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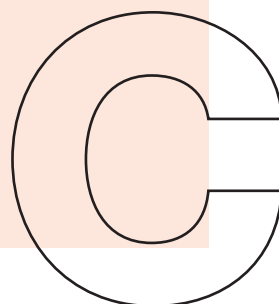
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our opinion

Under no illusions



lear, co-ordinated dialogue between industry and government has never been more important.

It's fair to say that in the corridors of Westminster the business of manufacturing tends to fall in and out of fashion depending on the economic weather and the enthusiasm of those concerned.

When times are tough, manufacturers – tangible wealth creators with a dynamic story to tell – are feted by politicians. When things are more settled, affections seem to cool. It's a pattern that's been repeated since the last General Election with the ever-present Vince

Cable giving way to Sajid Javid, a business secretary who didn't even deliver a major industry address until he had been in the job for several months.

However, in the aftermath of last month's momentous Brexit vote, it's vital that manufacturing – which accounts for more than a quarter of the UK's GDP and half of its exports – is at the centre of the decision-making process. And as politicians attempt to chart a course through the uncertain months ahead, it is critical that industry works closely with government to ensure that the UK retains access to the tariff-free markets and global skills base essential to its growth and survival.

So far, positive steps have been taken to ensure that these arguments are heard. Last week, in a welcome show of unity, the Royal Academy of Engineering announced

"Automotive sector leaders have refused to speculate on the consequences of a hard exit from the EU"

it was joining forces with the UK's 38 engineering institutions to present a united front to support and advise the government on negotiations.

But industry needs to dig in its heels. Indeed, at last month's SMMT summit, leaders from the UK's automotive sector, while ruling out any knee-jerk reaction, refused to speculate on the consequences for the UK of a hard exit from the EU.

It's hard to say whether the current administration is even capable of listening, but the early signs are that there is at least an appetite for dialogue. Indeed, making a rare public appearance at the SMMT's event, Javid explicitly called on industry to flag its concerns and pledged to do his best to secure a settlement that worked for industry.

We should all make sure that he and his colleagues are under no illusions about the challenges that lie ahead. ☺

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MEDICAL

Patient work for AI monitoring devices

Project investigates devices that keep tabs on critically ill patients

HELEN KNIGHT REPORTS

Artificially intelligent medical devices that are capable of continuously monitoring critically ill patients and administering treatments when needed, are being investigated in a UK research project.

The research network, involving the universities of Nottingham, Oxford and Warwick, will identify technologies that can provide more personalised and responsive care for cancer and intensive care patients, and those with chronic wounds.

The three-year, EPSRC-funded project, which is being led by Prof Stephen Morgan at Nottingham University, will investigate technologies to monitor patients and administer medicines or adjust treatments as necessary, using information from built-in sensors.

A particular focus of the research will be on devices that use the type of closed-loop control system of feedback and intelligence found in power electronics used to control motors, said Morgan.

"These continuously measure

and feed their output back into the system, so they can constantly adjust," he said. "So in healthcare, they would monitor a particular parameter relating to the wellbeing of the patient, and continuously adapt the treatments accordingly."

Mathematical models used in machine-learning for artificial intelligence (AI) will help technology designers to understand how the body works, and how diseases such as cancer behave.

The researchers will also investigate advanced sensors such as those based on optical fibres, said Morgan.

For example, 200,000 patients in the UK have a chronic wound, costing the NHS at least £3bn each year, or around three per cent of the nation's health budget. Smart wound dressings, consisting of fabric embedded with sensors to spot signs of infection and administer antibiotics, could help to reduce this burden.

Optical fibre sensors, in which the conventional fibre cladding is replaced with a sensitive coating, can be used to monitor parameters such as humidity, oxygen saturation and pH, added Morgan.

For example, high levels of humidity will affect the amount of light travelling through an optical fibre coated in a porous and hydrophilic film.

"You then don't need to remove the dressing in order to check whether a wound is healing or not, you can just monitor its environment," he said.

Meanwhile, technologies to help improve the condition of the 100,000 people admitted to intensive care units in the UK each year could include a device that uses sensors to continuously monitor a patient's breathing for irregularities.

"We could use a humidity optical fibre sensor to measure breathing rate, because as you breathe in and out you are expiring more humidified air," said Morgan.

The device could then automatically tailor the amount of oxygen being provided, and personalise the forces used to ventilate their lungs.

The researchers also hope that early detection and better treatment could substantially reduce the burden of cancer care worldwide.

As part of the project, three Grand Challenge workshops, covering wound care, critical care and cancer treatment respectively, will be held to bring together researchers, clinicians and patients. The workshops are designed to highlight the challenges faced by patients, and to identify the most effective monitoring and treatment.

The workshops will produce a roadmap for the development of closed-loop control systems for improving medical treatment.

