160 years of innovation
theengineer.co.uk
September 2018 | £3.70

the ENGINEER

FIRST FOR TECHNOLOGY & INNOVATION

En route to autonomy

Inside the UK's biggest driverless car trial

Aerial view

The technology behind the world's most advanced fighter pilot helmet

»29

Conservation game

Architect Kirstie Robbins on collaborating with engineers to keep the past alive

»32

Leader of the pack

Five years after its launch, the BMW i8 still looks like a glimpse of the future

»34

Advanced manufacturing

News, opinion and in-depth analysis of the latest manufacturing and production technologies

»47

FREE TRAINING on all XYZ CNC machine tools

LOW COST CNC MACHINING

XYZ 500 LR

18 HP SPINDLE
580 x 400 mm TABLE
510 x 400 x 450 mm TRAVEL
8000 RPM SPINDLE
(12000 RPM optional)
SOLID CASTING
2400 KG

XYZ 750 LR

18 HP SPINDLE
830 x 410 mm TABLE
750 x 440 x 500 mm TRAVEL
8000 RPM SPINDLE
(12000 RPM optional)
SOLID CASTING
3500 KG

XYZ 1000 LR

18 HP SPINDLE
1060 x 500 mm TABLE
1000 x 500 x 500 mm TRAVEL
8000 RPM SPINDLE
(12000 RPM optional)
SOLID CASTING
4600 KG

500 LR PACKAGE FROM ONLY £3.72* PER HOUR £128 A WEEK

The **XYZ *500 LR*** great value package includes:

- **Remote Handwheel**
- **18HP**
- **580 x 400mm Table**
- **510 x 400 x 450mm Travel**
- **BT40 Spindle 8000 RPM *(12,000RPM Optional)***
- **Automatic Tool Changer**
- **Siemens 828 Control**
- **Rigid Tapping**
- **Flood Coolant**
- **Work light**
- **Steel Concertina Guards all Axes**
- **Powder Coated Guarding**
- **Free Training**
- **Warranty**
- **Delivery and Siting**
- **Vice**
- **Clamp Kit**
- **Tool Setting Gauge**
- **1 off Face Mill Arbor**
- **4 off Side Lock Holders 6, 12, 20 & 25mm**
- **1 off ER32 Collet Chuck and set of Collets**
- **3 off ER 32 Collet Chucks**
- **2 off Keyless Chuck and Arbor**

Great value for money

"For many this will be an ideal opportunity to upgrade and modernise their workshops."

N Atherton

Nigel Atherton
XYZ MANAGING DIRECTOR

Price is with a £5000 + ALL VAT deposit and based on a 39 hour week, 46 week year. Subject to status.

The XYZ 2018 Machine Tool Range,

All XYZ CNC machine tools come with free training, full 12 month warranty,

XYZ Machine Tools

To learn more please call 01823 674200

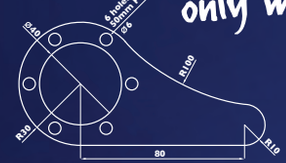
MACHINE TOOL DEMOS ARE AVAILABLE AT ANY OF THE XYZ UK

FROM ONLY
£99
A WEEK
+VAT SUBJECT TO STATUS

PROTO TRAK®
ON THE MILL OR THE LATHE

The ProtoTRAK® Mill can increase manual production up to 6 fold

drawing to component in only minutes



The ProtoTRAK® Lathe can increase manual production up to 15 fold

Call today to arrange a 30 minute ProtoTRAK desktop demo at your place.

XYZ UMC-5X

In its price bracket, this is at the forefront of five-axis simultaneous machining.

- **Siemens 840DSL ShopMill (iTNC 640 HSCI Heidenhain optional).**
- **Front loading 600mm diameter trunnion rotary table *90 rpm*.**
- **High accuracy rotary axis direct drive high torque motor *90 rpm no worm and wheel.***
- **Traori/Kinematic functions for 5 axis simultaneous.**
- **Comes with fully dedicated 5 axis XYZ Service, Training and Programming Help Line.**

**Price is with a 10% + ALL VAT deposit and based on a 39 hour week, 46 week year. Subject to status.*

DIRECT DRIVE HIGH TORQUE MOTOR
90 RPM
NO WORM OR WHEEL

FROM ONLY
£19.20*
PER HOUR

each one the very best in its class.

hp 3D printing has arrived

extended warranties, free programming helplines, nationwide service engineers.

sales@xyzmachinetools.com **www.xyzmachinetools.com**

SHOWROOMS DEVON BLACKBURN NUNEATON SHEFFIELD & LONDON

ALL IN UK STOCK NOW


SOLIDWORKS
IMAGINE OVER 100
EXPERT ENGINEERS
IN YOUR CORNER
Solid Solutions is the UK's most trusted reseller of SOLIDWORKS adding value and expertise to over 15,000 businesses nationwide.
With the largest number of Elite engineers in your corner saving you time and money, why wouldn't you switch to SOLIDWORKS?
Switch with Confidence to SOLIDWORKS
T: 01926 333 777
www.solidsolutions.co.uk/switch2solidworks
SOLIDSOLUTIONS
SUPPORTING EXCELLENCE

this**issue**

Volume 297
Issue No.7889
Established 1856

news

opinion

features

our**opinion**

From driverless cars to the internet of wings

For many road-users, the prospect of driverless cars becoming the norm remains a far-fetched and unwelcome prospect. Despite the hype around the technology, and the fact that it increasingly dominates the car industry's vision of the future, numerous surveys on the topic suggest that many members of the public are sceptical that it will happen and concerned about what might happen if it does. But not everyone fears the rise of the autonomous vehicle. As with all disruptive technologies, first-hand experience often dispels initial concerns. And as we report in this issue's cover story, two groups with a somewhat more enlightened view are the respective populations of Milton Keynes and Coventry, which are currently playing host to Autodrive, the UK's biggest trial of autonomous and connected vehicles. Set up to grow the UK's expertise in the field and explore how driverless cars can be integrated into society, Autodrive has helped keep the UK at the forefront of autonomous car development. As we report, the project has provided the UK's first real-world showcase of fully autonomous road vehicles; driven the development of a range of closer-to-market connected vehicle technologies; and played a critical matchmaking role, bringing together the range of different disciplines - from robotics to insurance – required to make driverless cars a reality.

> "Not everyone fears the rise of the autonomous vehicle"

Despite astonishing progress, there are still significant issues to overcome, not least developing the navigation systems and technology that will enable cars to operate autonomously beyond geographically constrained areas. But as one of those involved in the project tells us, the automotive sector is uniquely capable of driving the rapid technological change required to make autonomous vehicles a day-to-day reality sooner rather than later.

Elsewhere in the issue, we turn our attention to a sector arguably less comfortable with rapid change: the more conservative world of aerospace, which many believe stands on the cusp of an equally disruptive period of change. Visitors to this summer's Farnborough airshow saw numerous examples of this at work. The event even featured, for the first time, an aerospace 4.0 hall showcasing the ways in which a host of digital processes are changing the way the industry works.

And in this issue's Advanced Manufacturing section (p47-67), we look at some specific examples of this: from the way in which advanced new simulation techniques are helping to speed the sector's adoption of 3D printing (p56) to the development of robot bugs able to crawl inside a jet engine and perform vital maintenance tasks (p58). ■

Jon Excell Editor
jon.excell@centaurmedia.com

UK subscriptions £75 pa UK/£117 pa overseas. Order online at www.theengineer.co.uk/subscribe or by telephone on +44 (0207) 292 3705.

ISSN 0013-7758. Printed by Precision Colour Printing, Haldane, Halesfield 1, Telford, TF7 4QQ. **Visit www.theengineer.co.uk for constantly updated news, products and jobs and to sign up for our FREE weekly email newsletter and tailored job alerts**

the ENGINEER **Centaur Media Plc, 79 Wells Street, London, W1T 3QN**

Direct dial 020 7970 followed by extension listed Advertising fax 020 7970 4190 **Editor** Jon Excell (4437) jon.excell@centaurmedia.com **Features editor** Stuart Nathan (4125) stuart.nathan@centaurmedia.com **Senior reporter** Andrew Wade (4893) andrew.wade@centaurmedia.com **News editor** Jason Ford (4442) jason.ford@centaurmedia.com **Commercial director** Justyn Gidley (4942) justyn.gidley@centaurmedia.com **Recruitment advertisement manager** Michael Maunsell (020 7970 4679) michael.maunsell@centaurmedia.com **Business development manager** Paul Tilston (4487) **Account Manager** Lindsay Smith (4811) **Production** Wendy Goodbun (4807) te.production@centaurmedia.com, Gillian Maher, Tim Walker, Mark Westwood, Press Association **Publisher** Simon Lodge (4849) simon.lodge@centaurmedia.com **Subscriptions & Customer Services** tecirc@centaurmedia.com

The Engineer is available for International licensing and syndication. For more information please email simon.lodge@centaurmedia.com
NEWS 020 7970 4442 DISPLAY 020 7970 4487 RECRUITMENT 020 7970 4110 SUBSCRIPTIONS/CUSTOMER SERVICES HOTLINE 020 7292 3705

CENTAUR MEDIA

MEDICAL

Surgical robots aim to end need to go under the knife

New generation of miniaturised ultrasonic devices seek to go deeper into the body to perform complex procedures HELEN KNIGHT REPORTS

Going under the knife could one day become a thing of the past, thanks to the development of robotic surgical tools that might ultimately carry out even complex procedures using ultrasound.

Ultrasonic devices are already used to perform some forms of surgery, but design restrictions mean they are limited to procedures where access to the operating site is through a simple, direct route.

However, accessing many points in the human body requires the surgical device to take a complicated path, limiting the use of minimally invasive ultrasonic tools.

Now a team of UK researchers, funded by EPSRC, are developing a new generation of miniaturised ultrasonic devices that, when integrated with flexible, tentacle-like surgical robots, will be capable of performing procedures deep inside the human body.

The ultrasonic tools could allow minimally invasive surgery to be carried out with higher precision and much lower force, while protecting delicate structures, according to project leader Prof Margaret Lucas at Glasgow University.

"If you are trying to penetrate bone, for instance, [with traditional surgical tools] it requires quite a large force, whereas with ultrasonics it requires almost no force," said Lucas.

"Ultrasonics can also be tissue-selective, so if you have the surgical tip operating at the right frequency and vibration amplitude, it will cut through one material, but will stop when it hits another type of material," she said.

The technology could allow more procedures to be carried out on an outpatient basis. To develop the tools, the researchers are investigating ways to overcome some of the existing constraints of ultrasonic surgical tools.

Crucially, existing surgical tips must be in resonance with the transducer that is producing the vibration, which limits how small the devices can be built, said Lucas.

"Once you decide what frequency you will be operating at, that determines what the size of the transducer has to be, and it also dictates to some extent what size your surgical tip has to be, and that can be a big restriction," she said.

So, for example, existing ultrasonic surgical devices often tend to be long and straight, restricting the types of procedures that they can be used for.

Instead, the team has been investigating ways to adapt a type of transducer known as a flextensional transducer, more commonly used for underwater sonar applications, for use in surgery.

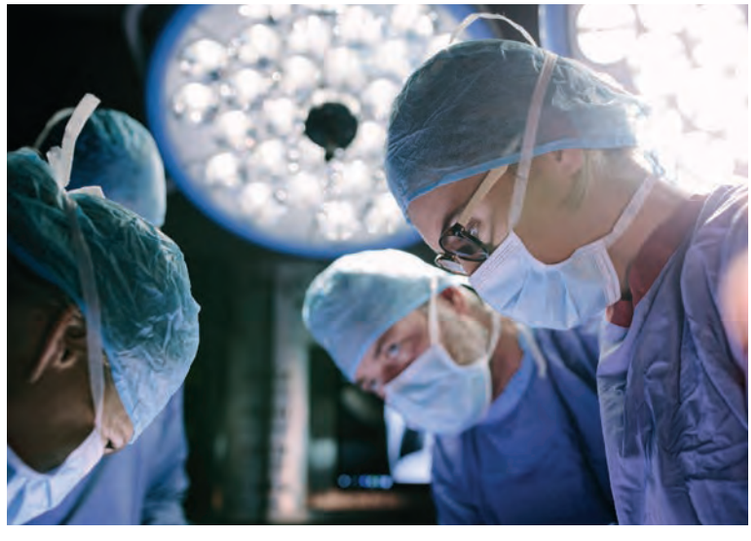
Flextensional transducers can produce enough vibration that the surgical tip does not need to be in resonance with it, allowing the device to be miniaturised. It could then be attached to a flexible, tentacle-like robot, to allow it to reach any part of the body.

"So you would have a tentacle-like robot with an ultrasonic surgical device on the end of it, and you could bring that into the human body along quite tortuous pathways to the site of surgery, and then the ultrasonic device would be activated to perform the surgical procedure," said Lucas.

The devices will be tailored to deliver the exact amount of ultrasonic energy to the precise location required for the surgery.

To this end, the researchers will also be investigating the effects of ultrasound on tissue, at and around the site of surgery, using ultra-high-speed imaging techniques.

By better understanding the biological impact of ultrasound on tissue, they hope to be able to optimise the design of the ultrasonic devices. The project includes researchers from Southampton, Edinburgh, Leeds and Birmingham universities, plus the NHS, Shanghai Institute of Ceramics, and medical technology companies including Stryker, Active Needle Technology and Intuitive Surgical. ■



Readmoreonline

Aerospace
ASTERIA CubeSat becomes first to observe an exoplanet

Automotive
Low-carbon automotive projects receive £35m of UK government funding

Civil & Structural
Lidar looks inside fires to help measure structural collapse

Defence & Security
Powering tomorrow's bomb disposal robots

Electronics & Communications
Nanocomposite coatings turn fabrics into pressure sensors

Energy & Environment
What price palm oil?

Medical & Healthcare
'Tricking' amputees into accepting their prosthetic

Manufacturing
Manufacturers challenged to rethink plastic food packaging

Policy & Business
UK urged to make more of its IP

Process
Treatment system selectively removes toxins from water

Skills & Careers
The new normal: perceptions are key to women's participation in STEM

DUGARD **Lathes**

Exclusive UK dealer of

Hanwha

one of Korea's largest corporations

A new alternative for sliding head lathes

With over 50 years in the machinery business, Hanwha invest heavily in their technological development and innovation programmes allowing them to offer superb quality CNC lathes featuring:

- State of the art technology
- Fanuc or Siemens controls
- 7 ~ 42mm bar capacity
- Removable guide bush
- Affordable quality

Hanwha lathes are just part of our huge range of vertical and horizontal machining centres, lathes and borers. Make a date to come and view the range at our open house, 17 & 18 October, at our Hove showroom

DUGARD
Open House
17 & 18 October

CHEVALIER. Hanwha KIWA Japan MATEC GmbH SMEC MACHINE TOOLS VARNSDORF TOS YOU JI

DUGARD www.dugard.com | sales@dugard.com | 01273 732286

ENERGY

Turning buildings into batteries

Cement that stores electrical energy HELEN KNIGHT REPORTS

A smart cement mixture that can store electrical energy and discharge it on demand could convert buildings, bridges, kerb stones and even street lamps into batteries.

Researchers at Lancaster University have developed a cement mixture, consisting of the waste material fly ash and an alkaline solution, which is capable of conducting electricity. Unlike existing smart concretes, which are typically based on graphene and carbon nanotubes, the mixture does not contain expensive materials, and is cheaper to produce than conventional Portland cement.

In the mixture, known as a potassium-geopolymeric (KGP) composite, electricity is conducted via potassium ions that hop through the crystalline structure, according to project leader Prof Mohamed Saafi.

"To make cement you have to mix the fly ash with an alkaline solution, in this case we use potassium hydroxide and potassium silicate," he said. "When you mix them together they form a cement material, containing potassium ions that act as the electrolyte." The mixture could ultimately store and discharge between 200 to 500W/m^2. A house constructed with exterior or partition walls made with KGP, for example, could store electricity from solar panels during the day, and discharge it at night. Panels built from KGP could also be retrofitted on to homes and other buildings.

A 6m-tall lamppost built from KGP would be capable of storing enough renewable energy to power itself through the evening – typically around 700W. Meanwhile, kerb stones could provide power to sensors capable of monitoring traffic, drainage and pollution levels.

Large numbers of KGP-built structures could also be used to balance the grid, storing excess renewable energy and releasing it when demand is high.

"We're trying to turn buildings and bridges into batteries to reduce the cost of energy," said Saafi. "At the moment, we have a lot of renewable energy sources, but we don't have a large-scale storage system."

The researchers are now carrying out further work to optimise the performance of the KGP mixtures, and investigating the use of 3D printing to create different shapes.

The research, funded by the European Commission's Horizon 2020 programme, will be published in the journal *Composite Structures* in October. ■

C2I 2018

Celebrating innovation

2018 awards finalists announced JON EXCELL REPORTS

The finalists for *The Engineer*'s 2018 Collaborate to Innovate Awards (C2I) have now been announced.

This year's awards, spanning eight categories – including aerospace, automotive, manufacturing technology and healthcare – have attracted a record number of entries from a truly world-leading set of collaborative engineering projects.

Shortlisted entries range from life-changing applications of healthcare monitoring technology, to pan-industry autonomous vehicle research projects and real-life industrial applications of paradigm-shifting industry 4.0 technology. Readers can view the full shortlist at: http://conferences.theengineer.co.uk

The winners will be revealed at a party in London on November 6, and *The Engineer* will be reporting in detail on these projects in the days and weeks following the event.

Now in its third year, C2I uncovers great examples of engineering collaboration – which is considered critical to solving many of the challenges faced by society. It celebrates collaborative innovations in a series of broad vertical sectors and features two categories focused on education and engagement: Academic Innovator (for a university department that demonstrates excellence in innovation and collaboration across multiple projects); and Young Innovator, which celebrates initiatives aimed at educating and inspiring young people about the role of engineers.

Previous winners include: the QE aircraft carrier; the EPSRC Centre for Innovative Manufacturing in Medical Devices; and SmashFest UK – an initiative aimed at inspiring young people from deprived communities to consider a career in engineering.

The competition is judged by leading figures in UK engineering and supported by organisations such as EPSRC, Engineering UK, Frazer-Nash Consultancy and Babcock International Group. ■

Newsinbrief

Hypersonic weapon deal

Lockheed Martin has been awarded $480m (£369m) to start work on a prototype hypersonic weapon. The contract from the US Air Force follows a $928m (£713m) contract awarded in April to develop an air-launched Hypersonic Conventional Strike Weapon (HCSW). The latest contract will see Lockheed providing "the critical design review, test and production readiness support" for an Air-Launched Rapid Response Weapon (ARRW).

Bendable breakthrough

A contact-printing system that embeds silicon nanowires into flexible surfaces could lead to new forms of bendable electronics. Engineers from Glasgow University fabricated high-mobility semiconductor nanowires on to flexible surfaces to develop what are claimed to be high-performance ultra-thin electronic layers. Those surfaces could be utilised in video screens, health monitoring devices, implantable devices and synthetic skin for prosthetics.

Lithium-ion cell boost

A new rechargeable battery technology could double the output of current lithium-ion cells, extending electric vehicle ranges and the time between mobile phone charges. Using a ceramic, solid-state electrolyte, University of Michigan engineers harnessed the power of lithium metal batteries without the historic issues of poor durability and short-circuiting.

WiFi bomb detection

US engineers have developed a system that uses WiFi signals to passively screen bags for weapons, chemicals and bombs. Led by Rutgers University, the study describes how fine-grained channel state information (CSI) from WiFi is used to detect what material an object in a bag is made of and then calculate the dimensions of the item.

The revolution is underway. Will you emerge a winner?

Machine Learning, Virtual Reality, and 3D and 4D printing are pushing the limits of design.

As in any revolution, there will be winners and losers. Those who embrace emerging technologies will steer your industry into a new era. Will you take advantage? We'll be by your side, constantly innovating to give you the powerful tools you need to lead the way.

Find out more about the powerful computing technology allowing you to drive the revolution at hp.com/uk/designrevolution

HP Z2 Mini, the world's first mini workstation

SPACE

Water discovered 1.5km beneath surface of Mars

ESA uses advanced MARSIS radar system to map wide body of liquid underneath layers of ice and dust

STUART NATHAN REPORTS

An instrument on board ESA's Mars Express orbiter spacecraft has detected a wide body of water 1.5km below solid ice and dust near the south pole of Mars.

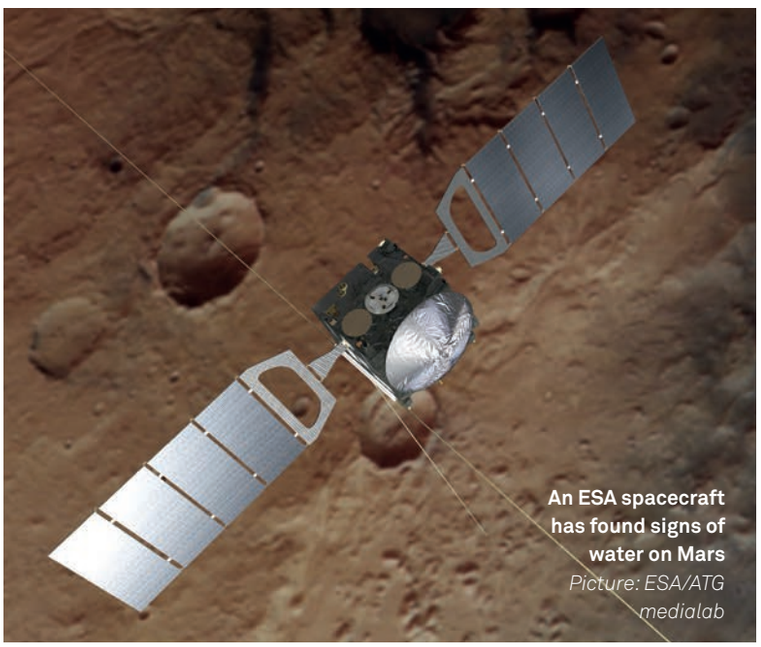
The planet is scarred with remains of river valleys and channels where water flowed, but changes in its climate mean that it cannot exist today in any persistent form.

An onboard instrument called MARSIS (Mars Advanced Radar for Subsurface and Ionosphere Sounding) uses ground-penetrating radar to map Mars's subsurface topography. It sends radar pulses towards the surface and times their reflection. It then analyses the reduction in the strength of the returning signal, giving clues on the composition of the material through which the radar pulse travelled before being reflected. The discovery was made during an investigation of a 200km-wide area composed of alternating layers of ice and dust.

Of particular interest was a bright radar reflection underneath deposits within a 20km-wide zone. A bright reflection indicates that something below the surface is reflecting light more strongly than the surface itself, and to specialists that is strong evidence of the presence of water. The signal was coming from a depth of 1.5km, and originated from a deposit tens of centimetres deep.

Scientists suspect that water existed below ice on Mars as it exists under similar conditions on Earth. The weight of a glacier increases pressure at its base, which depresses water's melting point. The presence of water-soluble salts on Mars is proven, further reducing the melting point. The ESA team interpreted the MARSIS signal as a body of water that might be saturated with salts dissolved from sediments. In a paper in *Science*, they explained they had previously seen evidence of these features.

"We'd seen hints of interesting subsurface features for years but we couldn't reproduce the result from orbit to orbit, because the sampling rates and resolution of our data were previously too low," said Andrea Cicchetti, MARSIS operations manager. "We had to come up with a new operating mode to bypass some onboard processing and trigger a higher sampling rate, and thus improve the resolution of the footprint of our dataset: now we see things that simply were not possible before." ■



An ESA spacecraft has found signs of water on Mars
Picture: ESA/ATG medialab

MEDICAL

AI used to detect 50 eye diseases

Moorfields cutting delays with deep learning

DeepMind Health, working in collaboration with Moorfields Eye Hospital, has used artificial intelligence to analyse and detect a range of eye diseases.

The research applied deep learning techniques to thousands of historical anonymised retinal scans. Following this training, the AI system recommended the correct referral decision for over 50 eye diseases with 94 per cent accuracy. "The number of eye scans we're performing is growing at a pace much faster than human experts are able to interpret," said Dr Pearse Keane, consultant ophthalmologist at Moorfields Eye Hospital NHS Foundation Trust. "There is a risk that this may cause delays in the diagnosis and treatment of sight-threatening diseases, which can be devastating for patients.

"The AI technology we're developing is designed to prioritise patients who need to be seen and treated urgently... If we can diagnose and treat eye conditions early, it gives us the best chance of saving people's sight." **AW**

SECURITY

Scanner seeks to speed up airport checks

Removing liquids and laptops may be thing of the past, says Smiths

JASON FORD REPORTS

Travellers may soon be able to pass through airport security without removing laptops and liquids from their cabin baggage thanks to a computed tomography checkpoint scanner developed by Smiths Detection.

Unlike conventional X-ray scanners, which create a 2D view from fixed generators and detectors, the CT gantry inside the HI-SCAN 6040 CTiX rotates at a constant speed as the baggage is carried through it on a conveyor belt.

"It spins around the object taking hundreds of views at slightly different angles and then reconstructs the raw scan data into volumetric 3D images," said Kevin Riordan, head of airports and checkpoint solutions at Smiths Detection. "The comprehensive data collected is used to make more precise measurements and very accurate judgments on substances within the bag.

