any kind (5)
26 Irregular mass (4)
27 An evaluation (10)

Down

1 To remove cause of tension (6)
2 Cone-shaped tube (6)
3 In constant change (2,1,5,2,4)
4 Not firmly fastened (9)
5 Coil or spin (5)
7 Vessel used for high temperature chemical reactions (8)
8 Cause to be alert (8)
9 Intersections of a railway and a road (5,9)
15 Deteriorates in health (4,5)
16 At right angles to the plane of the horizon (8)
17 Every year (3,5)
19 Dye used in medicine (6)
20 Influence adversely (6)
22 Summons to appear in court (5)

When completed rearrange the highlighted squares to spell out a solid solution of carbon in iron.
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Last issue's highlighted solution: ARMATURE.

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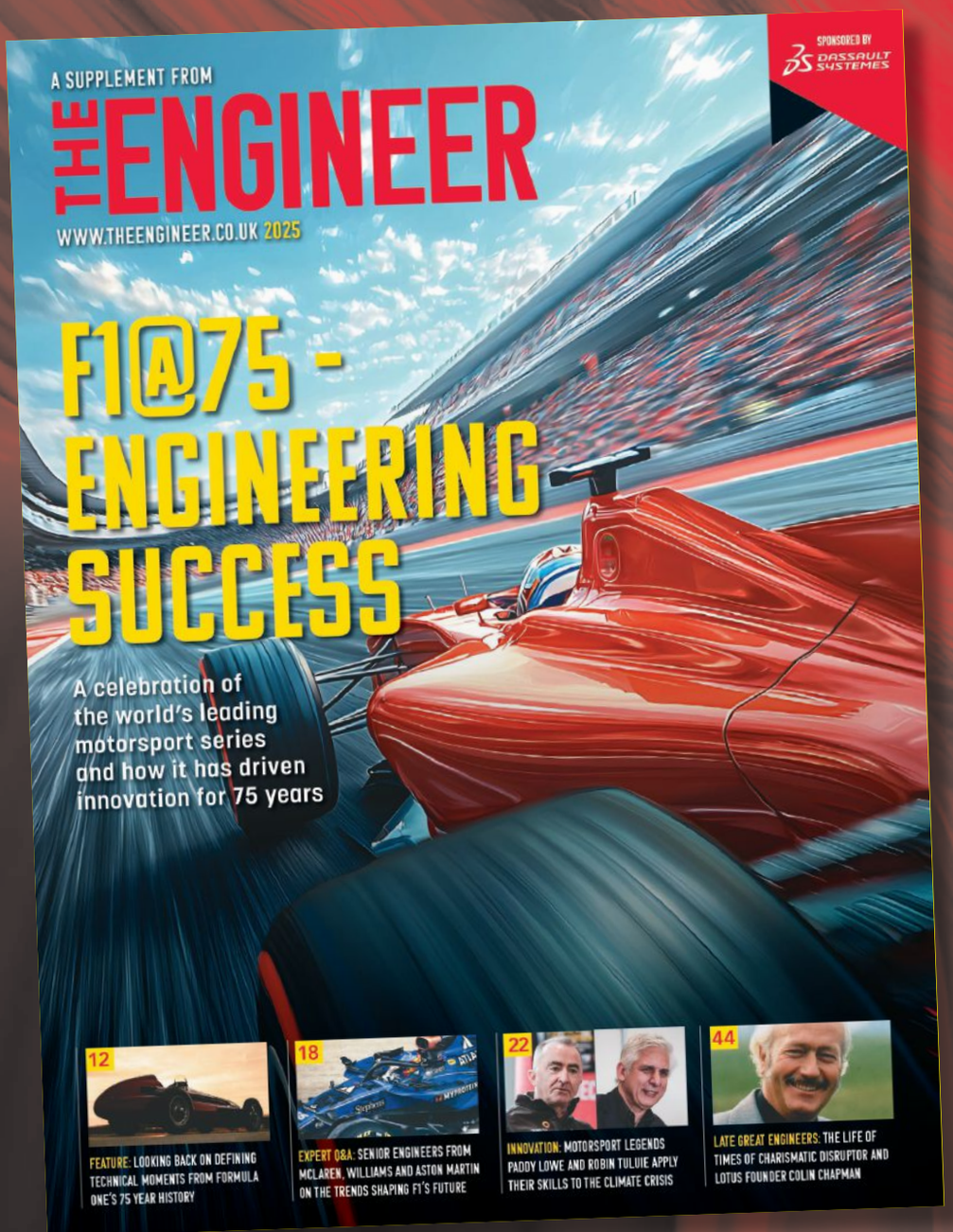

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