A series of eight feasibility projects, funded by the network, will tackle any gaps in knowledge. ©

The NHS treats 200,000 patients with a chronic wound each year



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PROCESS

Pressure regulator goes with the flow

Invention could reduce the need for water pipe inspection and maintenance

HELEN KNIGHT REPORTS



The device could help minimise disruption in water processing

A smaller, lighter, and more efficient pressure regulator could significantly reduce the need for water pipe inspection and maintenance, cutting costs and minimising disruption.

The patented regulator, developed by Oxford Flow, a spin-out from Oxford University and backed by a £320m investment group, is 80 per cent lighter than existing technologies and is considerably more economical to manufacture than existing devices.

The pressure regulation/pressure reducing valve (PVR) can be made from either plastic or metals, allowing it to be used in applications including water, oil and gas transmission.

The technology was developed by the university's Prof Tom Povey, while carrying out research into gas turbines, jet engines and scramjets, alongside Rolls-Royce. He became frustrated when even the best commercially available regulators were not capable of handling the high pressures and flows typical of his experiments, and so set about designing his own.

Unlike conventional PVRs, the

devices are not based on the use of a flexible diaphragm. These are typically made from elastomers, and can become fatigued, brittle, or erode, meaning they need regular inspection and replacement.

The Oxford Flow devices have a simpler design, based around a direct sensing piston actuator. One side of the piston is exposed to downstream pipeline pressure, while the other is balanced against a pressure cavity controlled by a pilot regulator.

When the downstream pipeline pressure exceeds that within the pressure cavity, the piston moves inwards, reducing the size of the cavity. As it does so, it progressively moves over a number of feedholes, covering them and thereby reducing the flow rate. This allows the piston to maintain a stable downstream pressure.

"When demand increases, the downstream pressure falls below that set by the pilot and the reverse operation occurs, the cavity expands as the pilot feeds it, opening the flow path, which increases flow and maintains a stable downstream pressure," said Povey.

The devices are compact and lightweight, and have just one moving part. They also have high accuracy, according to Povey.

"The Oxford regulators have a fast-acting, very precise control of flow over the full operating range," he said.

The reduced size and weight of the devices, with their increased reliability and the flexibility to produce them in a range of materials, mean they have already attracted interest from the water industry, the company said. They could also be used for handling liquids such as oil, petrochemicals or drilling fluids. 

News**in**brief**After the vote**

EEF has sought assurances about the government's commitment to securing access to the single market and protecting the UK's trading relationships following the EU referendum. It has also called for the government to send a clear 'business as usual' message to Europe and the rest of the world. The manufacturers' organisation is also urging ministers to go ahead with investment decisions.

Driving forward

The UK automotive industry continues to make significant gains in employment, economic contribution and environmental performance, according to SMMT. The industry body's 17th annual *Sustainability Report* reveals that the automotive manufacturing sector turned over £72bn in 2015. Jobs, production output and vehicle sales all grew.

Bloodhound prepares

The Bloodhound Supersonic Car will make its first World Land Speed Record attempt in October 2017. After securing additional financial support, the team has been able to lay out a roadmap for the next 16 months. Bloodhound engineers who had taken short-term contracts elsewhere will return to the project to prepare the vehicle for its record attempt on the Hakskeen Pan in South Africa.

What goes around

Nexeon has completed a £30m funding round with existing investors and a new investor, Woodford Investment Management, taking part. Nexeon, an Abingdon-based developer of silicon anodes for lithium-ion batteries, will use the funding to acquire IP and complementary technology, open a development lab in Asia, and begin work on the design of a larger manufacturing facility.

MILITARY

Python is now a safer bet to clear the way

Minefield breaching benefits from upgrade

ANDREW WADE REPORTS

Python, the British Army's minefield breaching system, has been successfully upgraded and tested to improve its safety, according to manufacturer BAE Systems.

The device consists of a 230m-long explosive hose that is fired with a rocket into minefields from a towing vehicle – either a British forces Trojan or Terrier. The rocket used is a cast double base Anthony Rocket from Roxel, which includes a strip laminate case for added protection.

When detonated, Python then clears a path at least 200m long and 7m wide, allowing defence forces to cross safely. A BAE spokesperson said the detonation of the hose is fully automatic and occurs after the hose lands, "once the built-in Safety, Arming and Firing Unit has detected the required launch and flight conditions". Two devices can also be used in tandem to clear a 400m-long path.

Python has now been upgraded to include an Insensitive Munition explosive, so it is resistant to bullet attacks that could threaten user safety.

"The hose fill in Python is a reduced vulnerability explosive, Rowanex 4400M, designed as an integral part of the Python system to be compliant with the UK MoD's Insensitive Munitions policy," BAE Systems' spokesperson explained.

"Rowanex 4400M is formulated to meet the performance requirements of the Python system in the form of a ground-penetrating, mine-disrupting blast wave but to also demonstrate reduced vulnerability to a range of hazardous stimuli such as bullet impact and fuel fire." 