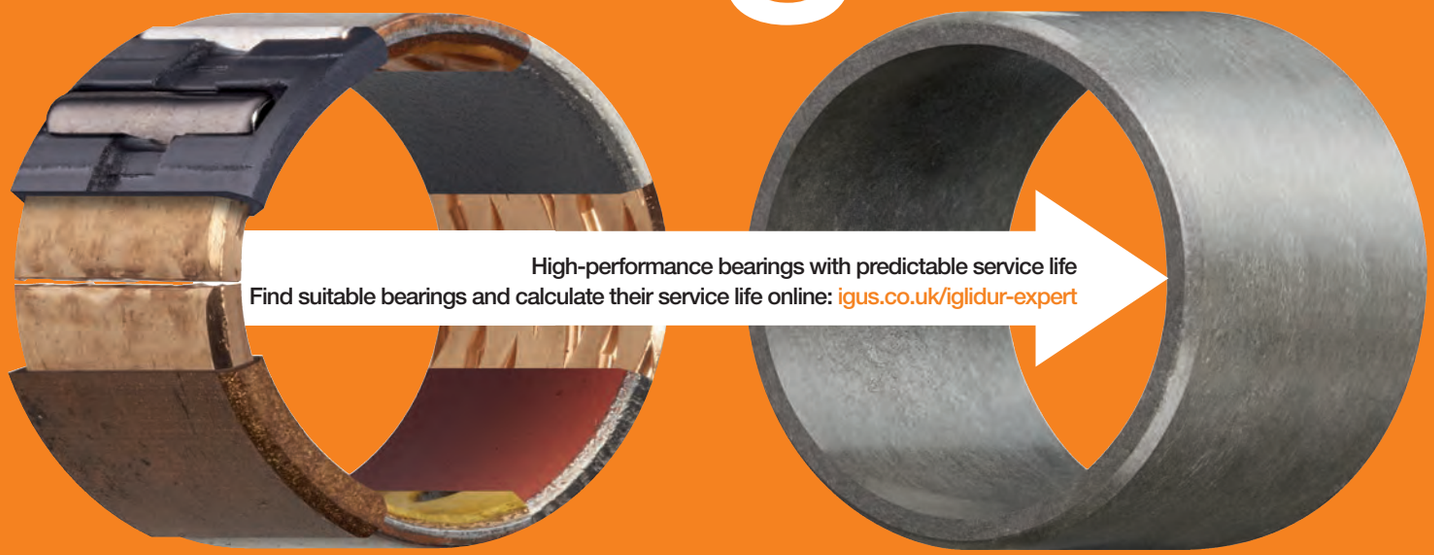
"Subject to regulatory approval, this enhanced technology enables security to scan electronic equipment and liquids without needing to remove these items."

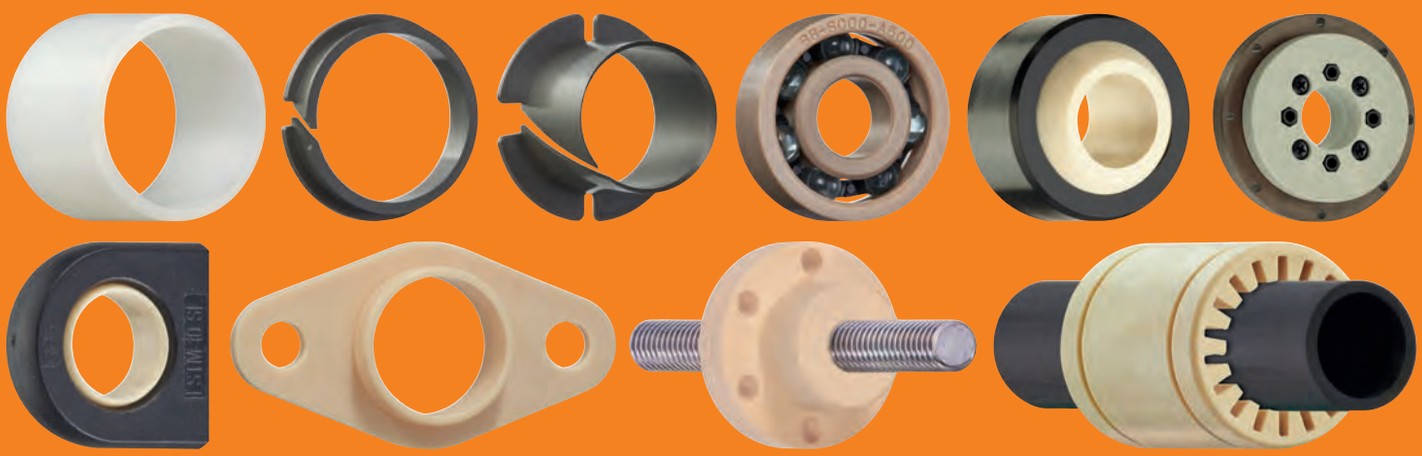
So far, the CTiX has gained European Civil Aviation Conference Explosive Detection System CB C2 approval, and testing for C3 is now under way. The technology has also managed to achieve Transportation Security Laboratory Advanced Technology Tier II certification from the US Transportation Security Administration.

First field tests of CTiX are under way in Europe and the US. ■

igus® dry-tech® ... lubrication-free bearings made easy

Change your bearing now





and save 40%

Whether bronze or sintered bearings, coated metal bushings or needle roller bearings: Reduce costs and improve machine performance with iglidur® polymer bearings. Lubrication-free, lightweight and wear-resistant for your moving application. Find out all you need to know about replacement of your bearings: igus.co.uk/change-bearing

igus® Caswell Road Northampton NN4 7PW
Tel 01604 677240 sales@igus.co.uk
plastics for longer life®

igus®.co.uk

MEDICAL

Surgery simulation tool 'cheaper than buying a cadaver'

Technology combines VR and haptics to mimic feel of human tissue

ANDREW WADE REPORTS

London start-up FundamentalVR claims its surgery simulation technology, which merges VR with haptics, can be acquired for less than the cost of a cadaver. FundamentalVR's Surgical Haptic Intelligence Engine (SHIE) is designed to mimic the feel of operating on various types of human tissue, from subcutaneous fat to muscle and bone.

Combined with off-the-shelf VR devices and standard haptic hardware, the platform can act as an immersive training tool for surgeons in waiting. Already available in the UK, the platform has now launched in the US, where the initial rollout will feature packages for orthopaedic surgery, including spinal pedicle screw placement, posterior hip replacement and knee arthroplasty.

"It involves creating 'haptic actions', which define the interactions between the surgical tools and the patient's virtual anatomy," said Richard Vincent, CEO of FundamentalVR. "To do this, we create haptic baselines through close consultation with our global medical panel, senior clinicians, comprising a range of surgical specialisms, and then, with our... calibration tools we are able to refine these through the development process to achieve the appropriate interaction. This requires a deep understanding of tissue behaviour under various conditions aligned with deep physics and mathematical computation."

Surgeon training is largely confined to classroom lessons and viewing cadaver-based teaching, with limited hands-on time with cadavers. According to FundamentalVR, a single cadaver can cost more than £10,000 and can only be used to train between four and six students. While haptic surgery simulation solutions do exist, these can cost in the region of £80,000, and fewer than 0.5 per cent of the world's surgeons have access to them. In the US, the company is pitching an entry point of $350 (£270) a month for its Software as a Service simulation platform.

"Our mission is to democratise surgical training by placing safe, affordable and authentic simulations within arm's reach of every surgeon in the world," said Vincent.

FundamentalVR says its software is future-proofed, designed to work in tandem with new developments in haptics. "We are, in effect, building a hardware agnostic haptic map of the human body, which, as other hardware solutions such as haptic gloves become economically viable for wide-scale medical use, we will be able to port directly into," said Vincent. ■

FundamentalVR's SHIE platform acts as an immersive training tool

MATERIALS

Energy-storing 3D-printed materials mimic eagle's grip

Auxetics act like talons latching on to prey

Scientists at Queen Mary University of London and the University of Cambridge have used 3D printing to create materials that store energy like eagles' talons as they grip prey.

Known as auxetics, the materials collapse in on themselves when compressed, rather than bulging outwards, allowing energy to be stored within the structures. Auxetics have recently been adopted for lightweight armour, the material collapsing upon impact from a bullet and absorbing the kinetic energy. But while the auxetics used for armour tend to have sharp corners that can fracture over multiple impacts, this new category has smoothed curves that allow multiple reuses and deformations. Similar to an eagle's claws, the material 'locks' the energy into place and maintains it with minimal effort.

"The exciting future of new material designs is that they can start replacing devices and robots," said Queen Mary's Dr Stoyan Smoukov, principal investigator of the study. "All the smart functionality is embedded in the material." AW

MEDICAL

Magnetic gel to reduce pain

Technique could revolutionise treatment

STUART NATHAN REPORTS

Researchers at the University California, Los Angeles are investigating a technique that uses magnetic fields to manipulate the microscopic activity of the human body and potentially reduce pain.

Bioengineers led by Prof Dino Di Carlo developed a gel-like material containing microscopic magnetic particles that can be injected into a site where a patient is experiencing pain. They used these particles to control proteins in cell membranes that, in turn, control the flow of ions involved in mediating and transmitting the sensations of pain.

Andy Kah Ping Tay, the lead author of the study, published in *Advanced Materials*, said the technique exploited neural network homeostasis, which describes returning a biological system to a stable state. This, he said, could lead to new therapeutic pain relief.

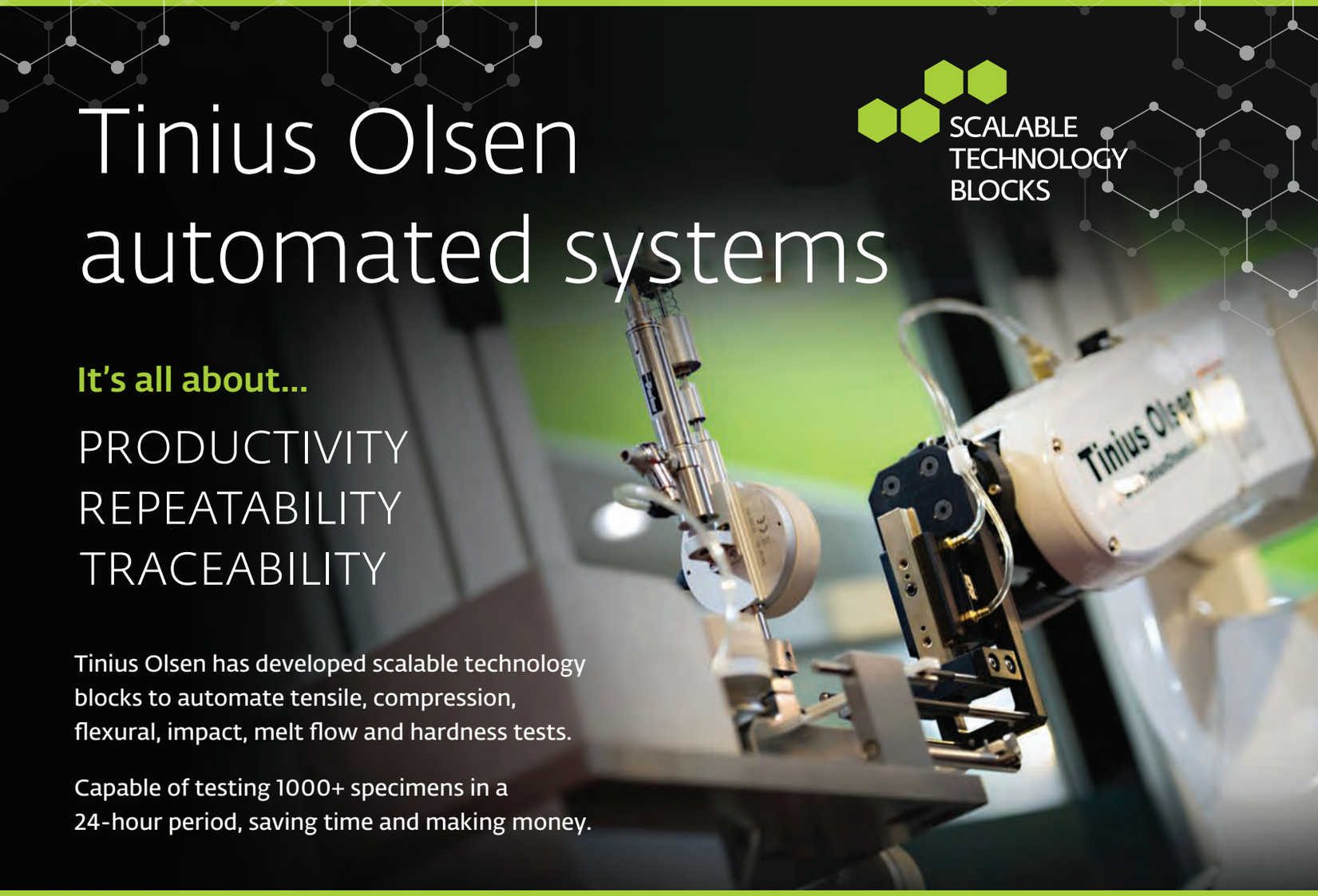
The magnetised gel is based on hyaluronic acid, a polymer that provides structural support in the spinal cord and the brain, and which is increasingly used in moisturising cosmetics. The team mixed magnetic microparticles into the gel, and then used it as a culture medium to grow a type of primary nerve cell – dorsal root ganglion neurons – through the gel mixture.

In laboratory tests in vitro, they used magnetic fields to manipulate the microparticles and found that the forces induced were associated with an increase of calcium ions in the neurons, indicating that the cells were responding to the mechanical forces. By increasing the force steadily and observing the calcium level, they deduced that the neurons were adapting to the continuous stimulation by reducing the signals for pain. ■

Tinius Olsen

Tinius Olsen automated systems

SCALABLE TECHNOLOGY BLOCKS



It's all about...

PRODUCTIVITY
REPEATABILITY
TRACEABILITY

Tinius Olsen has developed scalable technology blocks to automate tensile, compression, flexural, impact, melt flow and hardness tests.

Capable of testing 1000+ specimens in a 24-hour period, saving time and making money.

Scalable technology blocks

Tinius Olsen is excited to introduce the next evolution in materials testing – scalable automation.

At Tinius Olsen we have taken a fresh look at how our customers use materials testing machines and software to meet their specific needs in today's commericial environment.

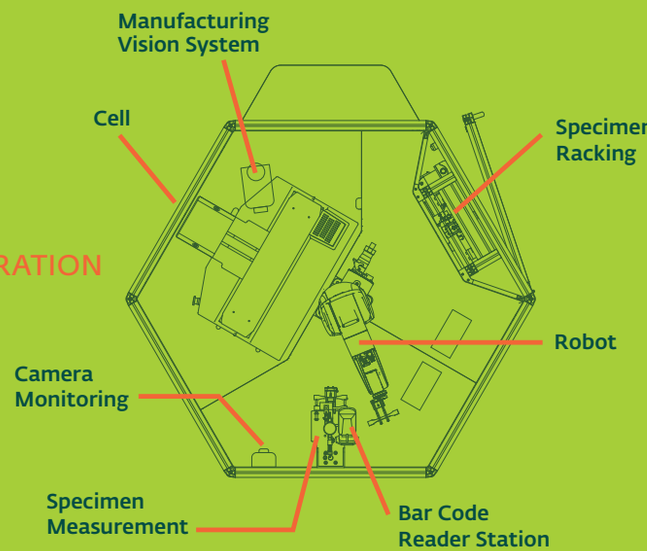
Accuracy, resolution, data rates, control, precise adherence to test standards, calibration, measurement of uncertainty and traceability are all essential parameters tuned to the highest standards and capabilities in Tinius Olsen testing machines and software.

The next workplace evolution is to ensure this technology is used as efficiently as possible in your test lab and in the control of your materials' product quality and performance. It's about providing a financially quantified step gain in productivity using Tinius Olsen technology.

To achieve this we have developed scalable technology blocks to automate tensile, compression, flexural, impact, melt flow and hardness tests. Our systems can deal with low milli-Newton forces to high thousands of kNs and process from 30 to 1250 tests a day.

Tinius Olsen can provide an affordable solution to deliver the step change in productivity and profitabilty your business needs.

CONFIGURATION EXAMPLE



www.tiniusolsen.com
sales@tiniusolsen.co.uk
01737 765001

ELECTRONICS

Flexible power for wearable devices

Graphene foam combined with solar cell in bendable supercapacitor

STUART NATHAN REPORTS

A Glasgow University team has developed medical sensors powered by a porous foam of graphene and silver, an advance with potential applications for wearable devices.

The Glasgow team used a commercially available graphene foam to make a layered structure with a silver-containing epoxy resin to form supercapacitors capable of storing three times as much power as any similar flexible supercapacitor, they claim.

In a paper in *Nano Energy*, the team from Glasgow's bendable electronics and sensing technologies (Best) group, led by Prof Ravinder Dahiya, said that lithium-ion batteries, which are inflexible and heavy, may not be suitable for wearable devices.

> "The underlying technology has a great deal of additional potential"

Supercapacitors, which charge and discharge quickly and can be made from more environmentally friendly materials, may be a more promising option, the team said.

Dahiya's team is exploring the emerging technology of hybrid supercapacitor batteries. These are more stable than traditional supercapacitors, they said, and capable of operating more than a million charge-discharge cycles without loss of performance.

Their device comprises several layers: a layer made up from 300 individual layers of highly conductive graphene sheet as a current collector, onto which a layer of silver epoxy was bonded, with graphene foam on top of that. A phosphoric acid electrolyte was dropped onto the foam and a polyester/cellulose sheet was bonded on top of that as an ion permeable membrane. This whole assembly was connected to a commercially available photovoltaic cell. The team also demonstrated that the capacitor could be charged by a flexible, solar-powered skin developed by the same group.

The team connected the power pack to a sensor designed to detect sweat pH to test the system, and obtained highly promising results. "We're very pleased by the progress this new form of solar-powered supercapacitor represents," Dahiya said. "A flexible, wearable health-monitoring system, which only requires exposure to sunlight to charge, has a lot of obvious commercial appeal, but the underlying technology has a great deal of additional potential.

"This research could take the wearable systems for health monitoring to remote parts of the world where solar power is often the most reliable source of energy, and it could increase the efficiency of hybrid electric vehicles." ■

The supercapacitor

DEFENCE

US Army moves forward with 100kW laser weapon system

$10m contract for new phase of programme

Dynetics and Lockheed Martin have been awarded $10m (£7.7m) for the next phase of development in the US Army's 100kW-class laser weapon system.

The 100kW weapon is being developed for the army's Family of Medium Tactical Vehicles (FMTV) and incorporates a ruggedised design and subsystems for battlefield conditions. The next phase of the programme will build towards a preliminary design review of the of the High Energy Laser Tactical Vehicle Demonstrator (HEL TVD) in January 2019.

"Hostile unmanned aerial systems and rockets, artillery and mortars present an increasing threat," said Iain McKinnie, business development lead for advanced laser solutions and strategy, Lockheed Martin. "Laser weapons offer a deep magazine and very low cost per shot, making them ideally suited to complement existing kinetic energy weapons.

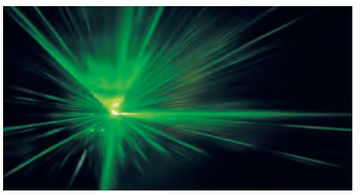
"The army's HEL TVD programme is a critical step toward realising this potential, culminating in 2022 testing of a mobile 100kW-class laser weapon system fully integrated with an army FMTV truck." AW ■

MATERIALS

Breakthrough in laser light

Engineers create 'best of both worlds' material

STUART NATHAN REPORTS



Researchers at the University of California, San Diego, have combined alumina crystals with neodymium ions to produce a material that delivers very short, high-power pulses of laser light.

Neodymium and alumina are common materials in solid-state lasers. The former is used to make high-power lasers; the latter makes lasers that emit short pulses of light and can withstand rapid changes of temperature and high heat loads. However, alumina can only host small ions, and neodymium is large.

Traditionally, alumina is doped – treated to disperse foreign ions within its structure – by melting two materials together and cooling them slowly so that the mixture crystallises. But if a molten mixture of alumina and neodymium is cooled too slowly, the neodymium crashes out of the solution.

Elias Penilla, the first author of the team's paper in *Light: Science & Applications*, devised a method based on speeding up the heating and cooling steps fast enough to prevent neodymium ions escaping.

The process places a mixture of alumina and neodymium powders under high pressure, heating them 300°C per minute until the mixture reaches 1,260°C, which forces neodymium ions into the alumina matrix, creating a solid solution. The solution is held at 1,260°C for five minutes and then cooled at 300°C per minute.

After characterising the structure of the combined crystal, the team, led by mechanical engineer Javier Garay, optically pumped the crystal with infrared light at a wavelength of 806nm and found that the crystal produced laser light at 1064nm. ■

PNY®

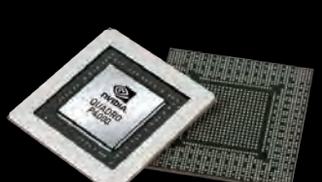
Professional Solutions

NVIDIA Quadro® / NVIDIA Tesla® / NVIDIA Grid® / Servers

PNY PREVAILPRO MOBILE WORKSTATION

Pro Performance. Anytime. Anywhere.

NVIDIA Quadro P4000 Mobile GPU | 1792 CUDA Cores | 8GB GDDR5
NVIDIA Quadro P3000 Mobile GPU | 1280 CUDA Cores | 6GB GDDR5



Certified by Independent Software Vendors:

AUTODESK

AUTODESK® 3DS MAX® | AUTODESK® INVENTOR®
AUTODESK® AUTOCAD® | AUTODESK® MAYA®

Adobe

Ai Illustrator | Pr Premiere Pro
Ae After Effects | Ps PhotoShop

DASSAULT SYSTEMES | SIEMENS

SOLIDWORKS | SOLID EDGE

Ultra Light: 2.18 kg

Ultra Thin: 0.73" / 1.85 cm

4K ULTRAHD Available in FHD or UHD

MAX-Q DESIGN

NVIDIA VRREADY

POWERED BY NVIDIA QUADRO®

intel inside CORE i7

Learn more and visit www.pny.eu

For more information please contact quadrouk@pny.eu

Insight
uk.insight.com
Tel: 0844 846 3333

Workstation Specialists
www.workstationspecialist.com
Tel: 01332 280380

Novatech
www.novatech.co.uk
Tel: 0239 232 2500

Scan Computers
www.scan.co.uk
Tel: 0871 472 4747

ENERGY

Charging ahead in battery research

New class of materials offers potential for faster transfer of lithium ions STUART NATHAN REPORTS

Researchers have identified a group of materials that could be used to make batteries with higher power. The team from Cambridge University's department of chemistry looked at niobium tungsten oxide as part of the search for materials with high-rate battery performance.

Niobium tungsten oxide has a complex atomic arrangement, which, according to postdoctoral researcher Kent Griffith, might explain why it has so far been neglected in battery studies. However, the team has found that this unusual structure allows lithium ions to pass through it much faster than conventional materials used in battery electrodes, such as graphite.

> "More lithium ions can move through them, and far more quickly"
> Kent Griffith

In typical batteries, electrons are extracted from the positive electrode during the charge cycle. They then move through its crystal structure and the battery electrolyte to be stored in the negative electrode. The faster this happens, the faster the battery charges.

One way that researchers try to speed this process up is to make electrodes from nanoparticles, because this should reduce the distance the ions have to travel. But this has drawbacks: nanoparticle electrodes tend to encourage unwanted chemical reactions in the electrolyte, reducing the battery lifetime, Griffith said.

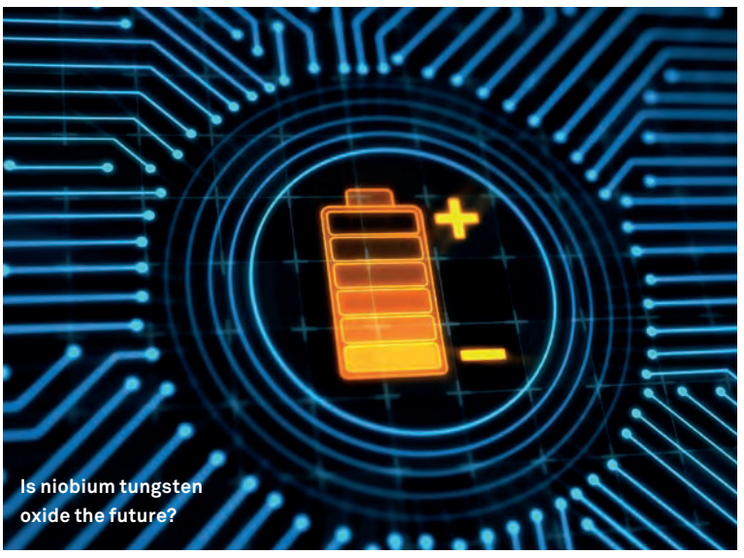
Moreover, as team leader Prof Clare Grey explained, nanoparticles tend to be difficult to make and to pack together efficiently. Niobium tungsten oxide is not a nanoparticle material. It has a fundamentally different crystal structure from many battery materials, Griffith explained.

The structure is held open by "pillars" of oxygen. "The oxygen pillars, or shear planes, make these materials more rigid than other battery compounds, so that, plus their open structures means that more lithium ions can move through them, and far more quickly," he said.