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BECKHOFF

Integrating additive manufacturing with standard CNC machining

Hybrid Manufacturing Technologies has developed a unique CNC-based hybrid tool control solution that enables virtually any CNC machine or robotic platform to deploy both metal-cutting and metal-adding heads in the spindle and conveniently change between them.



Hybrids system uses Beckhoff controls to integrate additive manufacturing with standard CNC machining

Founded as a commercial entity in 2012 by Dr. Jason Jones and Peter Coates, Hybrid Manufacturing Technologies actually began life in 2007 when the active use of a high-speed milling machine was initiated at De Montfort University's Additive Manufacturing (AM) and 3D printing research laboratory. The cross-pollination of additive and subtractive technologies led to a four year, UK-based research project named RECLAIM (REmanufacture of high-value products using a Combined LAsEr cladding, Inspection and Machining system) with support from the Technology Strategy Board and a number of industrial collaborators.

ADDITIVE MANUFACTURING

Key to the technology is its ability to provide both metal adding and metal removal tools on the same spindle; operations normally undertaken by discrete machines and requiring lengthy additional changeovers and programming steps. This also means that the majority of metal parts made by additive manufacturing can have post-processing operations, such as polishing, milling and surface blasting, performed without

having to locate to another manufacturing cell, resulting in fabrication and surface finishing being achieved in a single setup. The hybrid approach also allows different compositions of materials to be used in the same component, while in-process inspection can assure quality levels otherwise impractical or impossible to evaluate.

The company initially had issues – relating to both the Ethernet communications and the HMI – with its original control solution, which lead to the first contact with Beckhoff Automation in 2014. The result of this collaboration was a control solution that not only addressed the communication and HMI issues, but also facilitated easier connection at customer sites and offered greater capability to expand the solution as the technology and the customers' needs evolve.

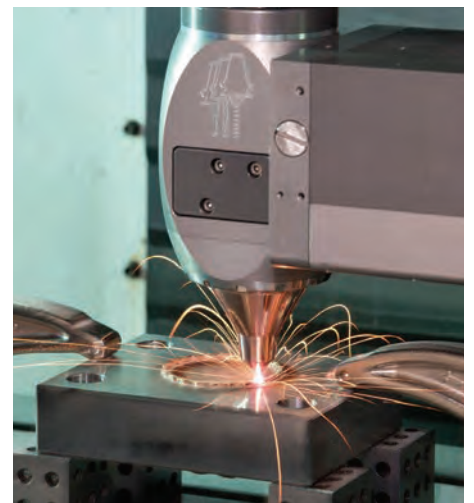
The technology is compatible with most CNC machine configurations and robotic platforms and can be supplied in collaboration with an OEM as an option on a new machine or added as a retrofit to new or used machines already in the field. A machine tool builder adopting Hybrid's system can use it to add additive manufacturing to the capabilities of a

standard machine. Hamuel, for example, first introduced an additive-capable model to a line of their machine tools in 2013 and several other machine tool builders have followed suit.

The current Hybrid system supports a range of AMBIT™ processing heads with different geometries, laser profiles, powder delivery configurations and de-focused energy beams to support tasks including 3D deposition, cladding, marking, cutting, drilling, pre-heating, annealing/stress relieving, surface re-melting and cleaning among others. The default setup accommodates up to 15 processing heads, but it can be expanded indefinitely, subject to space in the tool changer and controller capacity.

Beckhoff's motion control solution comprised a number of elements from its industry-leading portfolio. These included the EK1100 EtherCAT Coupler and other EtherCAT terminals and a Beckhoff CP2218 panel PC running Microsoft Windows 7 and TwinCAT 3 software for programming and control. Hybrid Manufacturing Technologies were particularly impressed by the Beckhoff HMI solution and the ability to deploy EtherCAT in the machine head.

Peter Coates, Co-founder of Hybrid Manufacturing Technologies elaborates on the technology and its capabilities: "We can make bespoke heads for customers, depending on their precise application needs, and these heads can be attached to virtually any machine tool. Looking beyond the machine, Beckhoff's use of EtherCAT means that connection to other cells is straightforward, and being based on a Window platform makes interfacing with Enterprise Systems far simpler from a protocol perspective and can leverage existing communication backbones. We will be looking to deploy Beckhoff systems in our standard product offerings as we expand worldwide, in step with the granting of foundational patents and intellectual property rights around the globe."



The unique head is controlled using Beckhoff's motion control solution

EASY TO USE

Commenting on the move to a new control solution, Peter Coates, explains: "It was a bit of a culture shock, as we were used to working with software and hardware from another supplier, but we were able to do all the programming using the TwinCAT 3 software with minimal training. We found it incredibly easy to use and will exploit further training opportunities to improve our knowledge of the system's capabilities. The beauty of the structured text programming is that we don't have to change the platform, this also allows us to expand it seamlessly by simply adding new PLC code and all of the controls run the same code, which is unbelievably useful. The connectivity will also allow us to license the software in a way that allows users to deploy it on a pay-per-use basis."

By offering an open architecture running on off-the-shelf software solutions, Beckhoff products can be used as separate components or integrated into a complete and seamless control system. This open approach also facilitates integration into customer sites, especially in relation to the deployment of Ethernet-based control and ERP solutions.

www.beckhoff.co.uk

MEDICAL

Prosthetic lower leg is prize asset

Linx incorporates robotic microprocessor control of knee and ankle joints STUART NATHAN REPORTS

The Royal Academy of Engineering has awarded its top innovation prize, the MacRobert Award, to a team of engineers that

has developed the world's most advanced commercially available prosthetic lower leg.

Prof Saeed Zahedi, Nadine Stech, Andy Sykes, David Moser and Rob Painter, who all work for Basingstoke-based clinical rehabilitation equipment producer Blatchford, won the award for the Linx prosthetic lower leg, which incorporates robotic microprocessor control of the knee and ankle joints.

The Linx system (*The Engineer*, June 2016) uses sensors in knee and ankle that communicate with a central processor, adjusting the contribution of assisting and braking mechanisms in both joints to adapt to the user's gait, activity, environment and terrain, handling 400 messages per second between the two joints.

This means that the prosthetic will,

The award-winning prosthetic leg



for example, lock when the user is standing still, allowing the user to relax and eliminating the need to hold the limb steady and balance, which requires energy and concentration with a conventional prosthesis.

Unlike the powered below-the-knee prosthetics developed by Hugh Herr of MIT, the Linx system works for above- and below-knee amputations and does not use motor assistance. Linx users do not have to meticulously plan their days to take account of the terrain they might encounter, giving them more

"Blatchford has combined compassion with huge ambition"

Dame Sue Ion,
MacRobert Award

freedom and confidence. The knee is programmed over Bluetooth when first fitted, then recalibrates itself some 4,000 times over the course of a typical day.

Chair of the MacRobert judging panel, Dame Sue Ion, commented: "Blatchford has combined a compassionate approach to patient needs with huge ambition and exceptional systems engineering. In doing so, it has created the first-ever integrated lower limb that behaves like a human leg, and produced a platform technology that signifies the beginning of the next generation of prosthetics."

Dame Sue also noted that Blatchford has retained its manufacturing base in the UK, although the NHS has deemed Linx too expensive to supply to patients; most users are in the US, Germany and Norway.

Long-term savings can be achieved, however, as Linx can potentially reduce secondary treatments required for back pain, arthritis, falls, and sound-side joint replacements, and extending the life of sockets. ☐

AVIATION

Greener horizons

Electric propellers are flying high as NASA project looks at reductions in aviation energy

NASA's new X-plane will be powered by 14 electric propellers, as the US agency looks to explore the frontiers of green aviation.

The X-57 is part of NASA's New Aviation Horizons project and researchers working directly on the new aircraft have nicknamed it 'Maxwell', in honour of the 19th century Scottish physicist James Clerk Maxwell.

Maxwell will start life as a prototype built using a modified Italian-designed Tecnam P2006T twin-engine light aircraft. The original wing and piston engines will be replaced with a long, thin wing



NASA's X-plane

embedded with 14 electric motors. They will power one large propeller on each wing tip for cruising, plus 12 smaller propellers on the leading edge of the wings.

NASA hopes to validate the idea that distributing electric power across multiple motors will lead to a five-time reduction in the energy required for a private plane to cruise at 175mph. **AW**

MEDICAL

Taking a more realistic look at the neurons

Model means better studies of brain-cell operation

HELEN KNIGHT REPORTS

A three-dimensional 'brain-on-a-chip' should provide researchers with a more realistic model of neurons and how they are affected by different medicines, according to its developer.

The 3D array, consisting of a sieve-like structure with hundreds of openings shaped like inverted pyramids, has been developed by Bart Schurink, a researcher at the University of Twente's MESA+ Institute for Nanotechnology.

It will allow researchers to carry out more realistic studies of brain-cell operations than the conventional 2D model consisting of a petri dish with flat electrodes, Schurink said.

"If you culture cells on a 2D surface, the cells will become flat, and they will not be in their evolved morphology, or shape, anymore," he added. "What biologists believe is that cells in the body have a round shape, and to get more

representative results, you need to have this round morphology on your electrodes."

The structure, known as a micro sieve electrode array, contains 900 pyramid-shaped openings. Each of these openings is equipped with an electrode to measure electrical signals from the cells or send stimuli to the network.