In *Nature*, Grey, Griffith and their colleagues explain that, although graphite has a high-energy density, in fast-charge cycles spindly fibres of metallic lithium (dendrites) form on its surface that can potentially cause fires and explosions.

Niobium tungsten oxides are also relatively easy to make, Griffith said. "A lot of the nanoparticle structures take multiple steps to synthesise, and you only end up with a tiny amount of material, so scalability is a real issue," said Griffith.

"But these oxides are so easy to make, and don't require additional chemicals or solvents." ■



Is niobium tungsten oxide the future?

AUTOMOTIVE

£8.3m test centre opens ahead of Real Driving Emissions tests

New facility will put vehicles through paces

An £8.3m test centre designed to prepare cars for the forthcoming Real Driving Emissions test regime has opened in Northampton.

Coming into force in September 2019, the Real Driving Emissions (RDE) test will put new vehicles through their paces on public roads in a variety of simulated real-life conditions. Alongside the lab-based Worldwide Harmonised Light Vehicles Test Procedure, RDE was formulated in response to the dieselgate scandal, in which Volkswagen and other manufacturers were found to be gaming existing emissions tests.

The centre, built by MAHLE Powertrain, will use a new four-wheel-drive chassis dyno to simulate real-world conditions. All vehicles certified for sale in the UK from 1 September 2019 must meet emissions targets on multiple road types, with various payloads and across a range of altitude and weather conditions. AW

ENERGY

Robots fuelled by the power of popcorn

Increase in volume of heated maize shows kernel of promise for mechanical actuators

Using the properties of materials as a power source is not a new idea. It's the basis of steam power, for example. But a team from Cornell University in New York is now investigating the potential of popcorn as a power source.

When heated, dried maize kernels expand more than 10 times in size, change their viscosity by a factor of 10 and transition from a regular shape to an irregular one within a fraction of a second, potentially exerting a significant force on any container that confines them.

PhD student Stephen Ceron and his supervisor, electrical and computer engineer Katrin Peterson, have co-authored a paper on this subject, which they presented at the recent IEEE International Conference on Robotics and Automation in Brisbane. Peterson explained that a goal of Cornell's Collective Embodied Intelligence Laboratory is to construct very minimalist robots that can work together in large numbers.

"Simple robots are cheap and less prone to failures and wear, so we can have many operating autonomously over a long time," she said. "So we are always looking for new and innovative ideas that will permit us to have more functionality for less, and popcorn is one of those."

Along with its material properties, popcorn is cheap, readily available, sustainable and biodegradable. "Pumps and compressors tend to be more expensive, and they add a lot of weight and expense to your robot," said Ceron, the paper's lead author.

"With popcorn... you just need to apply voltage to get the kernels to pop, so it would take all the bulky and expensive parts out of the robots."

SENSING INNOVATION IN PROCESS AND CONTROL

Temperature

Pressure

Flow

Level

Data Acquisition

Speak with our experts today

sales@omega.co.uk
www.omega.co.uk

OMEGA™
SENSING INCREDIBLE THINGS

Come and see what Brexit will mean

Time for SMEs to throw open their factory doors and educate MPs, before it's too late, about the perils of exiting the EU, says the MD of a UK SME

It's over two years since the UK voted to leave the EU. It's taken until very recently for the UK government to come to an agreed UK position for negotiations with the EU. Throughout the campaign, and since, Brexiteers have shown a complete disregard and total lack of understanding for the manufacturing processes for industrial goods in the modern age.

In automotive, aerospace and food manufacturing, to name just three of many, the requirement for integrated supply chains, just-in-time deliveries and seamless borders across Europe and Ireland are paramount. The cost of production is closely controlled and would be severely impacted by the potential of border delays and tariffs.

Simplistic arguments presented by Brexiteers show their lack of understanding of this process. Similarly, for common product regulations and standards, these are set worldwide, and if you wish to sell into any market you have to show compliance – this is true for both large multinationals and SME suppliers.

Perhaps Brexiteers would benefit from visits to JLR, BMW-Mini, Toyota and Airbus to understand the reality. It would be a breath of fresh air to hear informed comment from MPs, and certainly an improvement on the hugely negative recent comments by MPs and ministers about business.

For our high-technology SMEs supplying precision instruments to the international science markets, the impact of the vote has been dramatic, with a fall in market sentiment towards the UK. Previous excellent working relationships between European partners and the UK supply base have suffered due to the perceived sentiment from the UK, together with the huge uncertainty caused by the constraints of Brexit. This also seems to be the case with the Galileo project, where UK suppliers are being frozen out of the procurement process.

The ease of doing business on our doorstep with European science laboratories cannot be underestimated – modern travel means short, efficient visits to the Continent are possible. A common European culture with English as the language of choice further enhances the process. The ability to easily discuss and agree contract terms with Europeans is another advantage. Contrast this with Asian markets, for example China, where the process is controlled by government with onerous conditions together with a different language and culture. The distances involved mean visits are a full week, with time zones adding to the communication complexities. Yes, it's true China and Asia are huge expanding markets, but for an SME this represents a very difficult market to penetrate with many barriers to overcome.

I understand for many other technology-based SMEs having access to the EU Horizon framework has been the cornerstone of their development. What happens to this post-Brexit is still uncertain.

Access to skilled labour for all SMEs is a constant unsolved issue. In particular, apprentice-trained technicians are like gold dust for technology companies. Training your own is the only way since the reduction in supply of EU people coming to the UK only adds to this shortage. Retention of skilled labour is also difficult since the larger companies can offer better conditions than most SMEs and are a big magnet for UK-trained technicians.

Our SME exports regularly to the US, which until very recently has been a very open and friendly market for high-technology companies. Current duties are very low, typically two to three per cent. It's difficult to see a large change in US market potential with a new UK-US free trade agreement. It certainly won't replace any market loss in the European market caused by Brexit.

As the UK moves towards Brexit on 29 March 2019 it would help immensely if Brexiteer MPs would inform themselves about the issues the UK industrial manufacturing base, including the SME companies, truly face. Improving the quality of debate and moving away from soundbites and negative hits for political purposes on UK business can only help improve confidence in the future.

The spectre of a no-deal Brexit still looms large over UK manufacturing, with reversion to WTO rules. This would be disastrous for the UK industrial base, from multinationals through to SMEs. The impact on jobs and government finances would be catastrophic, and the UK may never recover from this scenario; educating our MPs and ministers about integrated supply chains, just-in-time supply and technology-based SME companies is a top priority. This option is more hopeful than the grim reality that Brexiteer MPs are so ideologically wedded to Brexit that they don't care about the economic consequences as long as they get a Brexit.

Maybe some MPs can still be enlightened by a visit to your factory and a greater understanding of these critical issues? Let's get invitations out! ■

Paul Murray is managing director of Instrument Design Technology Ltd, a specialist engineering SME based in Widnes

Beijing may be at the heart of an exciting market, but entry to it is difficult for SMEs

ADVANCED ENGINEERING 2018

31 Oct & 1 Nov 2018, NEC, Birmingham

10th ANNIVERSARY YEAR

The UK's largest annual gathering of OEMs and engineering supply chain professionals

- AERO ENGINEERING
- COMPOSITES ENGINEERING
- AUTOMOTIVE ENGINEERING
- PERFORMANCE METALS ENGINEERING
- CONNECTED MANUFACTURING
- NUCLEAR ENGINEERING
  NEW FOR 2018

REGISTER FOR FREE TODAY

Register your interest to visit the UK's largest engineering event, giving you access to:

- ✓ 600+ exhibiting suppliers and partners
- ✓ 200+ Continuing Professional Development certified presentations and case studies from OEMs, industry experts and government
- ✓ Innovative and exciting feature exhibits showing the latest technologies in action
- ✓ Enabling Innovation zone for SMEs and start-ups to present new inventions and idea

Register your interest to attend at:

www.advancedengineeringuk.com

#AEUK18

by EASYFAIRS

Mailbox

Thehottopic

Brexit remains a divisive issue

Our online poll on the UK's future relationship with the EU provoked an exasperated response from readers

The first big bank has gone. I guess if you want engineering work and to be paid, don't stay in the UK. Even at this stage, pay a fine, say sorry we made a mistake, we want in. I'm in Amsterdam.
Tristan Melland

There is no real reason for the Japanese car industry to stay in the UK now that they have a trade deal with the EU direct. Who are these 'rest of the world' nations who we will trade with after Brexit? Not the US, who don't want to trade with anyone on equal terms, not China who are extremely parochial and one-sided. Not, unfortunately, Oceania, who are too far away for low-energy export, certainly not Russia, and South America is broke. Who's left?
Sandy

I was in two minds about whether to write anything. This is so amazingly distracting; we exist in the world's largest free trade bloc. This works for industry and services, most of which do not 'understand' outdated national boundaries. If we turn our national borders into trade barriers, then 'just in time' manufacturing will struggle, and probably simply move the other side of said border. Services are already decamping. What do we gain from Brexit? So far as I can see, we simply lose. With regards to what we voted for, please remember that a little under 30 per cent of people didn't vote or spoiled their ballot. This presumably means that they were happy with the status quo?
Grace Nodes

There should be no more debate, it's absolutely crystal clear that any split with the EU will be damaging at best, and most likely catastrophic – it's as if 'Project Fear' was correct all along. However, who needs experts?
Evil Villain

Government has to be responsible for negotiating, but that doesn't mean the country has to accept something that may end up making us worse off. We need a vote on their efforts and the negotiation outcome. Following the referendum mandate, Brexiteers seem to think they can do what they want without regard to the consequences, mainly because they will be insulated. Their role is to do what is best for our country collectively, taking all things into account, not merely what suits them. And if they haven't done a good job then they should go, the same as any employee has to put up with.
Nick Cole

The fact is that no one, repeat no one, has a complete handle on the impact of leaving the EU – all we do know is that it's going to be damaging at best and catastrophic at worst – the Government's own research and subsequent forecasts predict such outcomes. We can be bloody minded about it and continue over the cliff, or we can take stock and think again.
Bruce Renfrew

A 'People's Vote' (the less desirable denouement but the essential backstop) is one way out but I believe the better way is for Parliament to stand up and do the correct thing: a free vote in both houses on the final package with a binary choice, leave in line with the negotiated bundle or rescind Article 50.
John Douglas

Inyouropinion

Next generation: response to inspiring tomorrow's engineers

At the end of the day, us engineers are largely practical, pragmatic people and whilst "shaping the way we live" and "making the world a better place" are undoubtedly true, they are a bit on the fluffy touchy-feely side and could equally apply to aspiring politicians and many others! "Well-paid" and "rewarding" seem a lot more practical sentiments to have.
Andy G

Difficult to understand why making the world a better place is a fluffy goal. I think it's most practical to want to preserve and improve life on Earth; it is what life means: survive, reproduce, flourish. The future engineers should focus only on solutions to existential (e.g. climate change) problems or social/economic/environmental problems, so that everybody in the world alive today and in the future will have a good life.
Silvia Leahu-Aluas

Surely the way to encourage the next generation is to stress that now, more than ever, the world needs engineers? Climate change is already striking home, and it's certainly going to get a lot worse. As engineers, we have contributed to this mess, many continue to do so, but we are better equipped than most to help save the ship.
Willy D

Engineering can make the world a better place, but so much of it is actually destructive, particularly the military, and to a less obvious extent the disciplines related to fossil fuel-powered transport. Engineering can be a force for bad, as well as good.
Nick Cole

I came to engineering because it fed a deep-seated need to make stuff that works and hopefully make a difference. I have spent a while doing both. In the right environment, a career in engineering is deeply satisfying on many levels, but we fail to convey that.
Waterboy

Join the debate theengineer.co.uk

Thesecretengineer

Whilst it's important to attract the next generation, engineering firms have a blind-spot when it comes to up-skilling existing talent, writes our anonymous blogger

I have written in the past regarding my concerns about what undergraduate engineers are being taught. This time I would like to address the other end of the spectrum. I vividly recall my redundancy from a position as design engineer a number of years ago, only one casualty of "restructuring" among many. The reason for my own dismissal was given as being that the company was going to use graduates to take a design from initial specification to a full set of detail drawings; a concept seemingly rather flawed to me both then and now. As, at the time, I didn't have a degree, that was me out.

Personally, I have never bought into the general notion that a lack of formal qualifications should bar you to any level within industry. There have been countless arguments about the status of the term "engineer", and whether or not it should be tied in with holding a degree, but this is different. Formal qualifications and ability in pertinent disciplines (not necessarily always the same thing) are important, but to be so focused on degrees, or other qualifications for roles below that ceiling, is to cut industry off from a significant pool of talent .

However, if this resource is to be utilised, a commitment by the company is required, and a willingness to offer structured support and training is essential. An added complication may be that any individual embraced by this process could have underlying reasons that have prevented them from achieving academically up to this point, with dyslexia in particular springing to mind. Thankfully, it is a condition now generally recognised and with help made available to sufferers but, even so, it may have blighted someone's experience of formal education.

The two extremes can be illustrated through one friend who runs a design office and has taken her qualifications all the way up to a masters degree despite her dyslexia, and another who, I fear, has always been held back by his. It is the latter who is the inspiration for this piece.

Sydney joined Sleepy Hollow Electronics part-time to help out in the warehouse, primarily with the marshalling of build kits for the shop floor. As far as I am aware, he has carried out these duties diligently and accurately, he is always pleasant to talk to, bright, and has what is generally known as a 'good attitude'.

Look beyond this though, engage him in conversation, and you will find that he is a keen motorist who has carried out much of the work himself to modify his car in a number of significant ways. The opportunity came to nurture and

encourage his natural talent when a new position was created for a second nurfing machine setter, a role that would probably not fill a complete week on its own but which had been declared as important to mitigate against an identified risk to the company.

Setting a nurfing machine is undoubtedly a skill that needs some engineering 'feel', but there are no complex calculations or other intricacies allied to any other form of 'book learning'. Sydney therefore seemed ideal to me and I encouraged him to apply for the post. However, I am sure primarily due to the dismissive way he is viewed by his manager (possibly underscored by a lack of confidence due to his dyslexia), he did not apply. Equally, his manager had not bothered to find out more about what his charge could offer and, sadly, was so brittle that any other member of the senior team suggesting Sydney would no doubt have had it counted as a mark against him.

Thus, the company failed to exploit a talent already available and Sydney was denied the first step along a path that I suspect would suit him very well. Sleepy Hollow Electronics ended up employing an experienced setter who still needed training on our machines and who spends a significant amount of time sat around bored and with nothing to do. Sydney remains part time on his previous duties. Multiple opportunities missed and, I suspect, no one really happy with the outcome. A situation that can't be good for anyone. ■

Working together to change perceptions

With more students taking STEM subjects at A-level, it is crucial that we maintain momentum in our efforts to attract more people into engineering careers

Many people have welcomed the rise seen this month in numbers of students taking STEM A-levels. Subjects classed as STEM by the Joint Council for Qualifications accounted for 36.2 per cent of all UK A-level entries this year, compared with 34.5 per cent last year. Entries in all three sciences were up – biology increased by 3.1 per cent and chemistry and physics both increased by 3.4 per cent, while maths remains the most popular A-level. The biggest proportional increase was in computing, where entries rocketed by 23.9 per cent, although this offset a 25 per cent fall in ICT. It was also good to see an increase in entries to STEM A-levels by girls, up 5.5 per cent from last year, including a 6.9 per cent increase in physics and an increase in the number of girls taking computing from 9.8 per cent in 2017 to 11.8 per cent this year.

However, not all STEM subjects fared as well. In design and technology, entries fell by 7.8 per cent. This highlights a serious issue for engineering. Design and technology provides opportunities for students to develop design solutions, informed by their understanding and application of science, mathematics and computing, to solve everyday problems in a practical way. While the popularity of many of the entry-point subjects seems to be rising, design and technology, which provides a vital bridge from STEM subjects to engineering, has been falling for a number of years.

This is why, at a parliamentary reception in early July, we called for politicians and businesses to champion design and technology in local schools, and talk to school leaders about how the subject can be better supported. The call was part of an action plan presented to MPs, engineers and – importantly – young people, who informed its recommendations. Other recommendations included that the government should tie 'taster days' into the upcoming careers strategy and that politicians, education providers and businesses should support and promote local careers fairs.

On the same day that A-level results were announced, the latest monthly apprenticeship statistics were published. Here again, the news is less positive, as apprenticeship starts are down once again, from 457,200 in 2016-17 to 315,900 in the equivalent period this year. The UK has long suffered from a perception that vocational pathways are less valuable than academic routes. This is part of a wider challenge to give students better access to high-quality careers advice, including about vocational routes, which is essential if we want more young people from diverse backgrounds to have the opportunity to participate in engineering careers. At the Royal Academy of Engineering, we will continue to work with our partners across the profession to engage policymakers with the recommendations in our action plan, and further, more detailed proposals that address the same challenges.

This effort goes hand in hand with our drive to change perceptions of engineering among young people and their influencers. As I have previously reported in this column, we launched an ambitious campaign in January – This is Engineering – to do just that. On September 10, we launch our second This is Engineering season. Centred on a series of short films that bring to life the breadth of engineering through young role models, the campaign has surpassed our expectations, amassing more than 16 million views from teenagers on social media. A survey of 1,000 young people before and after the campaign launch indicated a 41 per cent increase in the number of teenagers who, after seeing the campaign, said they would consider a career in engineering.

The engineering skills and diversity shortfall is a long-term challenge and, as a consequence, we have set out to make This is Engineering a multi-year campaign. As the government's Year of Engineering draws to a close, it is crucial that we maintain the momentum of our efforts to attract more people to engineering careers.

But driving a step change in the public perception of engineering and the likelihood of young people pursuing engineering is something we can only do in partnership – and we are continuing to work closely with EngineeringUK both on This is Engineering and the associated programme of schools engagement delivered under the Tomorrow's Engineers umbrella.

Reflecting that commitment to partnership working, I will soon be handing this column over to colleagues from across the profession. This will be my last column after more than a year and a half of contributions, which I hope have been of some interest to you. My thanks go to *The Engineer* for offering me this opportunity and to all those who have read and engaged with my articles. I look forward to working with many of you in the years ahead to tackle the issues that I have explored in this column, not least the much-needed step change in the strength and breadth of our talent pipeline. ■

Season two of This is Engineering will launch on September 10. To watch the new films, visit thisisengineering.org.uk, youtube.com/ThisIsEngineering or follow @ThisIsEng on Twitter.

Dr Hayaatun Sillem is chief executive of the Royal Academy of Engineering

maintec

NEC, Birmingham • 6-7 November 2018

The future of reliability, maintenance & asset management

62% increase in visitor attendance in 2017!

Maintec is the longest standing exhibition dedicated to the maintenance, plant and asset management industry in the UK.

Get access to 100+ of the top manufacturers and suppliers of maintenance technology and hear from leading engineering experts from some of the UK's biggest sites across a packed professionally accredited seminar programme - all for free!

Join your engineering colleagues at Maintec 2018!

Claim your free entry ticket at **www.maintec.co.uk**

Official media partner: Industrial Plant & Equipment

Event partners: rexroth A Bosch Company

Sponsors: PRÜFTECHNIK, INSIGHT

Supported by: bcas, BSiF British Safety Industry Federation

En route to real-world autonomy

Jon Excell reports **on the UK's biggest and most ambitious trial of driverless car technology**

The driver of the car stuck in front of us is getting angry. If only we'd acknowledged his subtle blend of hand-gestures and nods, done the decent thing and backed up a couple of metres, he could have performed his illegal (although not particularly dangerous) U-turn and been on his way. But we don't budge. And no amount of gesticulating is going to persuade us to. That's because our driver isn't like most drivers. Our driver is a robot. And robots like to stick to the rules, even if it means annoying their fellow road users.

And as he screeches off into the Milton Keynes rush-hour, his parting expletive ringing in our ears, our furious fellow-traveller leaves us with an illuminating reminder that while driverless car technology may be advancing rapidly, smoothly integrating it into society is another challenge altogether.

Overcoming obstacles like this is one of the remits of the Autodrive project: the UK's largest ever trial of connected and autonomous vehicle technology; and the reason *The Engineer* finds itself being chauffeured around Milton Keynes' famed grid system in a driverless Range Rover.

Led by engineering consultancy Arup, and involving a diverse mix of car-makers, local councils, academic research groups and even experts from the worlds of insurance and law, the project – which was launched three years ago in response to a government "driverless cars competition" – is aimed at preparing society for driverless cars and positioning the UK as a hub of connected and autonomous vehicle expertise.

Over the course of the last three years the project partners – who include JLR, Ford, Tata, MIRA HORIBA, the universities of Cambridge and Oxford, and a host of other specialists - have demonstrated a range of technologies both on the test track and on the streets of Milton Keynes and Coventry.

Meanwhile in the centre of Milton Keynes, as the project enters its final phase, a fleet of 40 driverless pods, developed by Coventry firm RDM group (see page 26) are being used to explore how autonomous vehicles (summoned by smartphone) might operate safely alongside pedestrians and reshape so-called "first and last mile" transportation.

01 Autonomous cars will only work with a high level of connectivity

02 Autodrive cars are programmed with a pre-mapped route

The Engineer's visit earlier this summer coincided with a series of public road trials including demonstrations of the vehicle described above: a prototype Range Rover capable of Level 4 autonomy: meaning it is theoretically able to perform all safety-critical driving functions (see fact box).

Equipped with a mix of lidar, radar and cameras, the vehicle was programmed to follow a pre-mapped route along public roads and had to cope with all of the unpredictability of a real-life traffic environment.

> "The grid-like nature is great. The traffic lights are great"
>
> Jim O'Donoghue

Reflecting on these trials, JLR autonomous vehicle research engineer Jim O'Donoghue told *The Engineer* that the vehicle has performed well in an environment that has proven to be an excellent test-bed for driverless technology. "The grid-like nature is great," he said. "The traffic lights are great – each four entry and exit points get their own go so we're not having to give way to traffic, which helps us out a bit. The dual carriageways are also an interesting element, as the car's having to cope with a lot of information."

Alongside JLR's demonstration, recent months have also seen trials of a range of closer-to-market applications for vehicle-to-vehicle connectivity technology based on DSRC (dedicated short range communications) – a low-latency, high-speed wireless communications technology similar to Wi-Fi.

01

02

Understanding autonomy

A widely accepted set of guidelines defined by The Society of Automotive Engineers (SAE) describes the differing levels of autonomy in driverless cars.

Level 1 - Commonplace for a number of years, Level 1 enables a single element of the driving process to be taken over in isolation. Examples include lane-keep assist and adaptive cruise control.

Level 2 - The current state of the art, this enables a car's computer to take control of two or more elements (for instance steering and braking) at the same time.

Level 3 - The next step. Capable of undertaking all driving functions under most conditions but may rely on a human driver as a fall-back system.

Level 4 - Capable of autonomously performing all driving functions. Doesn't rely on fall-back to a human driver and may or may not have driver controls. Restricted to operating within controlled, geo-fenced areas.

Level 5 - The long-term dream. Is not geo-fenced and can perform all driving functions anytime and anywhere.

These included a demonstration of collaborative parking – in which connected vehicles update each other on the location of available parking spaces, and an Electronic Emergency Brake Light (EEBL) feature which gives a warning when another connected car further up the road brakes heavily – potentially giving drivers several additional seconds to avoid a possible collision. The project has also demonstrated a so-called Emergency Vehicle Warning (EVW) system, which displays information about where an emergency vehicle is before a driver can identify it with their ears and their eyes.

Clearly, technologies underpinned by connectivity in this way, cannot be developed in isolation and one of the defining characteristics of Autodrive is the degree of collaboration between companies that are more used to fierce competition with each other.

It is, remarked project leader Tim Armitage, of Arup, an unusual but essential dynamic. "In the brave world of connected and autonomous vehicles it's not going to happen unless the vehicles are going to run collaboratively," he said. "It's no good if a Volvo only talks to other Volvos. There's been a lot of effort to ensure that the systems on the vehicles are interoperable."

Reiterating the importance of this cross-company collaboration, Dennis Witt, a research engineer with Autodrive partner Ford, said: "It's been really useful testing with Jaguar and Tata. If we just tested three Fords together with the same hardware and software it would all work – it's only when you get into that mixed environment that you can understand some of the interoperability challenges."

In a sign of the way in which connectivity is blurring the boundaries between different disciplines and sectors, the project has also involved a number of firms not automatically associated with automotive. Arup itself is a good example of this. "We can see that connected and autonomous vehicles are going to affect everything we do as a business, from building design, road design, infrastructure design," said Armitage. "It's going to have a huge impact on all the things that we do as an engineering consultancy."

Another key partner in this regard is security and transportation specialist Thales, which has been advising on cybersecurity measures for protecting data, and protecting connected vehicles from cyberattacks.

Cybercrime is a growing threat in almost every area of modern life. Indeed, recent government statistics found nearly half of all UK businesses suffered a cyberattack in the last year. But while the biggest threat in many areas is data-related, there's a growing realisation that cyberattacks on cars could actually directly put lives at risk. "This is a cyber-physical system, so attacks are around things like trying to stop the brakes by denial of service, and not around standard information things," explained Peter Davies, technical director at Thales e-Security.