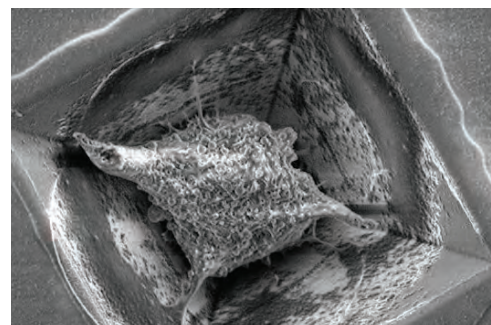
"This means that you can essentially do single-cell recording of each of the neurons, instead of seeding cells at random on a 2D electrode," said Schurink.

Liquids can also flow through the holes, allowing researchers to pass nutrients or medication to individual neurons. Neurons form a network once they are placed inside the pyramids. A micro reactor on top of the array allows the network to grow vertically, as well as horizontally.

Growth and electrical activity can then be monitored, with each cell identified by the particular pyramid it is located in.

The micro sieve electrode array has already been tested on living cells. ☐

The 3D array is a sieve-like structure



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INSTRUMENTATION

Manufacturing at the atomic scale

Insight into surfaces could lead to more precise and less wasteful processes HELEN KNIGHT REPORTS

Faster, more precise and less wasteful manufacturing processes could be developed, thanks to a scanning technology that

provides an unprecedented insight into surfaces at the atomic scale.

Researchers at the Centre for Materials and Structures at Liverpool University, led by Prof Paul Chalker, are establishing a Low Energy Ion Scattering (LEIS) facility with funding from EPSRC.

The technique directs beams of low-energy ions at the surface of an object to reveal information about the atomic structure of the surface.

The researchers aim to develop a tool to examine the surface of

the charged particles interact with it, according to Chalker. "They hit the surface of any material you want to look at really quite gently, and the ions interact with the atoms in the surface of the material and bounce back," he said.

The amount of energy the ions lose when they interact with the surface depends on the mass of the atom, he said. In this way the technique can reveal details about the type of atoms in the surface of the material.

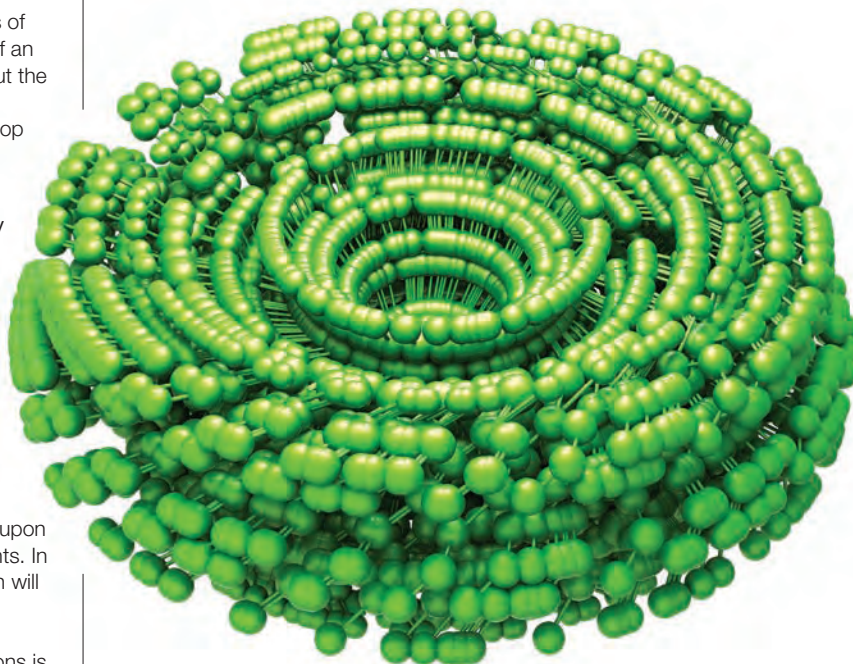
"By tuning the energy of the

incoming ions, you can look at the very outer surface of the material, or you can tune the scattering process so that you can look just underneath the surface," said Chalker.

The researchers plan to combine the LEIS technique with a processing chamber, which will allow samples to be treated using different manufacturing techniques and then intermittently characterised without exposing the surfaces to atmosphere.

"Our project couples together a LEIS spectrometer with a manufacturing chamber, to allow us to simulate various manufacturing environments," he said. "We can put various component parts into the simulated environment, and then we can process them by adding or removing material."

By carrying out repeated cycles of a simulated processing treatment – such as atomic layer deposition – and LEIS characterisation, the technique will reveal snap-shots of the evolving surface structure. **■**



The technique can reveal atomic structures

"By tuning energy of ions you can look at the very outer surface"

Prof Paul Chalker,
Liverpool University

components during the manufacturing process itself, or upon exposure to reactive environments. In this way they hope the approach will lead to improved manufacturing methods and better products.