In terms of the technologies showcased through Autodrive, developing processes and methodologies for protecting pods is, said Davies, a more straightforward challenge than ensuring that high volumes of road-cars are hack-proof. "In many ways [the pod] is a public service vehicle so it's

much closer to things we do on the railways and elsewhere where it's not owned by somebody," he said, "but as you move into autonomous vehicles made by a multitude of different manufacturers those issues are far more problematic and outside the usual engineering experience."

As a fast-paced global industry, which is more comfortable with change than most, Davies believes the car sector is well-placed to get to grips with this emerging threat. Nevertheless, the challenges it faces are exceptional. "It operates at scale, it's mobile, it has to take liability for what it's doing, it's got personally identifiable and safety critical information, it's a heterogeneous network that talks to satellites, roadside infrastructure. All of those elements are part of what they're trying to consider. It's a mind-bogglingly difficult set of things that they're trying to do."

And this is just one of a number of critical challenges that will be need to be addressed before the kind of Level 4 capabilities showcased by Autodrive enter the mainstream, including, said Armitage, making the technology affordable. "It's not so much working out how to do the things we want to do," he said, "but it's a case of working out how we can do the things we want to do with hardware that's at the level of cost you can put on a car."

03 The Autodrive fleet is involved in the largest such trial to date

"This is not to decry what we've achieved," he added, "but we've done it the easy way: we've thrown technology and sensors and processing power at the problem. If you open the boot of one of our cars you wouldn't get your weekend case in there because it's just full of tech and computers and electronics. Now the challenge is how do we replicate that functionality with more affordable sensors."

Though these challenges are extreme, solving technical problems is at least familiar territory for engineers. However, industry is on slightly less comfortable ground when addressing the softer issues around public acceptance of the technology.

Armitage said that it needs to improve the way it talks about driverless cars. "Industry has been woefully inadequate in the way it has described driverless cars... for the most part there's complete misunderstanding in the outside world of what an autonomous car is."

Part of this, he said, is reminding the public that with most vehicles now boasting some form of driver assistance there are few vehicles on the roads that are not at least level 1 autonomous. "One of my pet lines in presentations is that if you want to know what an autonomous vehicle is, the car park outside is full of them." ■

Pod squad: how Coventry's RDM Group is shaping the exciting future of 'first and last mile' transport

The unassuming, scruffy-looking industrial estate from which it operates is an unlikely looking site for the birthplace of a transport revolution. But it's entirely possible that in years to come Coventry's RDM Group will be regarded as one of the pioneers in the world of 'first and last mile' transportation.

The company, which began life producing wiring harnesses for Jaguar Land Rover, has been making a name for itself in this emerging field, firstly with the development of a two-seater driverless pod for the Government's Lutz pathfinder project, and more recently with the design and production of the fleet of four-seater autonomous pods currently being tested in pedestrianised areas of Milton Keynes as part of Autodrive.

With a top speed of 15mph, the distinctive-looking vehicles are powered by an easily swappable lead-acid battery pack with a life of up to eight hours. Explaining the decision not to use lithium-ion batteries, RDM's chief designer Elliott Hawkins said that the ready availability of lead-acid batteries around the world, coupled with the low speed and range requirements of the pods, actually made lead-acid the logical choice. "It's very weird to see a modern electric vehicle with lead-acid batteries, but we've used the limitations of lead-acid as a positive," he said.

The Milton Keynes Pods, lined up and ready to go

The pods are built on a steel space frame chassis. This is covered in a laser-cut aluminium super-structure, which is then clad in vacuum-formed body panels. In the interior, Hawkins has taken a number of design cues from public transport: such as high-vis seat edges from taxis, and yellow grab handles. "Although it's an alien environment and autonomous you sort of feel at home because you're picking up on other cues you've seen elsewhere," he said.

As well as the vehicle body, RDM has also developed the autonomous control systems and algorithms that interpret data from the Lidar, GPS, ultrasonic and video sensors dotted around the outside of the pod and enable it to safely navigate a crowded and unpredictable urban environment. These technologies are constantly refined and tested in the group's Urban Development Laboratory – a facility it shares with JLR – where engineers are able to simulate and test a variety of different driving situations.

Unsurprisingly, when Autodrive's pod trial was first proposed, the prospect of driverless cars trundling around pedestrian areas wasn't universally well received. One particularly concerned group was Guide Dogs for the Blind, which feared that the pods would make a difficult environment even more hazardous.

Arup's Tim Armitage said that dialogue the project had with the organisation was an interesting example of how quickly perceptions can be changed. "Within the space of a day we explained how the vehicles would sense people and respond accordingly, and by the end of the day they were totally sold on the idea," he said.

The organisation has since been working with RDM to make the pods more accessible to partially sighted and blind people by introducing braille notices on the outside, choosing interior colours that can be detected by partial sighted people, and making them more dog friendly.

Alongside Autodrive, RDM is involved in a number of other projects including a collaborative effort with WMG to develop swarm intelligence systems for its pods and a proposal to produce a 40mph, 12-seater driverless bus that will operate along guided bus-lanes in Cambridge.

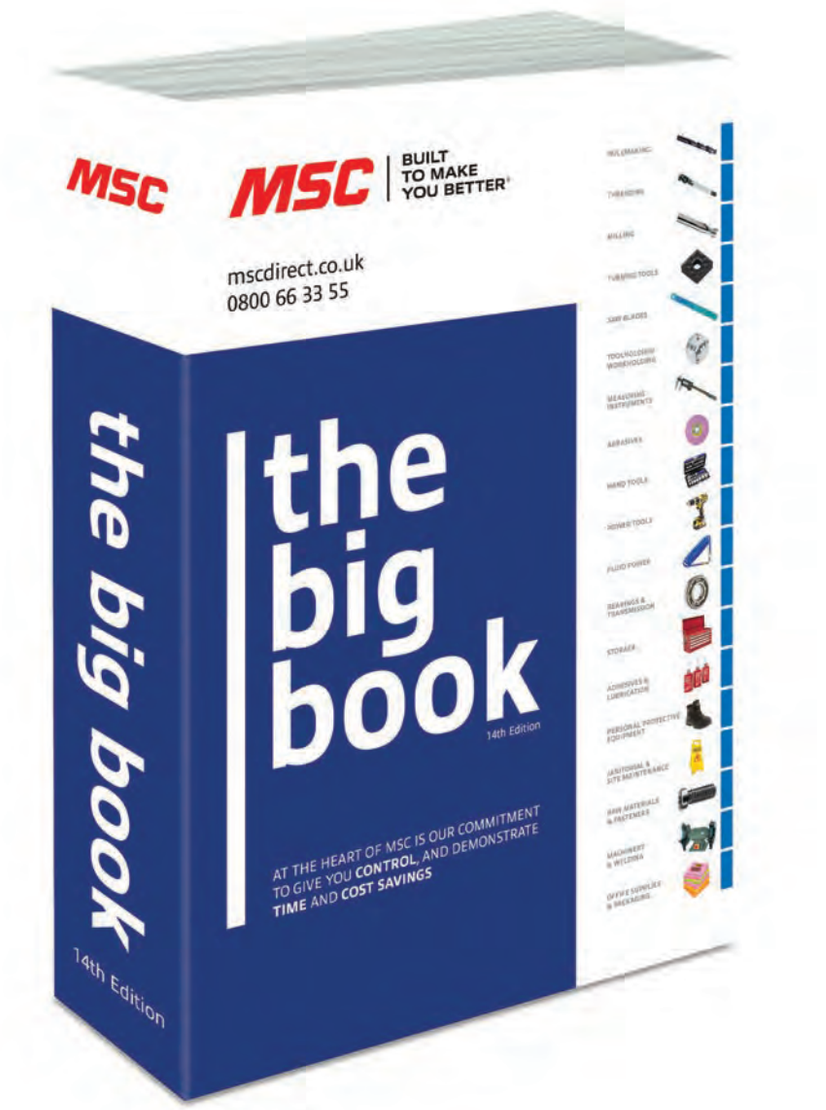
With a base in Australia, and a recently announced hook-up with Arup to gain a foothold in the US autonomous vehicles market, the firm is also exploring a number of international opportunities for its technology.

MSC | BUILT TO MAKE YOU BETTER®

REQUEST your free copy
Visit:
mscdirect.co.uk/bigbook/
Call:
0800 66 33 55

MSC IS PROUD TO LAUNCH ITS 14TH EDITION BIG BOOK CATALOGUE

As the only national supplier with a Metalworking heritage and an extensive Maintenance, Repair and Operations offering - trust us to deliver



Inside your new 14th Edition Catalogue...

Over 80,000 Stocked Products

Over 6,000 New Products

19 Product Categories

At the heart of MSC is our commitment to give you **control**, and demonstrate **time** and **cost savings**

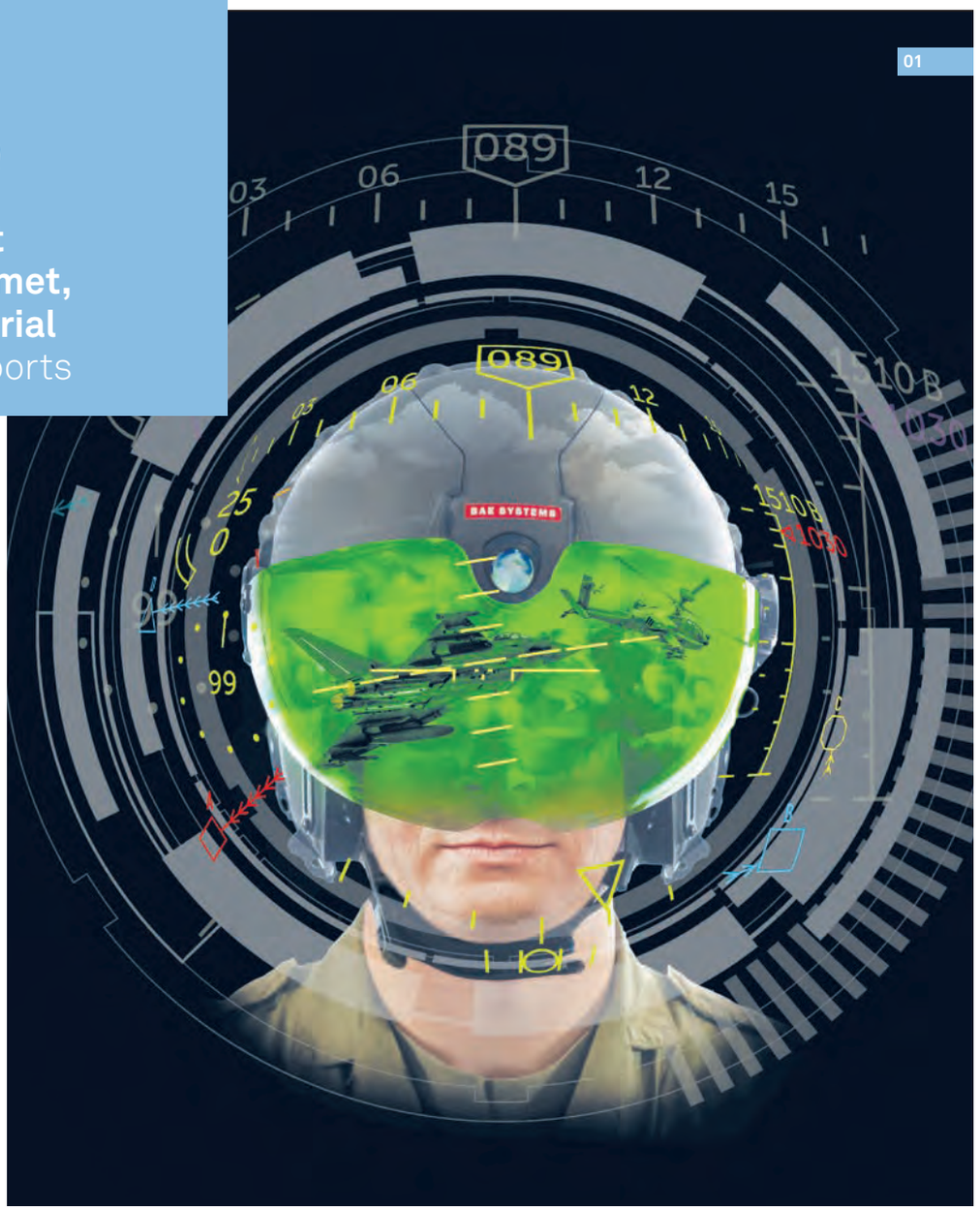
Follow us to stay connected to the latest news, events and promotions

MSCIndSupplyUK
MSCIndSupply
MSC Industrial Supply Co. UK

mscdirect.co.uk
0800 66 33 55

Vision of the future

Hailed as the world's most advanced fighter pilot helmet, Striker II will transform aerial combat. Stuart Nathan reports



The cockpit of a fighter aircraft is one of the most high-tech environments in the world. Pilots have to cope with an avalanche of information, from the view outside the canopy, to the instrument displays in front of them, feedback through the manual controls, and the various noises – including alarms – inside the cockpit. In future, however, pilots will have an important aid to help them make sense of all this and avoid total sensory overload: the Striker II helmet.

Developed by BAE Systems' electronic systems base at Rochester in Kent, Striker II is, as the name implies, a development of the Striker system which was originally designed for pilots of the Typhoon aircraft. "Obviously, products change to reflect the introduction of new technology," explained project manager Richard Orridge. "It wasn't that Striker was doing a bad job, it's more that with the advent of digital technologies we could make it a lot better."

The role of helmets like Striker and Striker II is to provide a display system to replace the heads-up display which projected information at the pilot's eye level onto the inside of the aircraft's canopy. Essentially, this is augmented reality. Symbology representing other aircraft – friend or foe, mission targets and incoming armaments, as well as targeting devices, are overlaid so that the pilot can understand intuitively all the information he or she needs that may not be visible to the naked eye or might require highlighting to ensure that it is not missed.

In the original Striker, that display was a small cathode-ray tube mounted inside the front of the helmet at the correct distance for the pilot to focus upon. This, Orridge explained, is essentially an analogue device: the display is formed by a ray of electrons electromagnetically rastered across a screen treated with a fluorescent phosphor. In Striker II, however, this is replaced by a 4K digital display. The outside view is provided by cameras on the exterior of the aircraft, and the symbology is overlaid digitally.

This presents a number of advantages, Orridge said. "First of all, we can do the symbology in colour; previously it was monochrome. Moreover, digital display is much lighter in weight than the CRT." Use of colour allows more information in the symbology: friendly aircraft can be represented in blue, hostiles in red and ground features in green, for example. This improves reaction times to threats and reduces the chance of "friendly fire" incidents. Another major advantage is that the field of view is much wider than with the CRT system.

Going all-digital also allowed the developers to overcome one of the major advantages of Striker. The helmet was equipped so that it could be paired with a night vision system, but this was literally placed onto the helmet and had to be pulled down in front of the eyes by the pilot. This was not ideal, explained chief systems engineer Colin Mills. "The night vision goggles are quite heavy, and mounted on the front of the helmet put it out of balance and tended to strain the pilot's neck," he said. "And even more seriously, the pilot would have to remove the goggles before ejecting in an emergency, and would much rather they were able to just press the button without having to worry about anything else."

In Striker II, the night vision system is integrated into the helmet and located between the pilot's eyebrows. This not only removes the need for cumbersome extra goggles, it allows the weight to be reduced significantly and distributed so the helmet is balanced perfectly when the pilot's head is in a neutral position.

> "Digital display is much lighter in weight"
> Richard Orridge

Among the other digital effects available to the 4K display is an image-in-image system that is brought into play during missions where the pilot has to fire armaments. As the aircraft gets into range of the target, the cross hairs the pilot sees are augmented by a small black-and-white pop-up image of the target area, so that he or she can be sure that when missiles are dispatched, the chances of collateral damage are minimised.

Overlaying symbology and other information

into the pilot's field of view requires that the system knows the position of the pilot's head precisely. In the old Striker system, this was done using infrared sensors mounted around the cockpit to detect and map head position. One drawback with this, Orridge said, was that the pilot's oxygen hose can sometimes get in the way of the detection system. In Striker II, the sensor system is augmented by an on-board digital position system using accelerometers, similar to those found in smartphones. This allows head position and orientation to be tracked precisely with little to no latency, Orridge said. "The symbology moves smoothly as the pilot looks around, with no jittering or timelag."

The system also allows tricks that would not be possible with Striker. Cameras mounted around the entire exterior of the aircraft allow the pilot to effectively "look through" the floor of the cockpit, allowing 360° awareness.

> "It is designed to be a platform-agnostic system"
> Colin Mills

The new helmet is also equipped with "3D sound", so that should another aircraft or an air-to-air missile be approaching from behind, the pilot receives the illusion of the sound arriving from the appropriate direction.

Striker II was initially developed for the Typhoon, which is currently undergoing a systems upgrade, and the Swedish Saab Gripen fighter, but the Rochester team is also developing it for the F 35 Lightning II, with the only major change anticipated being in the mounting points for the intercom and oxygen mask. "It is designed to be a platform-agnostic system," said Mills.

Other aircraft that would benefit from the use of this helmet are rotorcraft, added Jean Page, head of human factors at Rochester. "The display system would be a distinct advantage on take-off and landing, where you can have the problem of whiteout in snowy conditions and brownout in dusty and desert environments. In both cases, particulates are blown up by the downdraught and completely cut out the pilot's view. We can use the wide viewing angle of the display to give an enhanced image," she explained.

01 The Striker II has a 4k digital, full-colour display that feels intuitive

02 Pilots of the future will go into combat missions better informed

The system is also an integral part of BAE's ambitious plan for future cockpit environments: a "virtual cockpit" where the physical displays and dials and even switches are replaced by a graphical representation on the helmet display.

In this case, Page explained, the head tracking system might be augmented by gaze detection to determine precisely where the pilot is looking, while extra sensors track his or her hands and fingers to detect whether a switch is being manipulated. "We would augment the system with haptics to give the sensation of pressing a switch," Page said.

Virtual cockpit is planned to be part of the ongoing upgrade of Typhoon, and may be used in the new Tempest which is now being developed to succeed Typhoon in future decades. It will also allow displays suited to different anticipated roles for fast jets, including mission overview and control of drone swarms in the battle space. Additional displays could be moved around the pilot's field of vision to suit the mission; for example, a dedicated display might appear to assist with in-air refuelling.

However, ultimately Orridge and Mills are keen to stress that Striker II is primarily a piece of protective equipment. "Its first job is to keep the pilot's head safe," said Mills. "It has to ensure that they can function when they are pulling 9G in manoeuvres, and most importantly it offers protection in the case of ejection. That's a highly hostile situation where the pilot is subjected to very sharp acceleration, deceleration and possible impact. As soon as the pilot leaves the aircraft, their head is instantly placed into an airstream moving faster than 600 miles an hour.

"We have to ensure they are fully protected from that. In developing the helmet, its performance for those situations was the absolute primary concern, and getting all the electronics into it and making sure that none of them compromised that function was almost a bonus." ■

GEC

GLOBAL ENGINEERING CONGRESS

22 - 26 OCTOBER 2018
ONE GREAT GEORGE STREET,
WESTMINSTER, LONDON

ACTING TODAY TO CREATE IMPACTFUL CHANGE

Join some of the world's most inspirational engineering pioneers to learn and respond to the future challenges as set out by the UN Sustainable Development Goals.

KEY REASONS TO ATTEND:

ENGAGE
Contribute to an industry-wide response to sustainable development challenges facing our planet as outlined by the UN SDGs

INVEST
Empower your business and effectively compete for talent by integrating sustainability, raising your global profile

LEARN
From multidisciplinary engineers and worldwide thought leaders in a wide range of engineering, innovation and policy making disciplines

CONNECT
Network with resilience officers, sanitation experts, clean energy developers, innovative thinkers and climate change gurus in one of the world's most prestigious venues

Book now at ice.org.uk/Congress

Tickets start from only £150 per day. Group bookings and multiple day rates also available.

ice 200
Institution of Civil Engineers

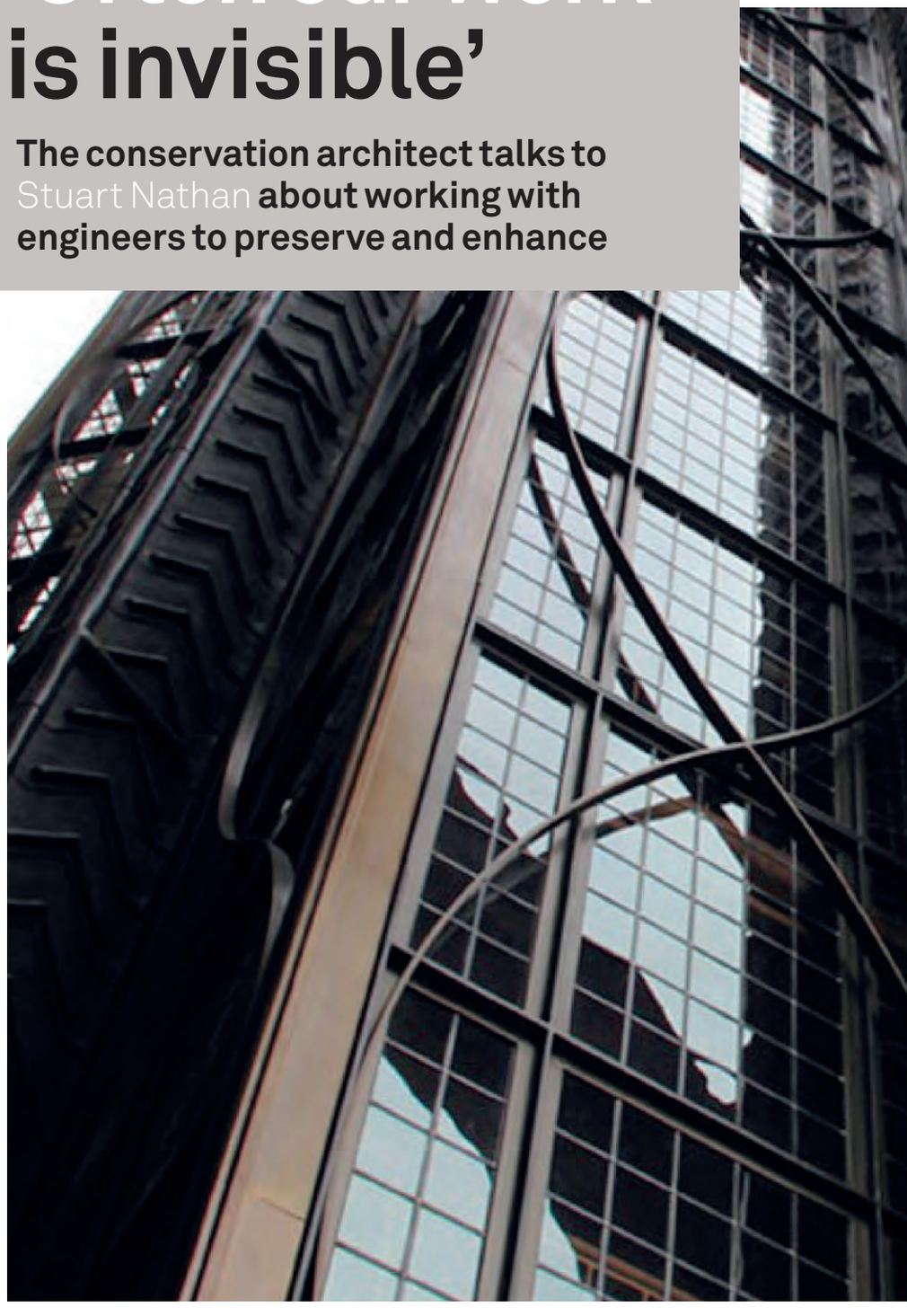
WFEO / FMOI
50 YEARS

UNESCO
United Nations Educational, Scientific and Cultural Organization

Under the patronage of UNESCO

‘Often our work is invisible’

The conservation architect talks to Stuart Nathan **about working with engineers to preserve and enhance**



A mildly disgruntled engineer once told me at length during a car journey that no engineers were well regarded in the UK apart from one group. This group, he explained, had the good sense not to call themselves engineers. They tended to dress in polo neck jumpers, wear angular glasses, and call themselves architects. This group, he argued, were universally lauded and even elevated to the House of Lords with no controversy.

But architects are not engineers, although they work closely together. Kirstie Robbins, a director with the architecture practice Ptolemy Dean Architects, points out that architects, in fact, tend to come from a very different background from engineers. “It tends to attract people from the arts side, possibly because of the way that architecture degrees are set up with their emphasis on drawing.”

Architects also need more of an awareness of history and visual arts than engineers, because their creations have to sit alongside buildings from many different eras and will naturally be compared by how they look.

Robbins and the firm she works for specialise in conservation architecture. “That is sometimes confused with, or even called, restoration architecture, but that is something completely different,” she explained. “Conservation is about preserving what is there and working in harmony with it. Restoration is making something old look like it was new, and we categorically do not do that.”

The most high-profile project Robbins has worked on recently is the creation of a new museum gallery and access tower at Westminster Abbey, which *The Engineer* covered in-depth on our website. Ptolemy Dean is the surveyor of the fabric at Westminster Abbey, so the project carries his name as chief architect, but like all projects of this type, this was teamwork. Robbins was project architect, responsible for the day-to-day running of the project, working on site, handling all necessary permissions to work and liaising with the building team.

Robbins admits that her route into architecture must not be typical. “A lot of architects come into the profession because they want to make a tangible mark on the world and create landmark buildings. I never wanted to do that,” she told *The Engineer* over coffee outside Methodist Central Hall on Parliament Square, overlooking her most recent work site (although the tower itself was not visible, being behind the bulk of the Abbey from that viewpoint). “I got on to a partial architecture degree, not the full one, but I did some work experience in an architecture office and I fell in love with the practice of architecture, so reconsidered my training.” After gaining her degree from the University of Edinburgh, Robbins completed her training at the Bartlett School of Architecture at University College London, specialising in the history and theory of the discipline.

> “We are always saying we want less steel, and they are always saying they want more steel”

As a conservation architect, most of Robbins’ work is in historic buildings, often returning them to a safe state after periods of neglect, rather than in making new structures. She has worked on projects at Arbroath, Glastonbury and Cleeve Abbeys, the Bishop’s Palace at Wells and Christopher Wren’s St James’s Church on Piccadilly in central London, as well as an ongoing project

01 Weston Tower, the new structure at Westminster Abbey

at Westminster School. However, the Westminster Abbey project was a novelty, in that it involved making a new structure as well as working on an existing space.

A large part of the project was converting the neglected triforium space above the nave into a gallery, displaying the Abbey's historic treasures. However, it also involved making the Weston Tower, a steel, glass and oak construction surrounding a lift shaft directly adjacent to both the oldest part of the Abbey and its most ornately decorated exterior section: the Chapter House, dating back to the 12th century, and the Lady Chapel, built by Henry VIII in the 16th century to house the remains of his parents and grandmother. On both parts of the project, Robbins worked with specialist engineering firms whose work is also often connected with historic buildings: structural engineers Price & Myers, and multidisciplinary engineering firm Max Fordham Partnership. "They were involved right from the start of the project, so it was very much a collaborative process. It was not a case of us coming up with a design and then presenting it to the engineers and saying 'build that'."

This may be the situation for other engineers working with architects. In her recent book, *Built*, civil engineer Roma Agrawal describes the structural engineering aspects of building the Shard at London Bridge, where she received drawings from the architect Renzo Piano's practice and her first task was drawing over their lines where she thought supporting steelwork would have to go. Steelwork is, in fact, one of the things that Robbins discusses most with engineers. "We are always saying 'we want to have less steel there,' and they're always saying 'sorry, but you need more steel or it's going to fall down'. That can be a constant back-and-forth."

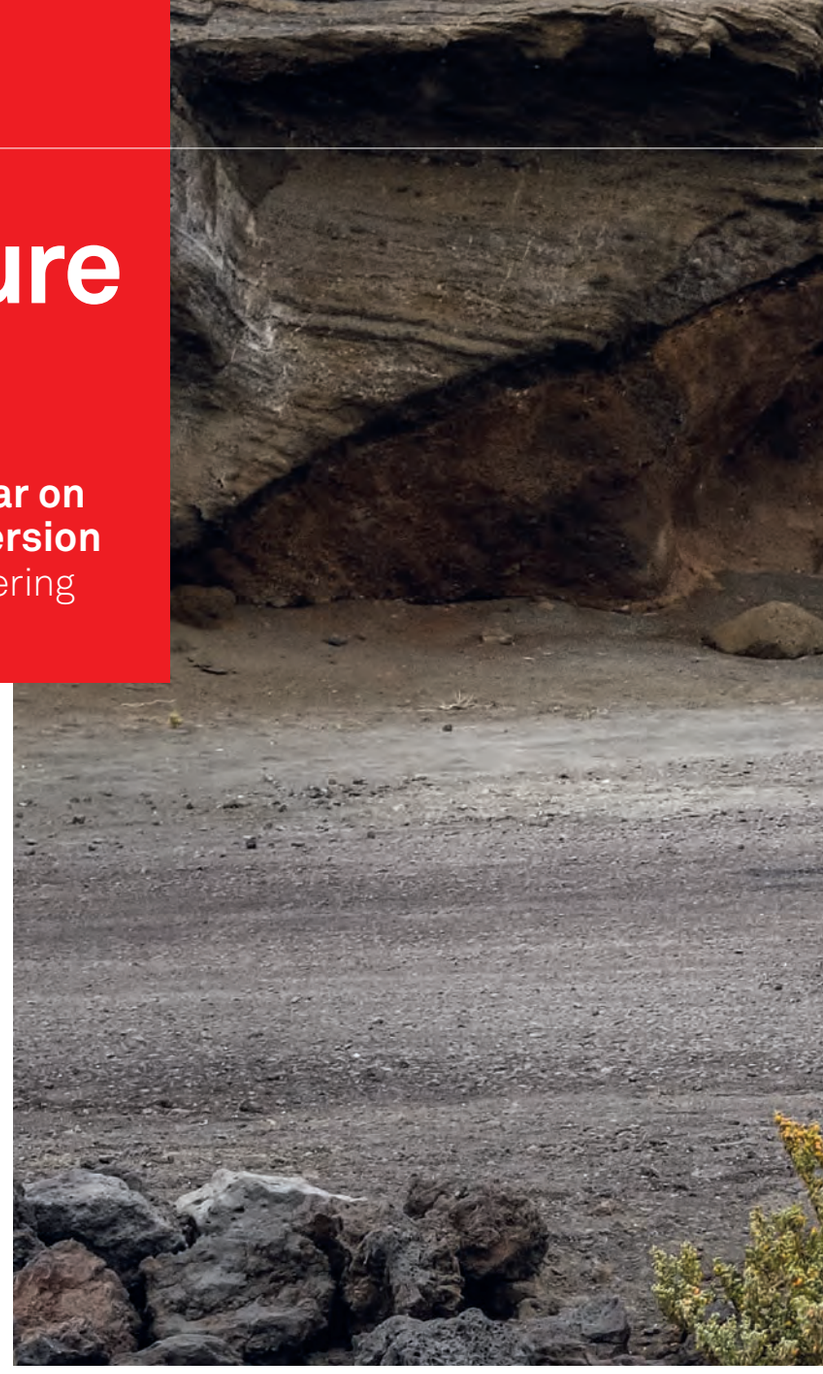
Robbins categorically does not consider herself to be an engineer, but is fully aware of how vital the discipline is to her profession. "Over time, you do pick up at least the language of engineering and you know roughly what questions to ask and what things they are going to be concerned about, but I wouldn't be able to do the calculations that they do to work out the point stresses and other suchlike data in the structure. Similarly, we are all using digital tools to design now but as an architect I can't pretend I use them in the same way an engineer does."

Working on the Weston Tower gave Robbins' work a visibility it doesn't often have. "Very often, the goal of conservation architecture is to be invisible. You want the space to look like it is the age that it is; you absolutely do not want it to look new. For example, in the triforium one of our jobs was to remove staining from the walls that had appeared in what was being used as a storage space; but we didn't remove all of it because that period is part of its history and we don't eradicate that. Similarly, all of the timber work in the space that was put there in the 17th century by Christopher Wren to support the roof when he was surveyor of the fabric had to be preserved, and if we had to shore it up that would need to be invisible. In the event, it was in very good condition, and one of the most striking aspects of the engineering that Max Fordham did in that space was on the junctions between those timbers and the new oak floor."

The Weston Tower engineering came out of conversations between Ptolemy Dean and Price & Myers. "There was a lot of liaison with the archaeologists on site because we just didn't know what was underneath the area where the tower would be sited," Robbins said. "And we had long discussions about the geometry and how that could be made to work without compromising the structure of the tower." Once again, junctions between old and new were the subject of much discussion. The tower only touches the Abbey's fabric at two points: its entrance lobby next to Poets' Corner and at the top, where a corridor takes visitors from the staircase or lift into the Queen's Diamond Jubilee galleries. "It was important that it was very clear where visitors were stepping from new into old," Robbins said. ■

Back to the future in the BMW i8

It was the first plug-in hybrid sports car on the market and the newly refreshed version still leads the charge, writes Chris Pickering



It's hard to believe that the BMW i8 has been with us for five years now. The basic design has remained largely unchanged since it debuted at the Frankfurt Motor Show in 2013. And yet it still looks like something that has teleported in from the future, complete with its concept car looks and those wonderfully flamboyant butterfly doors.

It's not just a styling exercise, either. Underneath the lightweight (plastic and aluminium) panels, there's a carbon fibre monocoque, which is mass-produced using a resin transfer moulding (RTM) process. The result is an immensely rigid structure that's half the weight of steel and 30 per cent lighter than aluminium.

Power comes from a heavily turbocharged, three-cylinder petrol engine combined with a 105kW hybrid-synchronous electric motor. The internal combustion half of that package is based on the engine used in the MINI Cooper and the BMW 2 Series Active Tourer. Built at the Hams Hall engine plant near Birmingham, it squeezes 231bhp from just 1.5 litres. This is fed to the rear wheels via a conventional six-speed automatic gearbox, but that's only half the story. On the front end there's a self-contained 'eAxle' produced by GKN, which combines the electric motor with a differential and a two-speed synchro-shift transmission. This extends the motor's speed and load range, allowing it to work right up to the i8's electronically-limited top speed of 155mph. Combined, the two halves of the powertrain produce 374bhp; enough to propel the 1,535kg i8 from 0 to 62mph in 4.4 seconds.

Flick the cleverly concealed handles and the doors sweep up and outwards to reveal a cabin that's unmistakably BMW. There's plenty in here a 1 Series driver would recognise. But slide over the broad carbon fibre sills and it instantly becomes clear that you're in something far more exotic. The view out of the front is sheer supercar theatre, with a low, wide dashboard that stretches out beneath a steeply raked windscreen. The view in the side mirrors is dominated by the big rear flanks and the deep 'stream flow' channels in the C-pillars, which are designed to sweep the air around the sides of the vehicle, reducing its wake. There's also a fully flat underfloor, 'air curtain' vents that divert the air flow away from the rotating wheels and active air vents that open or close to reduce drag. All this adds up to a drag coefficient of just 0.26.

Revised battery

All-electric mode whisks you along on a near-silent wave of torque. Even without the internal combustion engine's assistance, the i8 feels sprightly, pulling away at something close to hot hatch pace.

Earlier this year, the design underwent a mild refresh, which saw the cell capacity increased from 20 to 34Ah, raising the battery pack's gross energy capacity from 7.1 to 11.6kWh (9.4kWh net capacity). This also allowed BMW to increase the motor's output from 96 to 105kW. According to the official figures, the new battery is good for just under 35 miles range, which equates to around 20 miles in real-world driving.

The eAxle's two-speed transmission is genuinely seamless, while the only noise is a distant whistle, which deepens in pitch when the regenerative braking kicks in. In fact, so quiet is the i8 in this mode that you start to notice sounds of the outside world, like snippets of conversation when you drive down a busy high street and the chatter of distant lawnmowers. It's all rather serene. So much so that BMW now offers an optional pedestrian alert system, which synthesises a turbine-like sound (similar to vehicle wind noise) at speeds of up to 19mph.

01 The futuristic-looking BMW i8

02 Wonderfully flamboyant butterfly doors

03 The interior is unmistakeably BMW, with a low, wide dashboard and steeply raked windscreen

Switch to Sport mode, however, and they will certainly hear you coming. The actual transition is remarkably hard to spot, but as you accelerate harder you become aware of the combustion engine's presence. It has a gruff, raspy note, which sounds great from inside or outside the car. True, the little three-cylinder engine can't quite match the aural drama of a Porsche 911's flat six or an Audi R8's howling V10 – and you can pick out the tell-tale warble of a stereo-enhanced engine note if you listen closely. But it is a genuinely satisfying soundtrack. The blipped down changes from the six-speed gearbox are a particularly nice touch.

It's fast, too. Perhaps not as savagely quick as the supercar styling might lead you to expect, but firmly into Porsche 911 or Jaguar F-Type territory. What's more impressive, though, is the way that performance is delivered. Despite running a hefty 2.0 bar of boost pressure, the engine shows absolutely no signs of turbo lag at all; any that may actually exist is simply brushed aside by the instant torque of the electric motor.

01

02


03

Split personality

The i8's battery pack runs down the spine of the chassis, where the transmission tunnel would sit on a conventional design. This mounting position allows the cells to be placed right down on the floor, resulting in a very low centre of gravity. The upshot of this is that the i8 attacks corners with real tenacity. On entry to a bend, the torque split is biased towards the rear wheels to improve turn in, while, on exit, the electric motor is used to provide additional traction.

In fact, there's never really any point where you feel the i8 has been compromised by its hybrid layout. There are occasional hints – the brake feel, for instance, still isn't quite as good as a traditional setup – but generally the two powertrains add rather than detract from the experience. In particular, you notice its dual personality as the i8 glides effortlessly from baby supercar to luxury tourer. It's even a refreshingly simple experience, with just three principle drive modes (Comfort, Sport and Eco Pro) and mercifully few other options to select.

So, how does it stack up as a real-world proposition? Well, driven enthusiastically, the i8 returns around 30mpg. That might not sound like much compared with the official NEDC figure of 134.5mpg, but bear in mind that some of its more traditional V8-engined competitors would be down into the teens under similar circumstances. What it loses to these cars when it comes to visceral thrills it arguably claws back in terms of refinement, cruising ability and sheer sense of occasion. Half a decade on from its launch, the BMW i8 still feels like a glimpse into the future. ■

Bringing together the UK's maintenance engineering community

Maintec, the longest standing exhibition dedicated to the UK's maintenance, plant and asset management industry will feature an impressive line-up of engineering industry speakers and exhibitors, when the show returns to the NEC, Birmingham on the 6 - 7 November 2018.

The show attracts thousands of engineering visitors from across multiple industries including; energy, manufacturing automotive, hazardous environments, aerospace, utilities, oil & gas, food & drink, rail and ports & marine. This is the second edition of Maintec since its acquisition by Western Business Exhibitions, who in 2017, delivered the most successful event in the shows' recent history delivering a 62% increase in visitor numbers and saw attendance of engineering teams from 15 of the UK's top 20 manufacturing sites.

For 2018, the show has introduced a number of new exciting initiatives to ensure the event remains valuable to attendees. Jos Diamond, event manager, Maintec comments, "When we acquired Maintec in 2016, we made a promise to ensure Maintec remained pertinent to the UK's maintenance and reliability engineers. We are incredibly proud in the quality of the 2018 programme and pleased to be able to host keynote speakers and leading engineering suppliers on the show floor. We know that they bring a wealth of experience and expertise to the show and make the event a must-attend for all UK maintenance, reliability and asset managers."

BACKED BY THE INDUSTRY

Many of the UK's engineering associations and institutions have endorsed the new-look Maintec event and will be in attendance. Leading organisations including the British Compressed Air Society, the only UK technical trade association open to manufacturers, distributors and end users of compressors, vacuum pumps, pneumatic tools and allied products, who are joined by the Society of Operations Engineers, the professional engineering membership organisation promoting career development in road transport, plant engineering, or engineer surveying, and the British Safety Industry Federation (BSIF), the trade body for the UK's safety industry.

maintec

NEC, Birmingham • 6-7 November 2018

HOME OF THE VERY LATEST MAINTENANCE ENGINEERING TECHNOLOGY

Event partner Bosch Rexroth and sponsors Kimberly-Clark, SSG Insight and Pruftechnik are just some of the manufacturers and suppliers who join the impressive list of exhibiting companies for Maintec 2018 which is fast becoming one of the best line-ups in the show's recent history.

> **When we acquired Maintec in 2016, we made a promise to ensure Maintec remained pertinent to the UK's maintenance and reliability engineers**

Maintec has become the perfect opportunity for visitors to touch, experience and buy the most state-of-the-art products available on the market today. It is the largest coming together of dedicated maintenance engineering suppliers with many exhibitors using the show as a platform to launch new products in the UK market place.

LEADING ENGINEERING EXPERT SPEAKERS

In addition to the stellar list of exhibiting companies, visitors will also be able to experience a dynamic CPD accredited programme which features 34 top

Visitor registration for Maintec 2018 is now live. To claim your free visitor badge visit www.maintec.co.uk

engineering speakers delivering ten hours of professional conference sessions over the two-day event under the theme 'The future of reliability, maintenance and asset management'.

Content will take place across two theatres; Maintec Insights and Reliability Dialogue. The Maintec Insights theatre will include a combination of case studies, technical insights and state-of-the-nation presentations from key high-level maintenance engineers including keynote sessions from Dr Jenifer Baxter, head of engineering, IMECHE and Paul Adams, maintenance strategy manager at GlaxoSmithKline.

The Reliability Dialogue theatre, which is new for 2018 and sponsored by Bosch Rexroth, will address the changing face of reliability, automation and the impact this has on the future of maintenance engineering. Over a mix of presentations and panel discussions, leading experts will discuss and debate key topics facing end-users in the industry and will feature an opportunity for the audience to join in the discussion and ask questions of the panel.

This year, the CPD accreditation will be approved by the Society of Operations Engineers ensuring the seminar content is relevant and educational for the engineering audience attending the show.

Free registration for Maintec 2018 is now open, visit www.maintec.co.uk

> **The Maintec Insights theatre will include a combination of case studies, technical insights and state-of-the-nation presentations from key high-level experts**

PROGRAMME HIGHLIGHTS

This year's Maintec Insights programme features some of the UK's leading engineering voices. Key sessions include:

How maintenance can improve performance and reduce costs
Delivered by Dr Jenifer Baxter, head of engineering, Institution of Mechanical Engineers
Maintenance activities are often viewed as a business cost. But if carried out effectively, they can deliver a long-term boost to the bottom line. Dr Jenifer Baxter, head of engineering, Institution of Mechanical Engineers, looks at how good maintenance can improve organisations' sustainability and reduce the long-term costs of engineering equipment. The presentation will also look at how advanced technologies such as augmented reality headsets might improve maintenance performance further still.

Building a winning plant maintenance strategy for modern operational needs
Delivered by Paul Adams, maintenance strategy manager (Global Manufacture and Supply) at GlaxoSmithKline
Plant maintenance should be viewed as a driver of value inside industrial operations. Paul Adams, maintenance strategy manager (Global Manufacture and Supply) at pharmaceutical giant GlaxoSmithKline, outlines the seven things all winning maintenance strategies have in common, and explains how a 'detect it, fix it, prevent it' approach to maintenance can delivering results quickly, therefore sustaining long term performance.

Next-generation rail technologies and maintenance activities. Technical expertise for building stronger railways.
Delivered by Stephen Lewis, consultant, rail technologies, British Steel.
Effective maintenance is crucial to the performance of the railways, with advances in rail welding techniques for activities such as gauge corner restoration delivering extended rail life. Stephen Lewis, consultant, rail technologies, British Steel, looks at how intelligent maintenance can improve the performance of the railway network, and describes how the railways can navigate the shift from a 'find and fix' philosophy towards one of 'predict and prevent'.

The role of artificial intelligence in future maintenance strategies
Delivered by Daniel Dunn, hydraulic product specialist, Bosch Rexroth
Digitalisation is being applied across industrial sectors at a rapid pace, providing far greater visibility of the performance and condition of key operational assets. Increasingly, the collation and interpretation of plant data will be used to create artificial intelligence models and to power machine learning. Daniel Dunn, hydraulic product specialist, Bosch Rexroth, will look at how these emerging trends will lead to the development of more intelligent predicative maintenance methodologies.

Closing the skills gap in maintenance-related industrial sectors
Delivered by Verity Davidge, head of education and skills policy, EEF
A shortage of skilled workers in the fields of science, technology, engineering and mathematics threatens the performance of industrial organisations. Verity Davidge, head of education and skills policy, EEF, looks at how businesses and academia can help alleviate the skills problem, and explains how the emergence of the fourth industrial revolution will change the skills requirements of tomorrow.

Assemble acquisition builds on BIM platform

Software-as-a-service solution to be integrated into Autodesk's project management tools Supplier: Autodesk

Californian manufacturing software specialist Autodesk has acquired a Massachusetts-based company, Assemble Systems, and plans to integrate its software-as-a-service (SaaS) solution into its Building Information Modelling (BIM) platform. BIM is a system that allows information on the components used in building design to be incorporated into digital plans.

The Assemble solution allows construction industry engineers and architects to query and connect BIM data to key workflows across different aspects of a project, such as bid management, estimating, scheduling, site management and finance.

"I welcome the Assemble Systems team to the Autodesk family, as part of our efforts to digitise and improve the construction industry," said Andrew Anagnost, president and CEO, Autodesk. "We are connecting project data from design through construction, creating the cloud-enabled tools necessary to make the critical pre-construction phase of a project more predictable and profitable."

Assemble's software-as-a-service solution

Assemble's products are used by more than 170 customers in nearly 1,000 sites and offices working on 12,700 projects, according to Autodesk. The two companies have already worked together, and Autodesk invested in Assemble in its Series A funding round last year. "We're excited about joining Autodesk and continuing to make BIM data more useful across construction project workflows," said Don Henrich, CEO, Assemble Systems. ■

Comsol simulation apps give mechanical engineering students the edge

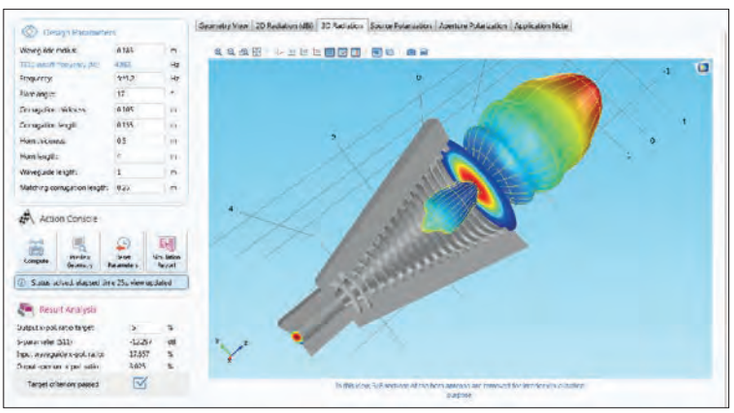
Hartford undergraduates build their own applications to gain deeper understanding of subject Supplier: Comsol

Simulation provider Comsol is giving a leg-up to students at the University of Hartford, enabling them to build apps using the company's software.

Ivana Milanovic, professor of mechanical engineering at the university, has pioneered the use of simulation apps by undergraduate students in the mechanical engineering programme. This inquiry-based learning method enables deeper understanding of the physics and theory underpinning the subject.

Students can then easily progress to learn more about the underlying model and even build their own simulation apps using the Comsol Multiphysics software.

"Our students tell us that the use of Comsol's 2018 simulation software has enhanced their learning and helped them to easily visualise difficult theoretical concepts without exposing them to the underlying complexity," said Milanovic.



Simulation apps serve as an easy entry point into numerical analysis. One such app, built by undergraduate students Iliana Albion-Poles and Jeffrey Severino, predicts the appearance of tones in a dual-stream four-strut nozzle for jet engines.

Their work is supported by the Connecticut Space Grant for Faculty Research.

"Once students are familiar enough with the concepts and the modelling techniques, they can eventually create their own apps using the Application Builder to further expand their knowledge and the reach of their collective analysis capabilities," said Milanovic.

Milanovic will deliver a keynote at Comsol's 2018 conference, which will take place in Boston in the first week of October. ■

PTC launches collaborative drive to tackle cybersecurity threats

Software firm calls on customers and partners to help identify vulnerabilities in IoT products Supplier: PTC

US software firm PTC has announced a new cybersecurity initiative that will see it working closely with customers and partners to deploy and operate Internet of Things products as safely as possible.

The Coordinated Vulnerability Disclosure (CVD) Program is designed to support the reporting and remediation of security vulnerabilities that could potentially affect the environments in which PTC's products operate, including industrial and safety-critical industries. The Internet of Things (IoT) has been a key focus for PTC for several years, with its ThingWorx platform designed to be a complete solution for the integration of industrial IoT technologies. At the company's recent LiveWorx event in Boston, Jim Heppelmann, CEO, invited partners and customers to work with PTC to improve security by helping to identify vulnerabilities.

The CVD Program is a key component of the company's Shared Responsibility Model, which defines a framework for cybersecurity collaboration with customers, partners and others in the industry. PTC will seek contributions from external researchers who detect vulnerabilities in ThingWorx products.

Jim Heppelmann, CEO of PTC

"Sophisticated software and hyper-connectivity are fuelling innovation at an unprecedented pace," said Joshua Corman, SVP and chief security officer, PTC. "Those conditions can potentially introduce new classes of accidents and adversaries. In this new world order, cyber safety and security must become everyone's responsibility, and we must work together to address such threats.

"PTC's CVD Program is one significant step toward such collaboration, inviting private individuals and organisations to identify and communicate security vulnerabilities in a way that we can quickly assess, mitigate and take corrective action to help further secure our products and customer implementations." ■

The answer is blowing in the wind

Record-breaking cycling simulation discovers the best position to occupy in a peloton Supplier: Ansys

In July, Chris Froome, Geraint Thomas, Peter Sagan and hundreds of fellow elite road cyclists completed the Tour de France. It's an event that is difficult for newcomers to follow. Why do the cyclists tend to ride in a huge bunch, known as a peloton? Why does the peloton so often catch up with cyclists who try to break away from the group?

The answer is the wind. Travelling at high speeds, cyclists experience wind resistance even in the still air, and with three weeks of riding and exertion, they will do anything they can to reduce their exertion. Riding in a bunch means that only the riders at the very front "break" the wind, as the unfortunate expression goes, and everybody behind them is sheltered.