As the beam of low-energy ions is directed at the surface to be studied,

CIVIL

Instrument has a steely gaze for structures

Device combines 3D and spectral imaging

JASON FORD REPORTS

Researchers are working on a device that combines 3D and spectral imaging into a single instrument to assess the integrity of steel structures.

The team from Nottingham Trent University and Opus International Consultants, a global infrastructure consultancy, expects the device to verify the integrity of such structures from a distance of up to 100m.

The three-year project will build on previous Nottingham Trent research that saw the development of a remote spectral imaging system that reveals the condition of paints in large-scale wall paintings. Red ochre – a natural earth pigment used to make paint – is made up of the same chemical ingredient as rust, namely iron oxide.

By performing 3D and spectral imaging, the instrument will provide information about the physical and chemical characteristics of the structure.

The so-called 'RustScan' instrument and accompanying 'RustDetect' software – which will be used via hand-held or tripod-mounted cameras or drones – will be able to generate detailed data regarding surface blistering and corrosion.

Prof Haida Liang, head of the Imaging & Sensing for Archaeology, Art History & Conservation research group at Nottingham Trent University, said that the new device will be able to scan as much of a structure's surface as necessary and that proven algorithms – already applied to large wall paintings – will automatically stitch images together. She added that current image-processing methods would be employed to automatically classify the regions of corrosion.

"Remote simultaneous 3D and spectral imaging will provide direct identification of surface rust and corrosion," said Liang. "The technology will also be able to provide a time-specific record of the condition of the bridge for future comparison with later scans – in addition to assisting in the development of an appropriate maintenance programme for the bridge." **■**

MATERIALS

Coming clean for sheet metal

Project harnesses new technology to develop fluid-repellent antibacterial surface

European researchers have made a breakthrough that they claim will enable the production of self-cleaning sheet metal on an industrial scale.

Taking inspiration from the Lotus leaf, the TresClean project harnessed new photonics technology to develop the first fluid-repellent, antibacterial metal surface.

This new technique will initially be used to create antibacterial surfaces for use in food production.

TresClean has used high-power laser-cutting devices to create a rough micro-topography on sheet metal that mimics the surface of the Lotus leaf, causing liquids to be repelled. This creates miniature pockets of air to minimise the contact area between the surface and a liquid.

Prof Luca Romoli, project coordinator of TresClean, said: "In the same way that Lotus leaves keep themselves clean, without the need for cleaning products or chemicals, their jagged, rough surfaces enable water to stay as spherical droplets by preventing 'spreading'." **AW**

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ROBOTICS

Aquatic robots for search and rescue

Prototypes can be assembled into arbitrary shapes to meet changing demands JASON FORD REPORTS

Researchers from Sheffield University have created an aquatic robot system that could be used for underwater search-and-rescue operations, or perform inspections on ageing water pipes.

The robots, developed by a team from Sheffield's Department of Automatic Control and Systems Engineering (ACSE), can be assembled into arbitrary shapes, allowing them to be customised to meet the changing demands of their task.

Six prototype cubic modules have been assembled with four micro-pumps built into them. They currently float on the surface of water and use their pumps to achieve motion via a process called Modular Hydraulic Propulsion (MHP).

"Rather than using some thrusters that are externally attached to their bodies, the robots move by routing fluid through themselves," said team leader Dr Roderich Gross. "The fluid can enter and leave the body in a large number of places – the more modules, the more possibilities for the fluid to be routed. This concept could enable underwater robots to move far more precisely than is currently possible."

The researchers set the robot a task to detect and move towards a light source and it executed the

mission with what Gross described as a 'decentralised brain'.

"Each module contains an identical fraction of it," he said. "The advantage of this is that all modules are identical, and hence, if a module breaks it can easily get replaced. The modules can also be produced in larger quantities and at a lower price. Another advantage is flexibility. For example, if a robot is split up into two, each part still has a brain."

Modular Hydraulic Propulsion could offer new solutions to problems

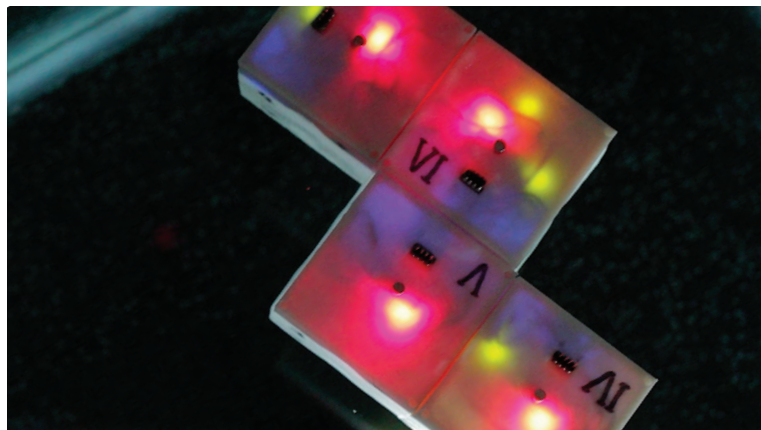
"Underwater robots move by routing fluid through themselves"

Dr Roderich Gross,
Sheffield University

requiring reconfigurable systems to move precisely in 3D confined spaces, such as the inspection of underground water pipes.