It's always been known that this is an advantage, and cycling strategy depends on it. But it is not well understood how much of an advantage that is.

Working with colleagues at KU Leuven, software company Ansys and supercomputer manufacturer Cray, researchers at the Eindhoven University of Technology (TU/E), led by physicist Bert Blocken, put a model peloton consisting of 121 cyclists into a wind tunnel to investigate the phenomenon, and combined the results with those obtained from computer modelling.

The studies required three billion cells of computer simulation, a world record for a sporting application. To calculate a full peloton, the team had to run their Cray supercomputer continuously for 54 hours, using a total of 49TB of working memory.

In the middle and at the back of the peloton, cyclists experienced only 5 to 7 per cent of the air resistance of a solo rider. Blocken said: "It is as if a rider is cycling at 12 to 15kph in a peloton that is speeding along at 54kph. That's why it feels right that riders expend so little energy."

This result could help cyclists decide what is the best position in the peloton to suit their goal. For example, sprinters need to be able to "jump" off the front of the peloton towards the end of the race so that they can speed towards the finishing line. Riding right at the back might give the best protection from wind, but it also means that,to get to the front, you have to ride past the entire swarm of riders.

"So for sprinters and riders in the general classification – that is, the elite group that can compete to be the overall winner of the race – the best place to sit in the peloton would probably be the sixth or seventh row," Blocken said.

It may also influence team strategy and lead to long, flat stages, where breakaway riders are inevitably reeled in by the energy-saving group behind them, having very different outcomes.

"The calculation models used to determine the best time to escape are, it turns out, based on the wrong assumptions," Blocken said. "This may explain why so few escapes succeed and why the peloton hauls in the riders that do escape." ■

weisstechnik®
a schunk company

Market-leading test chambers. Now with industry-leading warranty.

THINKING OF BUYING A NEW TEST CHAMBER?
CHECK WITH US FIRST
CALL 01509 631595

Our market-leading test chambers now offer 3 years warranty and servicing with parts and labour included as standard. So, not only do you benefit from the best design and performance, you also get total peace of mind knowing that expert servicing is readily on hand. Plus we have stock available now for fast delivery. Contact the sales team on 01509 631595 or email enquiries.gb@weiss-technik.com

Weiss Technik. The best chambers just got better.

*Offer only available in the UK on selected chambers. Orders must be placed by 31.12.2018. Excludes current contracts. Enquire now for full details. Models shown here include optional extras.

Weiss Technik UK Ltd
Loughborough Technology Centre, Epinal Way, Loughborough, LE11 3GE
Tel: 01509 631595

www.weiss-uk.com

Imaging for a shrinking world

As electronics become ever smaller, inspection is a challenging business, but technology from Flir offers a compelling option for engineers

Supplier:Flir

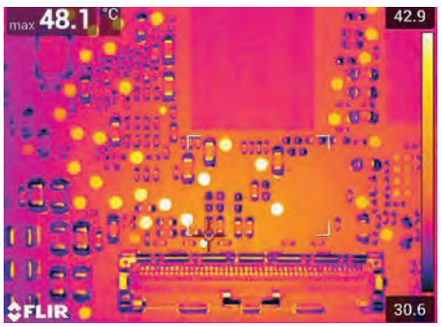
Thermal cameras are used throughout many stages of R&D and quality assurance. Electronics inspection is one of the most common applications for thermal imaging, which typically involves finding hot spots on printed circuit board assemblies (PCBAs) and ensuring various components are working within their design limits.

In today's world of shrinking electronics, the most common surface mount PCBA components can range in size from an 0603 (1.6mm x 0.8mm) to as small as an 0201 (0.6mm x 0.3mm). Accurate temperature measurements of these components require at least a 3 x 3 pixel area – or nine total pixels – on the target, with a 10 x 10 pixel area or greater being ideal for greater measurement accuracy.

For many thermal cameras, one pixel can cover 600µm – or 0.06mm – on a target; this represents the camera's spot size. So, to achieve the minimum 3 x 3 pixel coverage on an 0201 component, you would need a camera and lens combination that provides a much finer spot size – say, 100µm. An even smaller spot size would be needed to properly characterize the hot spots on a specific point on the 0201 component (Figure 1).

While thermal imaging is a versatile technology, using a camera with a single prime lens can be limiting. Sufficient magnification for electronics testing often requires additional macro lenses to reach the spot sizes required to detect hot spots, measure temperature, and properly characterize the thermal response of small components.

Having several of these lenses on-hand will produce superior images but isn't always cost-effective. Flir's macro mode offers a more flexible option when you want to inspect a wide range of small targets with a single lens. Macro mode allows you to capture accurate temperature measurements of small targets without changing lenses (Figure 2).



PCBA thermal imaging with macro mode

A Flir infrared camera with a standard 24-degree lens and macro mode enabled can reach a spot size as small as 71µm – no lens change needed. At this spot size, the camera can accurately measure temperatures and thermally characterize a 1.6mm x 0.8mm-sized 0603.

Traditional macro lenses are often challenged by their short working distance. And with the tall components on some PCBAs it can be difficult to physically position a camera close enough to focus on shorter components.

Flir's T540 professional thermal imaging camera

Flir's macro mode allows users to place the camera at a workable distance while still providing a small spot size. For example, a Flir T540 with 24-degree lens needs to be at least 150 mm from its target to capture a focused image. At this distance, the spot size will be limited to 140µm. Switching into macro mode reduces the minimum distance that a camera must be from its target, allowing you to focus on surface-mount components and other small objects instantly. The same hardware with macro mode enabled can provide a clear image from 60mm and achieve a spot size of 71µm – no lens change needed.

Macro mode works by adjusting the camera's detector position during the calibration process, which provides additional working distance between the sensor and lens. Enabling macro mode through a firmware update adds an "image mode" menu to the camera's GUI. However, since the thermal image's focus and clarity rely on the adjusted detector position, the visible light MSX imagery will be misaligned. This compromise means that a camera in macro mode will only save IR images.

Flir's macro mode is an innovative feature that offers R&D, quality assurance and other professionals the flexibility required for testing PCBAs and other electronic components without the need or expense of additional lenses. The standard 24-degree lens can be used to investigate a larger area or entire PCBA. Once a hot spot or smaller area of interest is found, enabling macro mode allows for more in-depth examination and thermal analysis without changing lenses. ■

Electronic device designers feel the heat

Tom Gregory, product manager at 6SigmaET, explains how advances in thermal simulation are helping engineers to meet the design challenges placed on modern electronic devices

Over the ast decade, consumer demand has driven unprecedented change in the electronics industry. Today, brands are manufacturing sleek and slender devices for multi-purpose use packed with high-performance hardware. To meet new demands, the size of electronic chips has been shrinking – which means that design and optimisation, among power, heat and performance, has become even more difficult.

The challenge for engineers is in placing powerful components into compact spaces without compromising reliability, usability or longevity. But with more power comes more heat. And with high power densities, there is greater focus on controlling heat output and managing its internal flow.

As a result, the importance of, and reliance upon, thermal simulation during the design process has increased – with a quarter of engineers testing their designs before producing any physical prototypes. Excessive heat poses a significant problem for electronics, with high temperatures leading to increased failure rates. But while overheating is certainly a major issue for modern devices, its effects are not always immediate or predictable, particularly as components and interconnects degrade through successive cycles of heating and cooling.

However, as devices become more complicated and simulations become larger and more detailed, engineers are turning towards more cutting-edge methods, such as conducting electronic and thermal simulation in tandem. Operating these two solvers together enables engineers to predict, with a greater degree of accuracy, the heat and temperature distribution in complex circuit boards. This helps them to predict when components will be exposed to excessive heat or inadequate cooling, taking them outside their design envelope, and impacting the mean time between failures (MTBF) for the product as a whole.

Previously, current flow and thermal analysis simulations have been typically conducted separately. But the desire to perform these simulations concurrently has risen alongside the complexity of modern electronic designs – as the physical spaces in which electronic devices have to work within are becoming smaller and smaller. The electrical function of modern devices is now so closely coupled with power distribution that conducting thermal simulation in isolation is no longer feasible. So, because the various elements within the chip are not isolated and easily confined, it is vital for engineers to consider the connection between (and interaction with) surrounding environments such as the package, PCB characteristics and the enclosure from a heat transfer perspective.

As functionality increases in smaller form factors, electrothermal co-simulation has been pushed to the forefront of many designs. A generally energy-efficient circuit can see internal temperatures soar due to spikes in current demand. This often occurs at local bottlenecks in the circuitry, and the device then runs the risk of overheating. While it's possible to identify this problem by conducting a simulation of the board-level current flow, thermal analysis is needed to ensure that there is sufficient heat dissipation and that the rise in temperature remains below the recommended levels.

For many modern devices, allowing any margin can be too expensive. For tablets and smartphones this is particularly true, as they possess so much functionality and processing power that (battery life not withstanding) they simply cannot run at maximum power to a steady state. At full power, they would simply overheat, or become too hot to hold. But by managing the relationship between power consumption and heat generation, engineers can ensure that their products provide the best user experience while also protecting the electronics.

Efficient electrothermal co-simulation may be achieved in many ways and will often require additional simplifying assumptions to speed up the calculations. For example, thermal boundary conditions may be derived from detailed CFD simulations and used in an extended circuit simulator or complex convolution and superposition techniques used to combine results from detailed simulations into a system which can be solved rapidly.

The final pieces of the jigsaw that will deliver co-simulation of the types described here are coming together. Firstly, the increased sharing and standardisation of design formats; secondly, the adoption of cloud-based solving hardware – which grants design teams (even those operating within modest budgets) access to high-powered, high-spec hardware, both easily and affordably. ■

The 6SigmaET thermal simulation software

SOUTHERN 18 Manufacturing & Electronics

Incorporating The Subcontract Engineering Exhibition
AUTOAERO
FARNBOROUGH • 6-8 FEBRUARY 2018

FARNBOROUGH | Hants | GU14 6XL

6th – 8th February 2018
9.30am – 4.30pm (3.30pm close Thurs)

2018 celebrates the event's 20th Anniversary with a move to the brand new FARNBOROUGH venue

The UK's must-attend event for every industrial engineering and manufacturing professional

Autosport
MARINE
Aerospace
Packaging & Logistics
Electronics
Automation & Robotics
Medical
Composites
Rail and Transportation

FREE SEMINARS
FREE PARKING

Meet over 800 national and international suppliers under one roof in the brand new Farnborough venue next February at Southern Manufacturing & Electronics (inc AutoAero) 2018.

See live demonstrations and new product launches of machine tools & tooling, electronics, factory & process automation, packaging & handling, labeling & marking, test & measurement, materials & adhesives, rapid prototyping, ICT, drives & controls and laboratory equipment.

Free industry seminar programme online @ **www.industrysouth.co.uk**

The exhibition is **free** to attend, **free** to park and easy to get to. Doors open at 9.30am on Tuesday 6th February.

Pre-register online now for your free entry badge and show preview at **www.industrysouth.co.uk**

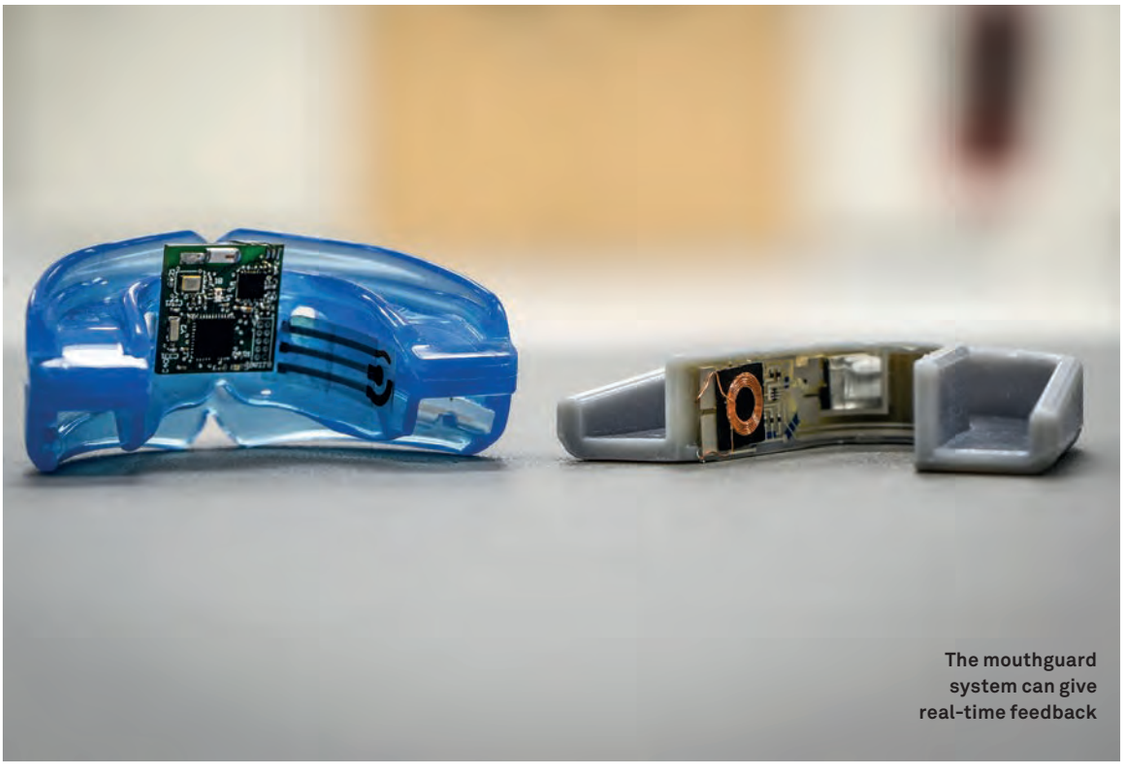
SOUTHERN MANUFACTURING & ELECTRONICS is an ETES event organised by European Trade & Exhibition Services Ltd

Tel 01784 880890
email philv@etes.co.uk

etes Regional Manufacturing Exhibitions

Register here with your smartphone

Advanced Manufacturing



The mouthguard system can give real-time feedback

New fabrication process creates wearable sensor for athletes

A new fabrication process has enabled the development of flexible-hybrid electronics embedded in a mouthguard to continuously monitor lactate, an advance that could help athletes optimise their performance.

Lactate is an important marker of fitness and fatigue and, by enabling continuous monitoring during training and sports, the mouthguard system is expected to give athletes and their coaches unique access to key performance information for real-time optimisation.

The wirelessly rechargeable electrochemical sensor – which uses Bluetooth Low Energy for data communication – is fabricated on a flexible plastic foil, then mounted on the mouthguard.

The mouthguard system is being developed by PARC, a subsidiary of Xerox Corporation, and the University of California, San Diego. It has received funding from NextFlex, a consortium of public and private entities formed to advance the development of flexible-hybrid electronics (FHE).

"In the semi-automated FHE fabrication process, the first interconnect is screen-printed on a flexible polymer substrate in a three-step process," explained Dr David Schwartz, project lead and manager of energy devices and systems at PARC. "The primary set of conductive traces are printed, a dielectric protective layer is printed in areas where two traces will cross over, [and] the conductive crossovers are printed.

"Next, anisotropic conductive paste [ACP] is extrusion-printed in the areas where component pads will be placed.

"A custom pick-and-place instrument is then used to place the discrete electronic components on the substrate. Heat and pressure is applied to bond them and electrically connect them via the ACP."

Schwartz said the primary challenges in this system related to making it work with a diverse set of components.

"We surveyed numerous anisotropic conductive adhesives, both pastes and films, and fine-tuned the heat and pressure application to enable bonding both of large and small components." **JF**

£100m for emissions research

The WMG High Value Manufacturing Catapult has received a five-year funding package worth £100m to continue its work on developing low-emission mobility solutions.

The funding is from £780m allocated to the UK's Catapult centres by chancellor Philip Hammond. In total, £271m has been allocated in the West Midlands, with WMG, the Manufacturing Technology Centre (MTC) and the Energy Systems Catapult in Birmingham all receiving funding.

Archie MacPherson, chief executive, WMG centre HVM Catapult, said: "The Catapult programme at WMG focuses on helping the UK become a world leader in low emissions mobility, from lightweighting vehicle components to make cars more fuel efficient, to accelerating the development of next generation technologies for energy efficient and autonomous transport.

"The investment will enable WMG to further expand its innovation capability to support companies of all sizes, to help them grow and create highly skilled jobs for the UK, in order to address the challenges of productivity, competitiveness and anchoring product manufacture in the UK." **JF**

Contents

MATERIALS

‘Lotus effect’ to repel water

Etching on metals recreates nature

STUART NATHAN REPORTS

Fraunhofer researchers have developed a method for creating a long-lasting “lotus effect” on metal surfaces, an advance that could lead to repellent coatings for aircraft.

Lotus plant leaves have a waxy covering that consist of microscopic structures in an ordered array. Water falling on the leaves forms into beads that role off, taking dust and dirt with them.

Researchers at the Fraunhofer Institute for Material and Beam Technology (IWS) in Dresden, working with the city’s Technical University and with Airbus, have now devised a method to use lasers to etch such patterns directly into metal surfaces.

Etched nano-patterns would be advantageous as coatings age quickly and deteriorate over time.

The world’s largest 3D DLIP system, based at TU Dresden
(© Fraunhofer IWS Dresden)

A team including project leader Tim Kunze, who heads up the IWS surface functionalisation group, has developed DLIP – direct laser interference patterning. It uses special optics to split a single laser beam into multiple partial beams, which recombine on the metal surface at which the optics are aimed. This creates very precise and controllable patterns of light and dark. When used on titanium, the team observed that the lasers ablated the material in the light areas, forming patterns that resemble halls of columns or corrugated iron roofs.

The distance between pillars can be set between 150nm and 30µm. This creates a surface on which water cannot “grip”; instead of spreading out to form a film, it beads and rolls off as with lotus leaves.

> “Water rolls of as on a lotus leaf”

Depending on whether titanium or polymers form the surface to be treated, DLIP can pattern up to 1m² of surface per minute. In addition, the DLIP laser heads can be integrated into standard industrial machines allowing medium-sized companies to access this technology.

As well as aircraft, nano-structured patterned surfaces could also be used to improve the biocompatibility of surgical implants. ■

4D PRINTING

Ceramics breakthrough

Complex shapes can now be printed

STUART NATHAN REPORTS

Scientists in Hong Kong have found that an elastomeric precursor allows 4D printing of mechanically robust shapes with complex geometry, with potential applications in electronics and aerospace.

Four-dimensional printing refers to the manufacture of geometries that can reshape or self-assemble, with the influence of external stimuli. It is particularly applicable to ceramics which are very difficult to print into complex shapes.

This has been a barrier to the structural application of ceramics, with the result that they have been largely excluded from the revolution that 3D printing has brought to the use of polymers and metals. The development from City University of Hong Kong (CityU) is to use a “ceramic ink” to print flexible forms that can be turned into a conventional ceramic material with heat treatment.

The ink, made from elastomeric poly (dimethylsiloxane) mixed with crystalline nanoparticles of zinc oxide, 20 to 50nm in diameter, can be printed and deformed through stretching, origami-like folding, or by using pre-defined joints and creases into complex shapes and then heat treated to turn them into rigid ceramic bodies.

Complex shapes made by ceramic 4D printing

“The whole process sounds simple, but it’s not,” said team leader Prof Lu Jian. “From making the ink to developing the printing system, we tried many times and different methods.”

The team developed two techniques for shaping the bodies. In the first, two forms – a 3D-printed ceramic precursor and substrate – were first made with the new ink. The substrate was stretched and joints for connecting it to the precursor were printed on to it. The precursor was then placed on to the stretched substrate, which was allowed to relax, morphing the materials into the desired shape.

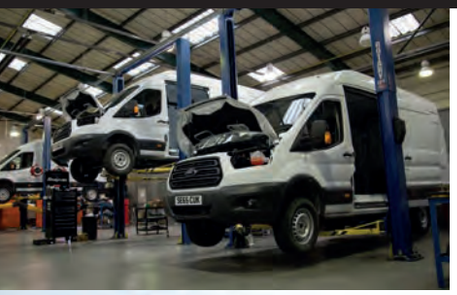
In the second method, a pattern was directly printed onto the stretched ceramic precursor. It was then released under computer control to morph into the final form.

Electronic devices will be an important application sector for this technology. Ceramics transmit electromagnetic signals much better than metals, and are expected to play a more important role in products such as mobile phones. ■

revolve™

The centre of excellence

revolve.co.uk



Revolve Technologies Ltd is a UK based company providing expertise in a number of Low Carbon Technologies to the Automotive and Marine industry.

- Hydrogen Systems
- Dual Fuel Technologies
- Electric Vehicles
- Hybrid Vehicles
- Fuel Cell Range Extender

With over two decades of experience and some of the best engineers in the business, whatever your engineering requirements, **Revolve** will deliver to exceptionally high standards.

OVER 20 YEARS OF EXCELLENCE

The **Revolve** business continues to provide engineering services for a number of OEM's, and has had much success in the development of Low Carbon Technologies for both passenger car and rail, and commercial vehicle applications.

We look forward to discussing your engineering needs.

RK ROSE+KRIEGER

A Phoenix Mecano Company

Tel: 01296 611660
Email: info@rose-krieger.co.uk
www.rose-krieger.co.uk
26 Faraday Road, Aylesbury
Buckinghamshire HP19 8RY

Machine Building and Automation Components

A subsidiary of the globally operative Phoenix Mecano AG, RK Rose+Krieger offers an unrivalled range of products in the field of profile assembly, linear, connecting and modular technology.

We work constantly and with great dedication on innovative products and solutions for our customers.

The range includes catalogue as well as tailor-made products. We are happy to advise you in choosing a product or to develop a tailor-made system solution with you from our extensive modular product range.

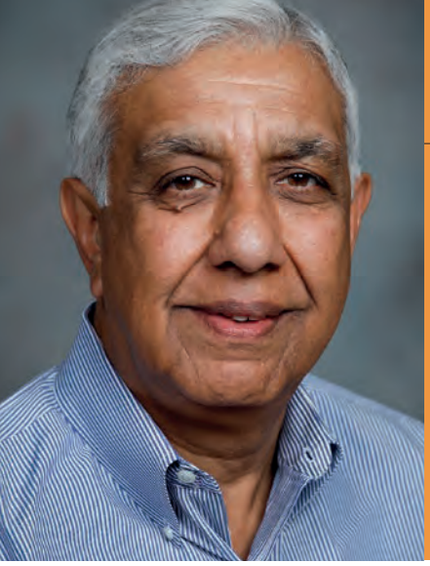
The many areas these components can be used in include machine building, construction of production facilities, automotive industry, aerospace industry, energy technology, medical technology and many more.

Profile Technology

Linear Technology

Connecting Technology

Modular Technology



Transforming metal additive manufacturing for automotive

General Motors' Anil Sachdev explores the industry's challenges with AM and what needs to change for it to become a mainstay technology

When it comes to the automotive industry, additive manufacturing (AM) is still very much the reserve of prototyping and small-volume parts, but we want to change this. Our charter is to take AM into high-volume manufacturing, making it an economically viable technology fit for automotive production. To do this we need product designs that exploit the specific benefits of AM and can also be produced economically in order to extend volumes from a dozen to at least one million per year. Until we can break this million-volume barrier, AM will keep hitting dead ends.

There are five main impediments standing between reality and this goal – three technical issues that speak to the 'can we make it?' question and two economic impediments that seek to answer the 'should we make it?' dilemma:

- **Machine size:** With most metal AM powder bed machines making a part limited to less than 400mm per side, there are only a few singular parts we can create in their entirety. And for small components, machine size still limits us to perhaps only creating five to ten at a time.
- **Accuracy:** The cost of AM is already high – and adding the labour and expense of post-processing makes the price for the technology too dear. Until AM can create accurate parts with minimal need for post-processing, it will not be economically viable for large-scale automotive production.
- **Materials:** Most AM materials are currently geared toward the medical or aerospace industries, where the volume (often singular in the medical field) and cost structure can justify expensive alloying additions. We need substantial developments in materials to support the high volumes required in automotive. This is the heart of the work I'm doing at General Motors R&D – using computation methods to design materials that are lower cost and meet our performance requirements when processed optimally with available AM methods. The alloys available don't necessarily exploit the rapid heating and cooling rates experienced in AM processes.
- **Throughput:** Currently, AM is too slow for automotive production, considering the rates relative to competing manufacturing methods. A stamping press can produce a part every six seconds, while additive takes several hours to produce a batch of small parts.
- **Cost:** As a high-volume and consumer-facing industry, cost is a major factor for automotive. For example, die casting (like AM) can combine many parts, but is almost two orders of magnitude cheaper. AM will have to compete with processes that have been optimised over the past 50 years.

All of these cannot be tackled by a single entity – or even one sector. While the machine builders are best positioned to continue to address size and throughput, our focus as an automotive entity is on materials development and processes. For example, I am researching metal powder development and processing as a function of throughput, which with advanced modelling techniques will help us to address – and overcome – AM's current impediments.

Metal powder is not new to automotive –about 300 metric tonnes of it are used per year in North America and it is recognised as an optimum solution when it comes to creating detailed, complex parts that need almost no post-processing. A 1:1 part substitution will not be sufficient to disrupt this well-established process. The driver to proliferate AM into the automotive sector will be aggressive designs that provide a key performance benefit.