The team is now looking for additional EPSRC funding to develop the research further. Gross added that Sheffield's Department of Civil and Structural Engineering has a 600m-long test pipe that the robots could one day be tested in. ©

Six prototype cubic modules have been assembled



AUTOMOTIVE

Hydrogen moves

European project involves the deployment and operation of 1,230 fuel cell vehicles

The number of hydrogen-powered vehicles across Europe is set to increase dramatically with the expansion of the H2ME (Hydrogen Mobility Europe) project, first unveiled in September 2015.

H2ME 2 will involve the deployment and operation of 1,230 fuel cell vehicles, as well as 20 extra hydrogen-refuelling stations (HRS) across the continent. The €100m project will bring together 37 partners from across Europe, and is backed by the Fuel Cells and Hydrogen Joint Undertaking (FCH JU) with funding from the European Union Horizon 2020 programme.



Fuel cell vehicles head for the roads

"[This] marks a significant day in the future of European transport," said Ben Madden, director of Element Energy and project coordinator for H2ME 1 and H2ME 2.

"Our aim has been to help bring the key businesses and public bodies investing in hydrogen mobility in Europe together to work on the common goal of making hydrogen-fuelled transport a reality." **AW**

MATERIALS

At the forefront of the corrosion inhibitor sphere

Process could become key post-hexavalent chromate

JASON FORD REPORTS

A material and manufacturing process that has been developed at Swansea University could be at the forefront of the multi-billion corrosion inhibitor industry when hexavalent chromate is phased out.

Corrosion inhibitors have a variety of applications and are commonly used to coat and protect steel products. To date, hexavalent chromate has been commonly applied as a common corrosion inhibitor, but will be prohibited in the EU from 2019.

The Swansea team's breakthrough is applicable to coated steel products, and its efforts have been rewarded with a £25,000 Materials Science Venture Prize from The Worshipful Company of Armourers and Brasiers.

The new innovation contains a stored reservoir of corrosion inhibitor that works by channelling electrolyte anions into the coating, triggering the release of the inhibitor. The product has been tested with salt spray, the standard test for corrosion, outperforming hexavalent chromate.

"We believe we are well ahead of other chrome-free products," said Dr



The Swansea University team at work

Adrian Walters, IP and project manager, SPECIFIC IKC, an academic and industrial consortium led by Swansea University. "We have tested the leading competing products and none perform nearly as well as our product, which is comparable to chromate in performance and price."

The £25,000 prize will be used to purchase a Jet Mill system to help eradicate the technical barriers to commercialisation.

Walters said: "Commercial-grade inhibitors have uniform particle size around 5µm to ensure the material remains homogeneously dispersed in the primer system during processing.

"Achieving this fine uniform particle size is technically challenging and to date we have only produced inhibitor with a non-uniform particle size distribution in the range of 10µm to 140µm, unacceptable for commercial processing. A Jet Mill will enable us to overcome this." ©



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MANUFACTURING

Tubular steel is on the way up

Plant will make wind turbine towers, T-pylons and other large-scale parts

JASON FORD REPORTS

The Liberty House Group has acquired plant to make wind turbine towers, T-pylons and other large-scale tubular steel parts.

The acquisition is said to be part of Liberty's so-called 'Greensteel' strategy to build a fully integrated steel and engineering business across Britain.

The equipment is central to a new manufacturing centre to supply the offshore wind market and turbine casings for Tidal Lagoon Power, whose first project is a tidal lagoon in Swansea Bay.

Liberty's newly acquired steel plants at Dalzell and Clydebridge in Scotland will make the heavy-duty steel plate required for the towers.

Liberty, part of the GFG Alliance, bought the steel tower production equipment that was closed down in September 2015 by Mabey Bridge Renewables in Chepstow, south Wales.

Equipment at the facility makes towers of up to 56m tall by 5m diameter for on-shore wind installations. Liberty has plans to

"Our Greensteel strategy involves investing in green energy as the basis of the steel industry"

Sanjeev Gupta,
Liberty House Group

upgrade the facility to make 110m x 10m towers for offshore wind farms.

The plant will also make towers and cross-sections for the National Grid's newly introduced 35m-tall T-pylons.

The Liberty House Group's executive chairman Sanjeev Gupta said: "It is particularly appropriate that this new business will supply the renewable energy market in view of



The newly introduced 35m-tall T-pylons

our own Greensteel strategy, which involves investing in green energy as the basis of a competitive UK steel and engineering industry."