The importance of adding value

The true stumbling block for AM is its value proposition. Even factoring in the increased design capabilities of metal powder bed fusion, the benefits still do not outweigh the cost of AM for medium to large numbers of components. To be adopted, AM needs to create better value than our current processes. We are trying to find applications for AM that make sense in high volumes.

Let's look at the evolution of the drinks can as an example of how this journey can progress. The original design was a three-piece, steel cylinder. Aluminium – though lighter – was too expensive. Looking to improve upon the cans, the industry invested in researching new materials and processes. As technology evolved, they were able to create a lighter, two-piece can using closed-loop recycling. Despite being the more expensive material, aluminium replaced steel because its properties added value to the process and the product. Its benefits outweighed its cost.

A collective effort

By overcoming its technical and economic impediments, AM can achieve similar results. Like the drinks can, we need collaboration across industries to enable high-volume production and new materials. Suppliers and OEMs all need to be involved as well as automotive businesses, start-ups and research institutions to drive innovation.

Collectively, we can transform AM into a more viable technology for the automotive industry. By mapping the elements of this 'journey' against the five impediments we need to overcome, we can start to develop a roadmap to take AM from prototyping to high-volume production.

The need for standards

As we get closer to the solution, the need for standards is beginning to surface. Rather than pre-empting the process and trying to anticipate what may be required, however, standards need to evolve collectively across the industry. For example, we're already calling for a level of standardisation so powder suppliers can work with multiple machine builders. With the hundreds of millions of parts we require each year, it is not sustainable for every machine builder to have its own unique powder.

Powder standards are only the tip of the iceberg – by spreading the word and communicating what is required, the industry can work together to support the evolution of AM. ■

Dr Anil K Sachdev is principal technical fellow at GM's R&D Centre Global Research & Development, General Motors

Leading the race

Machine tools, and the selection of the right ones for the job, underpin our manufactured world, from the glamour of F1 to the workaday business of… machine tool production. Mike Excell reports

For some 20 weeks every year, Sunday is also Formula 1 day. Millions follow the races on television; the petrolheads may have some appreciation of the trackside and automotive technologies behind the speed and glamour, but possibly little appreciation of the manufacturing processes which underpin motorsport. There's a reminder in the presence of the Haas brand on the grid, but machine tool technology is really a critical but unseen element of the infrastructure upon which all teams rely.

The relationship between Yamazaki Mazak and McLaren Racing provides a good example. Mazak has been the team's exclusive supplier of CNC machine tools for 19 years; chief operating officer Simon Roberts says that over 12 per cent of the car is produced on its Mazak machines. McLaren's Technology Centre has now taken delivery of three more machines: two full 5-axis VARIAXIS i-600 Multi-Tasking machining centres, and a QUICK TURN 250MY turning centre, taking the machine tool inventory up to 36.

This in-house capability helps tackle the changing rules within F1; in 2017, for example, McLaren changed every single Mazak-made part to comply with the new laws – with nearly 3,000 parts made in one week alone.

Producing in the UK

Heller, like Mazak, maintains machine tool production in the UK. Latest news from the company concerns the supply of a large, heavy-duty machine to GKN Aerospace Filton. A machine was required to complement existing capacity for rough-machining titanium aircraft components as GKN's customer dramatically increased demand over two years, and the Heller H 16000, with a high-torque spindle was selected. Notwithstanding its size and rigidity, it weighs under 50 tonnes, so the location needed no special foundations.

GKN exploited the H 16000's arrival to re-engineer a family of five structural aircraft components now being machined 24/7 from titanium forgings. The contract requires leaving a 3mm stock allowance ± 0.127mm over the entire surface of each part. None requires simultaneous milling in more than three CNC axes, so cycle time savings could be achieved on the 4-axis machine compared with the previous 5-axis process routes. For the largest of the five components (2,400mm by 200mm wide by 170mm), cycle time dropped from 70 hours across two operations to 52 hours, a saving of over 25 per cent. Similar reductions have been achieved on all parts, the smallest of which still requires 14 hours of machining.

Large workpieces are also the priority for the new DMC 1850 V vertical machining centre from DMG MORI, with 1,850mm x 700mm x 550mm axis travels and a maximum table load of three tonnes. Features include a one-piece cast iron bed, twin ballscrews in all axes and comprehensive cooling measures. The machine is designed to deliver high stability and extreme accuracy, including circularity of less than five microns, and so is suited to mould making and production of high-precision aerospace parts. Ergonomic operation is another feature of the machine, thanks to a door that opens to nearly two metres and a distance from the front of the machine to the centre of the table of just 677mm.

01

No swarf entanglements

Companies such as Astley Diamond Tools represent the other end of the machined component spectrum. This Birmingham-based business has invested in the latest Low Frequency Vibration (LFV) turn-mill technology from Citizen Machinery. LFV is based on initiating selectable sequences programmed at the machine control through 'G-codes' to impart the size of chip to be produced. Within three months of installing the Cincom L20-VIII LFV, the company has transformed blank turning operations for its diamond tool production. Proprietor Ben Astley points to the example of a batch of 500 rotary diamond burrs, produced for a Polish customer, that are used to fettle cast iron. An ageing machine used previously had to be stopped every five or so parts to clear the tangled 'bird's nest' of swarf. "It would take at least 70 hours to produce the batch," he says. "With LFV I complete the same order inside 16 hours. As swarf is chipped so finely, the only attention required is to change over the short bar feed and remove completed parts from the outfeed conveyor." The investment has also enabled new markets, underpinning a competitive sub-contract small part turn-milling service. Investing in appropriate technology is critical for any successful subcontract business – the Accranut Company, along with its sister business Coventry Collets exemplifies this, having purchased several machines from XYZ Machine Tools. Both companies actually serve the machine tool industry, Accranut developing locknuts for use by machine tool companies; supporting machine builders with bespoke fixturing and workholding; and

02

01 Mazak has been McLaren Racing's exclusive supplier of CNC machine tools for 19 years

02 Astley Diamond Tools transformed its business following installation of Citizen Cincom L20-VIII LFV for blank turning and the addition of a sub-contract machining service

03 Collets being produced on a XYZ SLX 355 ProTURN lathe at Accranut

03

04

05

04 Mould for a car mat machined on a DMG MORI DMC 1850 V

05 Heller H 16000 (fitted with automatic pallet changer)

manufacturing machine parts that are no longer available as standard. Coventry Collets focuses on manufacturing collets and feed fingers. Machines from XYZ include the latest LR series vertical machining centre – from XYZ's first range of Siemens-controlled vertical machining centres with linear rail technology. Accranut's CNC investment started in 2012 with two lathes and a bed mill, all using the ProtoTRAK control. Managing director Andy Davies comments on the latest move: "We had become so familiar with the ease of use of the ProtoTRAK control that I thought the next step was to bring in the XYZ 2-OP machining centre, (also ProtoTRAK control). However, after seeing a demonstration of an XYZ 750 LR vertical machining centre, the additional capacity swayed our decision. By adding a fourth axis rotary table as an option, we made further gains in capability." ■

Cutting tool developments

Roughing turbine blades

Traditionally, button-style milling inserts have been selected for rough machining turbine blades. The limiting factor is that feed rates are relatively low using this style of insert. The development from Cutting Solutions by Ceratizit of the MaxiMill HFC-TUR milling system addresses this, doubling feed rates. The insert design's large effective radius suits it to a variety of 3D machining applications and general face milling and its soft cutting action assists in cutting components with thin sections and large unsupported areas, such as turbine blades. The cutters can be used on lower-powered machines, that would not be suitable for high-feed milling style cutters.

ISO turning tools with internal cooling

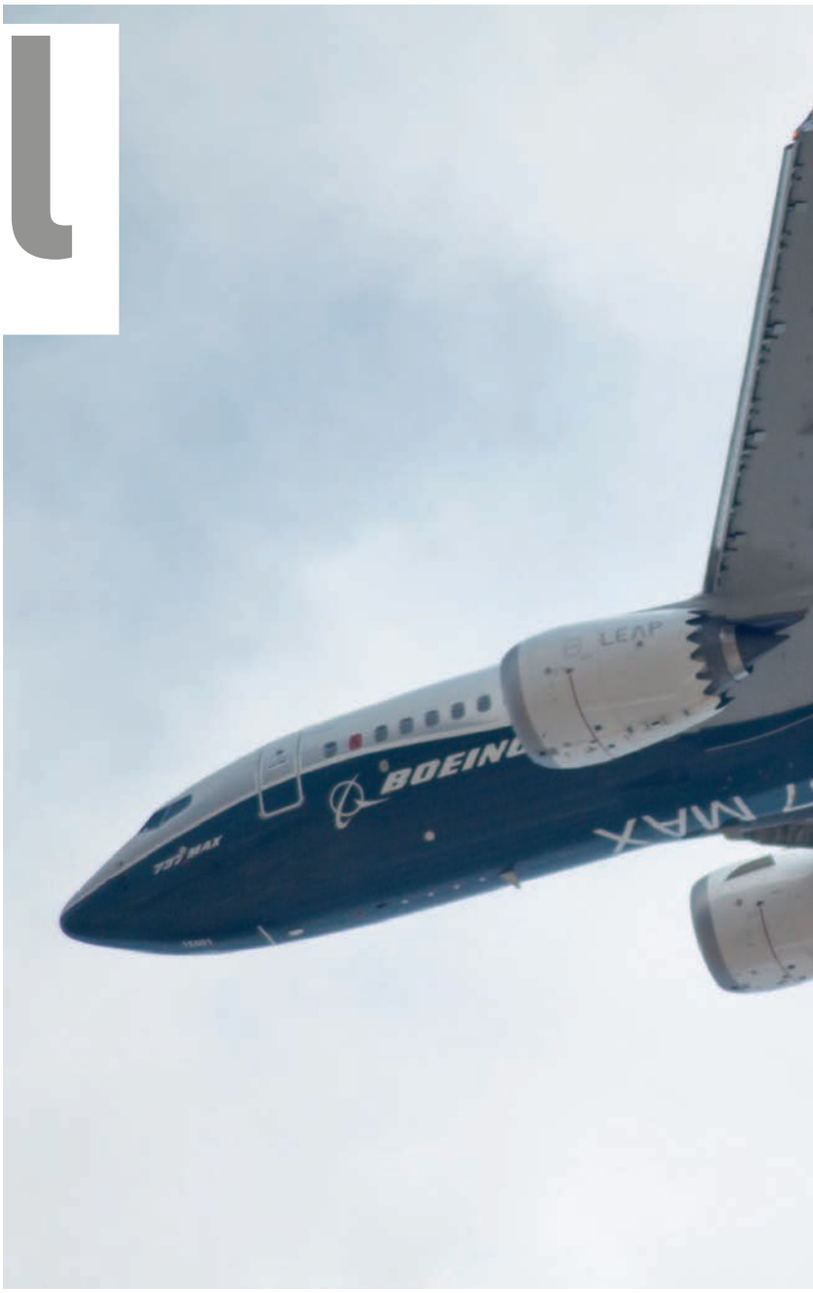
Ringwood-based Horn Cutting Tools has announced the availability of Boehlerit's new turning toolholders with connections for internal coolant supply. They are available from stock with toggle clamp (ISO-P) and screw clamp (ISO-S) systems, allowing manufacturers to benefit from the productivity advantages of cooling directly at the cutting edge. The P variety is suitable for all ISO indexable inserts. There are no loose parts and only a few spares are required, making them easy to handle. Inserts can be clamped quickly and securely and released easily. Chip flow is smooth, as there are no obstructions. The S toolholders also enable the insert to be secured simply and safely, in this case using a cone-shaped positioning screw. Here too, chip flow is not compromised and a maximum of three spare parts is needed. In both cases, the coolant is supplied at the back of the shank end as standard or from below the head as an option.

Sumitomo's HFT system uses octagon CBN inserts with special wiper geometry; trials show 12 to 16 times faster processing

Insert-based high feed turning system

Sumitomo Electric Hardmetal's High Feed Turning (HFT) system is said to deliver higher productivity hard turning at higher speed and feed rates. Performance is based on the more economic use of a specific design of octagon insert incorporating special wiper geometry, which enhances surface finish. Based on cubic boron nitride (CBN) insert technology, HFT hard turning trials have provided 12 to 16 times faster processing times over existing methods while enabling existing manufacturing surface finish and tolerances to be maintained. Also, insert life was doubled aided by the availability of eight cutting edges from the CBN insert.

Digital wings



How simulation and certification are helping aerospace adapt to additive manufacturing. Andrew Wade and Jon Excell report

Aerospace, by its nature, has to take a conservative approach to new technologies. Failure at 30,000 feet has consequences not commonly found in other engineering sectors, and a low tolerance of risk is inevitable. As a result, the aerospace industry has perhaps not enjoyed the same benefits of digitalisation that less risk-averse sectors have. But at this year's Farnborough International Airshow, the winds of change were blowing.

For the first time, Farnborough hosted an Aerospace 4.0 Zone. Exhibitors included SAP, Deloitte and Frazer-Nash Consultancy, alongside organisations such as the High Value Manufacturing Catapult and Sheffield's Advanced Manufacturing Research Centre (AMRC). While a range of digital technologies were on display, additive manufacturing (AM) and its potential benefits were undoubtedly the focal point.

"There are massive opportunities in aerospace for AM," Andy Brooker, additive manufacturing development manager at Frazer-Nash Manufacturing, told *The Engineer*. "It's kind of the perfect technology for it."

According to Brooker, the manufacturer has been working with several space companies over the past five years, laying a foundation for moves into the wider aero industry. But where space start-ups can perhaps tolerate some of the risks associated with nascent technologies like AM, the aviation giants must tread more carefully. Added to that, certification to operate in the sector can be time- and cost-intensive.

"We've just passed our second stage initial audit for AS9100 approval, and we now we go into a three-month cooling off period where they do all the investigation and check it all," Brooker explained. "So we should get that for the entire company around October. That'll enable us to go directly to aerospace companies like Boeing and Airbus.

"It's a lot of expense to pay out when there's no real guarantee of return. I

01 The Farnborough Airshow hosted an Aerospace 4.0 Zone for the first time in 2018

02 A Frazer-Nash Manufacturing part created using AM. The part was produced for Project Sirius, a biopropellant rocket concept developed by the University of Southampton

01

think AS9100 is about £20,000 for the initial audits, so unless you're going to get £100-150,000 back in business, it's kind of difficult to wage it. Because we already work with space companies, we can justify it without spending out for it."

Where Frazer-Nash Manufacturing has an advantage, said Brooker, is in its roots as a traditional machine shop. High-end AM parts will often require some CNC finishing, which the firm can easily provide, allowing it to offer an end-to-end service to the customer. Despite this, he doesn't expect the company's push into aerospace to be a gold rush, describing the process as more of a "slow burn".

"Aerospace is incredibly slow moving," said Brooker. "But it's an interesting time to be in aerospace."

Luke Hill, project engineer at the AMRC, agreed. But, like Brooker, he acknowledged that certification is undoubtedly a barrier to entry, especially for smaller manufacturers. "I think certification is still one of the big challenges," Hill explained. "Because we're a research institution, in theory we're in a good position to help with the certification side of things."

Inextricably linked to the certification issue – and perhaps the biggest challenge facing AM – is repeatability off the production line. Adoption will only gain momentum once there is confidence across the whole supply chain that parts are being produced exactly in accordance with their CAD dimensions, to tolerances that consistently compare with traditional manufacturing. It's an area that Hill is exploring at the AMRC, and one where simulation is playing an increasingly important role.

"One of the big problems for certification is the residual stress," said Hill. "How do you guarantee the parts have come off the way they should? How do you guarantee the part is going to be anywhere near the CAD model? So we're doing a lot of work at the moment on managing residual stress so you can minimise the defects during build, and also looking at simulation beforehand so you can understand how the part is going to behave."

Speaking to *The Engineer* at Farnborough, Paolo Colombo, aerospace and defence director at software giant Ansys, said advanced simulation tools are helping to drive innovation by giving engineers greater confidence and understanding of a range of new approaches and technologies.

"Additive manufacturing; electrification; autonomous systems – all of these things are bringing a huge amount of innovation," said Colombo. "If you want to keep pace with it you have to either bring more risks into the equation or find a way to keep those risks lower, and this is where simulation is playing a big role."

AM has huge promise for the aerospace sector because of how it enables manufacturers to optimise the topology of components and reduces weight. But while AM is already used to produce a number of aircraft components, its application is limited. Echoing the comments of Hill, Colombo noted that concerns over the variability of parts was holding the technology back.

"In an AM machine many phenomena are happening," he said. "You never have a good part the first part you bring back, and there are some deformations that are very hard to predict even if you are very experienced."

However, in a development that Colombo said could be truly "revolutionary" for the sector, Ansys has recently developed a simulation tool for selective laser metal sintering that understands and predicts the variabilities arising from AM. It then feeds this information back into the process and automatically changes the geometry in such a way that the end component exactly matches the desired design.

Based on technology developed by 3DSim, a company acquired by Ansys in 2017, this multi-physics simulation tool takes into account a host of complex thermal, mechanical and electronic factors, explained Colombo. As well as understanding the performance of the machine and the process – for instance the complexities of what's happening at the melting point – the tool also factors in the behaviour of the part immediately after the process.

"When you have the part done there is a certain amount of time where it is 'moving' because it's cooling and so again you want to understand the stresses and the probability that the microstructure of the part is the structure that you want," he said.

Another area where he expects simulation to play a prominent role is in the development of electric aircraft, a major emerging trend for the sector.

"We don't have experience in putting powerful electrical systems in a flying environment – nobody has it, it's something new," said Colombo. "So, if you want to build experience very quickly and explore the design space to understand the problems that could arise or what happens when you put the whole system together – you don't have any alternative to simulation."

Here again, the ability to carry out complex multi-physics simulations that take into account a huge number of variables will be key to helping get the technology off the ground.

While simulation clearly plays an important role in driving forward new innovations, Colombo believes it's also becoming a useful tool for the regulators who will ultimately determine whether these technologies fly or not.

"Most of the time you have to go for a physical testing route," he said, "but there are a number of conversations going on with the regulatory entities about the need to have simulation as part of the certification process." ■

Bugs in the system

Jet engine giant Rolls-Royce is exploring a range of advanced new techniques for carrying out turbine maintenance. Will Stirling reports

Big data is not new. Rolls-Royce pioneered engine health monitoring in the early 1980s, taking temperature and pressure readings inside its RB211 engines. Not only very useful for product development, the move was crucial in effecting a completely new business model, the switch from selling engines and spare parts to providing availability contracts to customers. Big data at Rolls began a defining move that would see the aeroengine maker provide airlines with the service associated with the product – flying hours – and made the iconic company synonymous with the term "power by the hour".

Several decades on, and Rolls-Royce's next strategy for product-services is IntelligentEngine, a vision that aims to bring three separate things together: product, service and digital.

"Our Trent family engines already possess some intelligence, but our IntelligentEngine vision is to see these circles completely overlap, that brings a different set of value propositions for the customer," said Richard Goodhead, SVP marketing at Rolls-Royce.

When they fully overlap, he says, the engine possesses the "three Cs": it is connected, contextually aware and has comprehension. Connected in the sense it is connected to all the engines in the fleet for comparative analytics, and contextually aware, measuring its environment, how the pilot flies the plane, atmospheric sulphur levels and so on.

The IntelligentEngine system needs intelligent maintenance technology. The company's aim is to provide as much maintenance as possible to the engine on the wing, pre-overhaul. Presented at the Farnborough Air Show in July by Rolls-Royce and partners including Harvard University and the University of Nottingham, Dr James Kell, on-wing technology specialist for Rolls-Royce, demonstrated several smart maintenance technologies. "This team is about developing new repair techniques to keep engines flying in service until needing to come in for overhaul," he said.

Remote boreblending

One technique is a boreblending robot that can be remotely controlled by a specialist operator, for example at Rolls-Royce's global flight management centre in Derby, but fitted to the side of the engine by a less skilled field service engineer. The robot looks inside the engine and scans to inspect and detect damage on compressor blades. Scans create a 3D point cloud, which generates the trajectories that the repair team need to perform the maintenance.

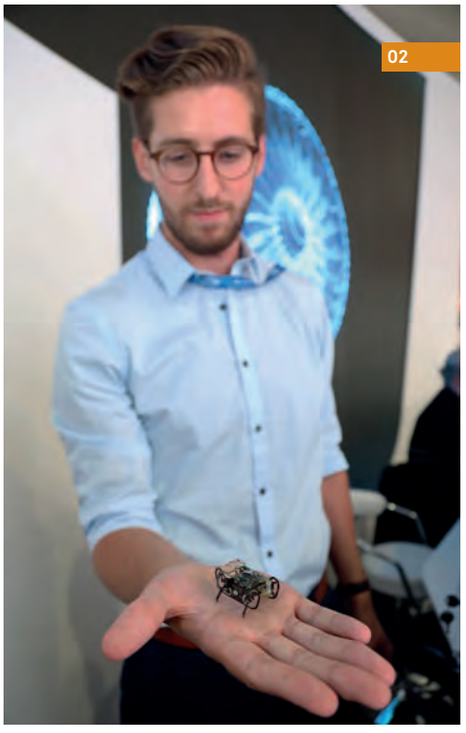
The device enables a skilled person to drive the robot and perform the repair while the engine could be on the other side of the world. "Sending out a skilled maintenance engineer to repair these is expensive, at times there are not enough engineers and it takes a long time," said Kell. "This will eventually allow us to service our engines in hours rather than days – potentially a revolutionary aid."

The project is part funded by the Aerospace Technology Institute (ATI), the research partner is the University of Nottingham, and has reached technology readiness level six; that is, demonstrations on real engines.

Snake robots

A device that can be used within remote boreblending is the "snake-robot" that enters the engine to search for blade damage and makes patch repairs on thermal barrier coatings, a collaboration between UK remote coatings company Metallisation and the University of Nottingham, which is also funded by the ATI.

The snake is tendon-driven using cables. It enters through the combustion chamber, inspecting the blade coating with a proprietary end-device, looking for any delaminating material. "It scans and takes all the cloud points to identify the damage," says Dragos Axinte, professor of manufacturing engineering at the University of Nottingham. "The operator then decides which are the points where the blade needs repair." It could then prepare the surface to allow for the second robot to come in and perform the coating deposition, or use a high-speed spindle to repair the blade. Data transfer is done by sending a package on a secure private internet.



01 Dr James Kell, on wing technology specialist, at Rolls-Royce, and Prof Dragos Axinte, director of Rolls-Royce UTC at University of Nottingham

02 Sébastien de Rivaz, research fellow at the Wyss Institute, Harvard University, with a SWARM robot prototype

03 An artist's impression of a maintenance bug

How rigorous is the repair? "For this process, we are just looking to make a patch repair," said Kell. "It will make it last until the scheduled overhaul, where those parts will then be replaced with new ones." Crucially he said, the remote repair avoids a very expensive unscheduled overhaul.

In another demonstration, 'Inspect' is a project helping the IntelligentEngine to become contextually aware. It is a network of 'periscopes' permanently embedded within the engine, enabling it to inspect itself using cameras to spot and report any maintenance requirements.

The bug inspectors

The snake-bot is really, as Kell describes, "a big piece of spaghetti with a camera on the end being operated with conventional techniques". The inspection of the combustion chamber could still take four or five hours.

Perhaps the most eye-catching project sees micro-cameras mounted to a 'swarm' of robotic beetles that work in a team to collaboratively map the whole environment.

Rolls is working with Harvard University on the walking device, the University of Nottingham on method for getting them in and out, with a joint funding proposal to EPSRC and National Science Foundation in the US.

The deployment mechanism is similar to that used for the snake robot, and spits out the miniature walking beetles that swarm to all parts of the chamber. They send what they 'see' to a central location to be interpreted as an image, viewed by the control team. "To inspect the area conventionally would take us five hours. Using this method – who knows? – it might take us five minutes," said Kell. The beetles then evacuate the chamber and the engine can be used.

The bug-robot takes its inspiration from the cockroach and has been developed over the last eight years. The robots weigh just 1.5g and measure 4.5cm. "We have focused on the manufacturing techniques for these robots," said Sébastien de Rivaz, research fellow at Harvard University. "When perfected they can have many applications, engine inspection is just one of them. The aim is to miniaturise them further to explore smaller cavities, using the swarm behaviour to make a large area scan."

Technology readiness

Will we see snakes and beetles sliding and scuttling over a Rolls-Royce Trent 1000 soon? Rolls-Royce has done engine demonstrations with the remote boreblending applications and expects to be going 'live', in service, with them soon. The beetles are TRL level 2, with much work remaining.

Goodhead stressed these futuristic gizmos are Rolls-Royce's vision, not proven technologies, and expects to accelerate their use after they are introduced. As for the competition, while Rolls-Royce is aware that competing engine manufacturers are working on aspects of the technology that are similar, everything displayed at the Farnborough Show is unique to Rolls-Royce. ■

Impcross ramps up aerospace production with Mitutoyo

Gloucestershire-based Impcross is expanding its use of Mitutoyo metrology equipment as it enhances its offering to the aerospace sector

Supplier: Mitutoyo

Impcross has recently shifted its strategy to focus exclusively on aerospace OEMs, having spent many years also manufacturing high-end components for the defence, petrochemical and motorsport sectors. Mitutoyo's equipment has been ever-present.

"Not only has Impcross worked with Mitutoyo since its inception, my father and company founder Richard Arnold previously owned another business and he's worked with Mitutoyo since the 1960s," said Steve Arnold, Impcross operations director.

Two years ago, Impcross won a contract to manufacture reverse thrust valve housings for a defence customer. To reduce weight, the housings are manufactured from aluminium. A critical feature on the housing is a thread that connects to a hose with a through pressure of 5,000psi. Producing an aluminium part capable of accepting such pressure, the customer developed a unique thread geometry that was developed in conjunction with its tooling supplier prior to awarding the contract to Impcross. With thread forms tied to a tolerance of less than 50 microns, the aerospace customer also supplied Impcross with a Mitutoyo Contracer CV-4500 to measure the thread forms

"We work in partnership with our clients and this particular OEM customer even provided the Mitutoyo Contracer to guarantee conformity," said Arnold. "From a conformity perspective, our Mitutoyo metrology equipment provides comprehensive

reporting and many of our OEM partners also use Mitutoyo equipment, so they are all too familiar with the format, quality, consistency and reliability of the Mitutoyo reporting system. This particular housing is a critical aircraft component and the Contracer CV-4500 is responsible for checking every housing. The Mitutoyo equipment has been integral to the success of our business." ■

Hexagon 3D scanner aids composite inspection at AMRC

The University of Sheffield Advanced Manufacturing Research Centre (AMRC) is automating composite inspection with an upgraded Hexagon 3D scanner.

Supplier: Hexagon Manufacturing Intelligence

The Hexagon Blaze 600A uses three high-resolution cameras to capture digital imagery to generate 3D models of measured parts. Its enhanced projection technology allows it to scan shiny, black and composite materials without the need for surface preparation, while compatibility with robotic installations means it no longer has to be manually guided by an operator.

"It offers a better understanding of the total part and total assembly performance," said Thomas Hodgson, large volume metrology technical lead for the AMRC's Integrated Manufacturing Group. "Traditionally, if you needed to scan something and it was composite or a shiny metallic part, the process was to use white spray which dulls the surface and allows it to be scanned. The problem with that is you have to clean the part and you have to buy the spray. It can be very costly.

"With this system, it's not just cost savings from a procurement point of view but it's time savings as well because you don't have to clean things and that's quite a big benefit."

A significant advantage of the new automated system is its greater speed, resulting in improved throughput and increased shopfloor productivity.

"The way the system works when it is used manually is that an operator has to put positioning targets on the part being scanned, which are small white stickers that the 3D scanner uses to position itself and recognise the part and where it is. That all takes time," said Hodgson.

"When you automate the system, you can rely on the robot to provide the repeatability so you do a one-off scan with the positioning targets and for each subsequent scan you don't need them. That's the advantage it has over other systems that still require these positioning targets." ■

We want to make work as straightforward as possible for you – doing so at the very highest level. Therefore, rather than simply optimising our configurator, we also completely overhauled it. The new HARTING Han® configurator offers a wide array of functions. You can not only save your solutions, reload them and share them with others, but also download the entire documentation at a single click.

Be inspired and discover new solutions!
www.harting.co.uk/the-new-han-configurator

HARTING®
Pushing Performance

Driving efficiencies through metrology

Better measurement has economic benefits for individual businesses and the productivity of the UK as a whole, says Bowers Group's Martin Hawkins

01

Accurate and efficient metrology solutions are absolutely essential for driving innovative advanced manufacturing. The greater the precision of measurement, the greater the speed of feedback from measurement to control, therefore increasing the effects on efficiency, quality and productivity.

Measurement also supports innovation by facilitating research and development. Metrology enables innovators to offer an objective method of demonstrating to customers the superiority of their product in relation to the competition.

The absence of such measurements may be unconvincing to a sceptical customer. However, if product characteristics can be measured in an objective, independently verifiable way, the marketing effort of the innovative producer can be fully supported. As a result, measurement can play an important role in avoiding market failure for innovative new products.

The Department for Business, Energy and Industrial Strategy (formerly BIS) regards measurement as one of the infratechnologies – the technologies that provide the infrastructure for further innovation. Measurement can also be considered a general purpose technology – a technology which will be widely used, and used for many things, and which has scope for improvement.

In its 2010 report: *The Economic Impact of the National Measurement System*, the department also alludes to Charles Babbage's *Economy of Manufacturers*, published in 1835. As a professor of mathematics, Babbage carried out an extensive amount of research into the practical details of how manufacturers went about their business, including the role measurement played in economic affairs. Babbage writes about the value of measurement precision in economising on the use of raw material inputs: "The precision with which all operations by machinery are executed, and the exact similarity of the articles thus made, produce a degree of economy in the consumption of the raw material which is, in some cases, of great importance."

Despite the fact that this was observed back in the 19th Century, Babbage makes a shrewd observation that measurement is not only an essential part of manufacturing, the assurance in the quality and accuracy of the manufactured products ensures direct economic benefits to businesses. For example, measurement allows businesses to provide customers with data to prove that parts are within tolerance, including clear records of measurement during the production process. In turn, rejects are kept to a minimum, operation costs are reduced and improvements are made to productivity, performance and quality. In short, when a business improves its measurement processes, the quality of the product naturally increases.

Measurement is also taking a leading role in process innovations in the UK with the new High-Value Manufacturing Catapult centres. Widely regarded as the catalyst for the growth and success of UK advanced manufacturing, the seven centres offer access to world-class equipment, expertise and collaborative opportunities. Advanced metrology for high-value manufacturing is, therefore, a key component in bridging the gap between technology concept and commercialisation.

As a world leader in measurement, naturally Bowers Group has encountered numerous ways in which metrology equipment has had a direct impact on a businesses' manufacturing efficiencies. For example, we worked closely with Moog Aerospace to provide an accurate and repeatable method of measuring critical components of servovalves used in a variety of different industrial applications, including aerospace. Bowers Group supplied Moog with an ACCRETECH Surfcom Roughness and Contour Detector, which has allowed the company to capture contours and surface roughness in a single measurement. As well as being quick, simple and accurate, the Surfcom is fully automatic and totally hands-free, so there's minimal operator intervention, therefore reducing the capacity for error. It can also take multiple measurements in one run and print them out in a collaborated document, which is a great visual aid for checking tolerance compliance, saving time and money.

Bowers Group was also able to provide a number of bespoke probes specifically designed for their processes. Their old method of measurement was causing the probes to break because of the manual intervention, but the new hands-free method has allowed them to save £12,000 a year on probes alone, not to mention significant amounts from their improved efficiency.

01 Moog has felt the benefits of investment

02 Martin Hawkins of Bowers Group

02

Metrology investment is no longer seen as an expense for advanced manufacturers; it is very much an asset. Planned measurement can improve a businesses' performance; not only does it make a big difference to efficiency, it's also a really important method of quality control, as well a step towards improving production at the design stage. It's not all about checking product conformity, it's about considering metrology at the early stages of production process design, and carefully planning measurement processes to lower production costs and improve productivity. The investments made in precision measurement can benefit all stages of the manufacturing process, and can also be used as a production management tool.

When specifications are improved by stating precise measurements and accepted tolerances, the quality of the finished product improves. Reducing the cost of rejects is a goal for any business; they're a big problem in manufacturing due to costs, and, of course, customer dissatisfaction.

Rejects can be minimised easily by investing in thorough measurement processes. In turn, the control of the production process is improved, as well as the quality of the manufacturing. By encouraging specified measurement requirements, each measurement requested is needed for a precise purpose, and based on actual requirements.

In conclusion, high-precision metrology equipment has a dramatic effect on the efficiency and productivity of manufacturing industry. Quality assurances drive efficiency, innovation, and ensures direct economic benefits to businesses. ■

Martin Hawkins is UK sales manager for Bowers Group

Over 100 years invested in the UK's future

Leonardo has over 100 years of history at the leading edge of advanced design and manufacturing in the UK.

Over 7,000 highly-skilled employees and a vast network of suppliers and partners design and develop industry-leading aircraft, electronics, space, defence and security systems for UK and export customers, worldwide.

Inspired by the vision, curiosity and creativity of the great master inventor - Leonardo is designing the technology of tomorrow.

leonardocompany.com

Helicopters | Aeronautics | Electronics, Defence & Security Systems | Space

LEONARDO

Regenerated.

The new and improved Engineer Jobs website brings you quality jobs across 45 sectors within the engineering industry.

With special functions allowing you to easily apply to jobs you're interested in, whether you are using your mobile, tablet or a desktop computer.

ON THE MOVE?

Get the jobs you're interested sent directly to your inbox.

FLAG IT UP

Flag jobs you're interested in as 'Favourites' and apply to them later at your leisure.

EASY CV UPLOAD

Use our nifty File Chooser that allows you to easily upload your CV from your computer, Dropbox, Google Drive and more.

ONE-CLICK APPLY

Easily apply to jobs you're interested in with just one click! Job done.

EXPERT INFORMATION

Get quality career related news, advice and insight for our expert Careers Insight section.

Search and apply today at theengineer.co.uk/jobs

THE EVENT FOR DESIGN-TO-MANUFACTURING INNOVATION

3D PRINTING | ADDITIVE MANUFACTURING | INSPECTION
MACHINE TOOLS | CAD/CAE/CAM/PLM SOFTWARE | MATERIALS
METROLOGY | MOULDING AND TOOLING | POST PROCESSING

25
26
27

SEPTEMBER 2018
NEC, Birmingham, UK

Being recognised as a world-class company is only achieved by constantly improving every part of your design-to-manufacturing process chain.

The pace of development in technology, materials and software is incredible and with over 300 cutting edge exhibitors that CAN help you enhance your design and manufacturing process, it is no surprise that more than 10,000 professionals from product development, engineering and manufacturing functions choose to attend the TCT Show every year. Join them this September.

WHATEVER YOUR MISSION,

Find your insights, intelligence and inspiration at TCT Show.

Register today at WWW.TCTSHOW.COM

tct SHOW

A chance to learn, network and gain inspiration

Manufacturing showcase will feature 300 cutting-edge exhibitors and 10,000 professionals from 60 countries

Running from 25-27 September at the NEC Birmingham, TCT Show 2018 promises to deliver business-critical insights on 3D printing, additive manufacturing (AM), CAD/CAE, metrology and inspection as well as conventional manufacturing processes such as moulding, casting and CNC machining.

Over the course of the three days, more than 10,000 professionals from 60 countries and 20 key industrial sectors are expected to attend the show to find solutions to their design and manufacturing challenges, to visit the event's 300 exhibitors, and to tap into the latest thinking courtesy of a conference programme consisting of 64 separate presentations.

"There's so much going on at TCT, this year's event will attract more people and showcase more technology than ever before," said Scott Humphrey, marketing manager for TCT Group. "Visitors will gain key insights into the latest AM and 3D printing technologies, materials and processes that will help shape the future of design-to-manufacturing innovation."

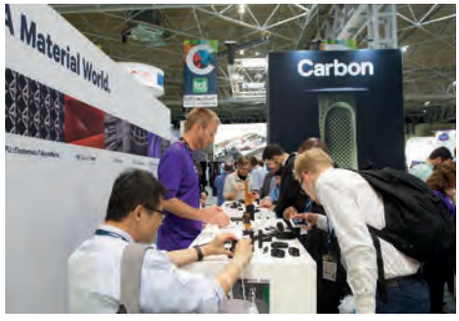
Visitors will benefit not only from the opportunity to connect with cutting-edge exhibitors, displaying the most innovative and dynamic technologies and services available on the market, but also from product launches, demonstrations and presentations from a world-leading speaker line-up.

Taking place across three dedicated stages, the free-to-attend conference will cover themes such as transport, healthcare, materials, design/CAD software, introduction to AM and skills for AM plus much more.

On the TCT Conference Stage, speakers from some of the industry's most prominent companies will share their experiences of how technologies are making a real impact in the manufacturing world. Meanwhile, over on the TCT Introducing Stage, the focus will be on the latest developments in hardware, software, materials and services.

TCT Tech Stage hosts captivating talks on the current issues in the manufacturing world. Leading professionals will share their knowledge on overcoming industrial challenges. They will discuss such crucial matters as data ownership, standards, skills and health and safety.

In addition to the conference and seminar programme, visitors to TCT Show will be educated and entertained throughout the three-day event with exciting show floor features, including Inspex @ TCT, which focuses on inspection and metrology technologies; TCT Inspired Minds powered by CREATE Education, providing more than 300 schoolchildren the opportunity to get a real hands-on experience; The Acceleration Zone; a new feature designed to help take new ideas to the next stage; and The Forum, an exciting new feature that will house exclusive exhibitor-led activities. ■



TCT Show takes place in Hall 3 of the NEC, Birmingham, from 25-27 September. Visitors can register for free at: https://tctshow.com/pr-register-now

TCT Show features insights into the latest manufacturing techniques and speakers from across the globe

Boost the efficiency of your production line

The smart manufacturing showcase will mark its 30th birthday in style this month, boasting 350 exhibitors, guests such as Mark Price and a new Enterprise Zone

Celebrating its 30th anniversary this year, the PPMA Show will return to the NEC Birmingham from 25-27 September to showcase the latest innovations in smart manufacturing, processing technology and packaging machinery, aimed at increasing production line efficiencies, and enhancing business performance and profitability.

Presenting the biggest and most comprehensive line-up of production technologies and solutions for the food and beverage, pharmaceutical, toiletries and FMCG sectors, visitors will see 350 exhibitors representing 1,500 brands. Leading players confirmed include Schneider Electric, Ishida Europe, Bosch, ABB and Omron Electronics UK, creating an unrivalled platform to connect, engage and network.

New to the show this year will be the Enterprise Zone, which will offer visitors a focal point for learning, networking, discovery and live debate. This area will include a series of educational features, including live workshops, presentations, interactive discussions, question and answer sessions, and panel debate covering key topical issues and industry trends.

The keynote address will be delivered by Lord Mark Price, minister of state for trade and investment, who will bring his years of experience as managing director of Waitrose and deputy chairman of the John Lewis Partnership.

The morning of day two will focus on the future of food manufacturing, hosted by Craig Leadley of scientific, technical and advisory services organisation Campden BRI. With presentations from the National Centre for Food Manufacturing, the Manufacturing Technology Centre and Campden BRI, the session will cover robotics and automation, augmented reality and the virtual factory, as well as preservation technologies and food safety management, and conclude with an interactive discussion.

There will be a full speaker programme running throughout the show, delivered by a line-up of high-profile and respected industry experts. Presentations and case studies will offer real examples of manufacturing best practice and excellence in processing and packaging production.

Networking will also be a highlight of the Enterprise Zone, with dedicated meeting areas and organised activities to facilitate engagement with industry peers. The Enterprise Zone will also feature a helpdesk and a free advice service for start-up ventures and entrepreneurs, as part of the PPMA's new Start-Up Ambassador Programme. Visitors will be matched and introduced to specialist experts, who will be available during the show to offer advice. Also present in the zone will be the British Plastics Federation to discuss the latest developments in materials and handling technology.

Dr Andrew Mint, chief executive of PPMA Group, said: "We know that there is still a tremendous appetite to seek out new innovations, technologies and solutions and to discover the unexpected. We therefore look forward to opening the doors of the PPMA Show 2018."

> "We know there is a tremendous appetite to seek out innovations"

September 1946 Post-war take-off

How *The Engineer* covered the Radlett aircraft exhibition


THE ENGINEER

The Society of British Aircraft Constructors Exhibition

THE ENGINEER

A Seven-Day Journal

By anyone's standards, the 2018 edition of the Farnborough International Airshow was a resounding success, with UK industry set to reap £28bn from over 1,400 aircraft orders and commitments made during the event.

The biennial aerospace showcase is organised by Farnborough International Ltd, which is a subsidiary of ADS Group, the trade organisation that represents Britain's aerospace, defence, security and space sectors.

ADS Group is itself formed from the merger of the Association of Police and Public Security Suppliers (APPSS), the Defence Manufacturers Association (DMA) and the Society of British Aerospace Companies (SBAC), which leads us to September 1946 and the forerunner of the Farnborough Airshow.

The seventh Flying Display and Exhibition of the Society of British Aircraft Constructors was held at the Handley Page aerodrome in Radlett, Herts and while the venue may have moved south, the aim of the show is as relevant now as it was 72 years ago.

The exhibition was the first since 1937 and held to show the world the products of the British aircraft industry to foster export trade. "Some 200 firms exhibited manufactures of aircraft, engines and components, and about 50 different types of civil and military aircraft were on view on the first day of the exhibition and were flown during the second day," wrote our correspondent.

The Radlett exhibition was closed to the public, due in part to a lack of suitable approach roads for heavy traffic, but that didn't deter the several thousand visitors, including many from overseas, who came to see what *The Engineer* described as the finest and biggest ever exhibition and display organised by the industry.

And while Farnborough's most recent efforts produced favourable financial outcomes, Mr WR Verdon Smith, then President of SBAC, provided visitors with some interesting figures of his own.

He stated that during the war the industry had built 125,000 aircraft, made spares equivalent to another 87,500 aircraft, and had repaired and restored to service a further 80,000.

"Since the war the industry had naturally shrunken in size," *The Engineer* noted. "We were now concentrating on the solution of new technical problems, and [Verdon Smith] believed that we stood well equipped for the development of all types of aircraft. Engine development was playing a remarkable part in our progress and we were fortunate in the lead we had in the production of pure jet and propeller jet equipment.

"Mr Verdon Smith stressed the urgent pressure of development which now characterised the aircraft industry, leading to much improvement in recent years in research and development equipment."

The technology showcased at Farnborough 2018 included Juno, the first aircraft with skin made from graphene, a material under a great deal of scrutiny due to numerous properties that include flexibility and strength.

At 3.5m wide, the Juno Graphene Research Aircraft – developed by engineers at the University of Central Lancashire and the National Graphene Institute in partnership with AMRC and Haydale Graphene Industries – is one that could help disrupt the aviation industry in the same way that the jet engine did. In 1946, the equally experimental Avro Lancastrian was on show. In its normal configuration the aircraft would be fitted with four Rolls-Royce Merlin engines, but the one on display had Nene gas turbines substituted for the outboard Merlin units.

The experiment was part of a programme of development of Rolls-Royce engines in flight, under contract with the Ministry of Supply.

"The objects of the experiment are stated to be to assess the efficiency of such jet engines in flight and investigate the performance with jet engines in a heavy aircraft," said *The Engineer*'s correspondent. "A comprehensive range of instruments is provided, with camera recording gear. The speed of the machine is said to be considerably improved with the piston-jet engine combination, and it has been flown using one Nene engine only, maintaining cruising speed in level flight."

In the same edition of *The Engineer* a description was provided of the Bristol Theseus, a jet and propeller gas turbine combination that marked the Bristol Company's first contribution to the field of gas turbines.

"It is evident that development in this field is going forward extremely rapidly, with keen competition existing not only between our own manufacturers but also between our products and those of the United States," wrote *The Engineer.* **JF**

Word of the issue

Anthony Poulton-Smith explores the origins of the word 'belt'

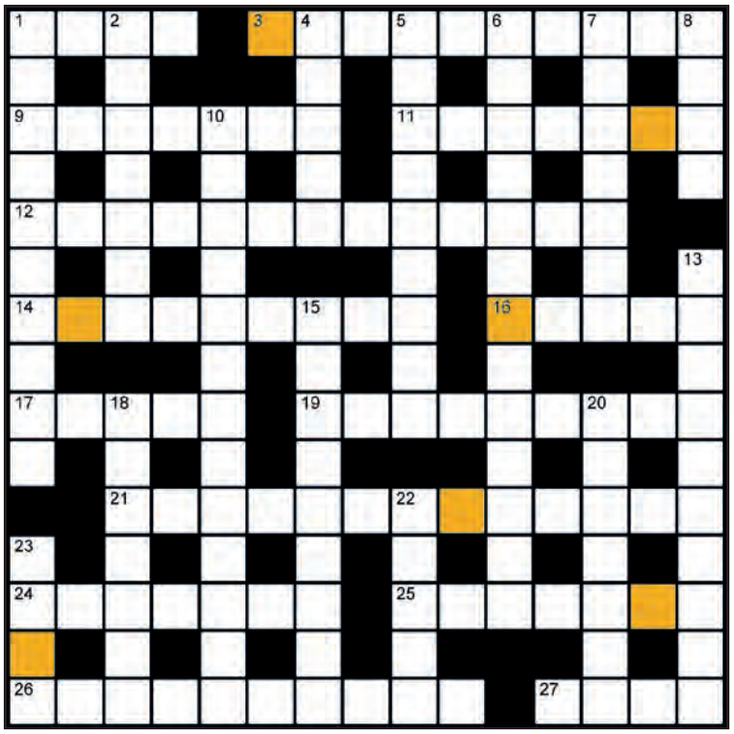
Virtually every machine uses a belt drive of some description. Indeed, a long and complex web of belt drives is often seen in imagery depicting early industry.

It will come as no surprise to learn the first use of 'belt' referred to a broad strip of material used in clothing, one encircling the waist. Firstly, this will have been to hold something and free the hands, such as a money purse or, as seen in the Latin balteus, a sword belt and others. All the terms, such as Old High German *balz*, Old Norse *Balti*, and Old Swedish *balte*, originate in the Proto-Germanic *baltaz,* 'belt, girdle'.

Note the engineering sense of the belt-drive is unrecorded before 1795. However, the earliest water-powered cotton mill came 25 years earlier – perhaps they used the alternative, 'strap'. The meaning is effectively the same for 'belt' and 'strap', simply the latter came to English from Old French estrop and can be traced to the Proto-Indo-European *strebh* meaning 'to wind, turn'.

Bigpicture

Bluebird K7 has taken to the water for the first time in 51 years following 15 years of restoration work by the Bluebird Project, led by project manager Bill Smith. Donald Campbell crashed K7 on Coniston Water, Cumbria, in 1967 during an attempt at his own world water speed record. K7 returned to water in August and completed successful runs on the waters of Loch Fad in Scotland. **Image: Mike Bull/The Bluebird Project**



Prize crossword

When completed rearrange the highlighted squares to spell out a suspension bridge across the Avon. The first correct answer received will win a £20 Amazon voucher. Email your answer to **jon.excell@centaur.co.uk**

Across

1 Powdery material in the air (4)
3 Course taken by aircraft (6,4)
9 A machine or tool for digging up plants (7)
11 Puts things in order (7)
12 Gained financially (6,1,6)
14 Remove from a list (9)
16 Can for storing tea (5)
17 Synthetic fibre (5)
19 Functional articles that equip a house (9)
21 Controlling mechanism in a steam engine (9,4)
24 Well-known resort area to the south-east of Honolulu (7)
25 Person who committed crime (7)
26 Any well-liked individual (10)
27 Scorch (4)

Down

1 Putting into a format to be read by computer (10)
2 More at right angles (7)
4 A stage of insect development (5)
5 Device for creating energy (9)
6 Visual indication to help vehicles (7,6)
7 Turned away or aside (7)
8 Fastener for a door or lid (4)
10 Degree of stress at which something snaps (8,5)
13 Office machine (10)
15 Unpleasant or disgusting (9)
18 Sheltered part of an object (3,4)
20 Dig up (7)
22 Bring upon oneself (5)
23 Pointed tools (4)

July's highlighted solution: Vauxhall. Winner: **Simon Williams**

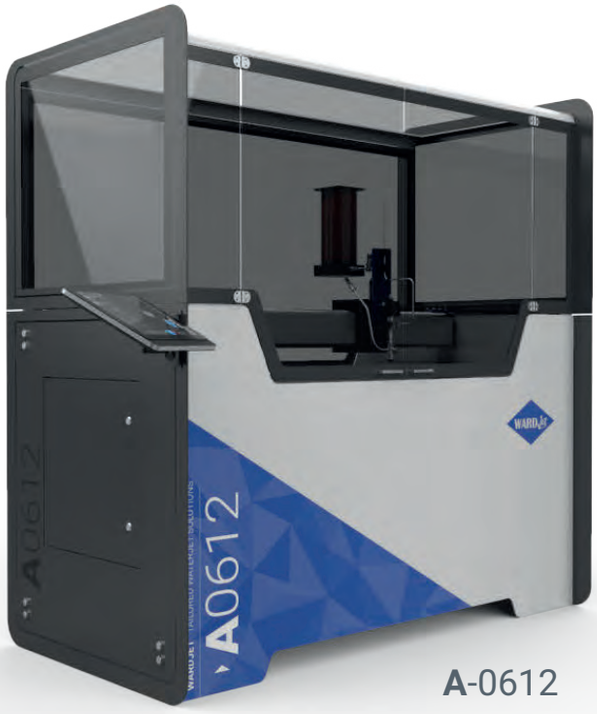
Waterjet Cutting Technology Now Available!

Open House

YOU ARE INVITED!

OCTOBER 10th 10am - 4pm

Telford 54 Business Park
Nedge Hill Park
TF3 3AL UK



A-0612

Now available at the **Telford sales and demonstration facility,** AXYZ International invites you to experience the incredible cutting power of our WARDJet waterjets during our October open house. Backed by years of automation expertise, our experienced staff will be on hand to fill you in on what you've been missing.

Ready to take your automation to the next level - reserve your spot today!

enquiries@axyz.com or call at: 01952291600

AXYZ INTERNATIONAL

WARDJet

www.axyz.co.uk

DCA

Helping our clients achieve success through great product design

www.dca-design.com