According to a spokesman, Liberty's Greensteel vision involves the melting and recycling/upcycling of scrap steel generated in the UK, with the process being powered by a variety of renewable sources, including biomass, gasification of waste and tidal lagoon power.

"We are hoping to convert the current SIMEC coal-fired Uskmouth Power Station at Newport to biomass with waste-to-energy on the same site and tidal power generated by lagoons in the nearby Severn Estuary," he said. "All of this is adjacent to the Liberty Steel plant at Newport, which we hope will eventually be powered by renewables. The wider vision is to have steel plants across the UK powered by green energy and melting UK scrap to supply the home market with new steel."

Liberty will announce the location of its new manufacturing centre within the next few weeks. ■

TRANSPORT

Keeping it cool

Sainsbury's operates delivery lorry cooled by liquid nitrogen-powered engine

Sainsbury's has become the first company in the world to introduce a refrigerated delivery lorry cooled by a liquid nitrogen-powered engine.

The technology, which is being deployed during a three-month trial, is expected to eliminate emissions associated with refrigeration.

Based on technology invented by Peter Dearman, the engine harnesses the rapid expansion of liquid nitrogen to deliver zero-emission power and cooling.

Traditionally many refrigerated lorries require two diesel engines, one to power the vehicle and one for the refrigeration unit. By replacing



The lorry is undergoing a trial

the latter, Dearman believes that a more sustainable solution for refrigeration may soon be widely adopted on Britain's roads.

During the trial, the technology is expected to help cut 1.6 tonnes of CO₂, 37kg of nitrogen oxides and 2kg of particulate matter. It will operate from a depot in northeast London, delivering chilled goods to stores in the London area. **JE**

AWARDS

Taking the prize for early-career achievements

Competition recognises work of young engineers

STUART NATHAN REPORTS

The Royal Academy of Engineering has announced five special awards for engineers at an early stage in their careers.

The RAEng Engineers Trust Young Engineer of the Year award is a new competition recognising outstanding achievement in early-career engineering. Each of the five winners receives a £3,000 prize.

The overall winner of the prize is Sithamparanathan Sabesan of Girton College, Cambridge, whose work on accurate battery-free tracking of RFID chips led to him co-founding a spin-out company, PervasID, of which he is chief executive.

His technology is likely to find application in tracking merchandise within factories and warehouses, and luggage around airports.

Sabesan previously won the RAEng's ERA Foundation Entrepreneurship Award in 2011 with PervasID co-founder Michael Crisp, and the EPSRC's ICT Pioneers Connected World Award in the same year.

Sabesan also wins the Sir George

Macfarlane Medal for excellence in the early stage of his career.

The other winners are Ben Britton, a lecturer in the Department of Materials at Imperial College, for work on the materials science and engineering of alloys useful in aerospace, nuclear and energy applications; and John Collins of Arup, whose work on suspension bridges has been key to vital repairs on the Forth Road Bridge and maintenance on the Humber Bridge.

Also recognised this year were Orla Murphy, the current IET Young Woman Engineer of the Year, an acoustics engineer at Jaguar Land Rover who is working on 2D and 3D sound systems; and Paul Shearing of UCL, a chemical engineer whose research on X-ray imaging of energy materials has been useful in understanding why lithium-ion batteries, such as those in the Boeing 787 Dreamliner, can catch fire or even explode. ■



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Brexit demands future planning

Following last month's momentous Brexit decision, addressing the 'productivity puzzle' has assumed fresh importance

The longer-term ramifications of the Brexit decision are still unclear as the country enters a new period of political uncertainty, nonetheless there are many points to consider when it comes to the future of the UK's manufacturing sector.

For its part, Siemens remains committed to our business in the UK where we have been active for over 170 years and where today we employ about 14,000 people across 13 manufacturing sites. As a major manufacturing business in our own right, we now urge the government to move swiftly to unify and agree the nature of the UK's relationship with the EU and other trading partners, and create clear roadmaps to encourage future investment.

Manufacturing is very important to the UK. It delivers 11 per cent of national GDP and employs 2.6 million people. Government focus on this area, as well as strategic advances such as the creation of the High Value Manufacturing Catapult, the delivery of increased apprenticeship opportunities and successful sector strategies in automotive, aerospace and electronics, are some tangible examples that we are moving in the right direction in efforts to boost economic success.

But, the overarching concern facing all stakeholders remains productivity.

Manufacturing has been identified by EEF – the manufacturers' organisation – as a key component in solving the UK's so-called 'productivity puzzle'. Meeting this challenge is vital as it is through

enhanced productivity performance that competitiveness is improved, economic growth is generated, skilled jobs are created and exports are increased.

While many will have a view concerning the critical impact areas on productivity, Siemens was keen to establish what both large and small-sized manufacturing enterprises across varied industrial sectors believe is required to support the fight to improve our national productivity outcomes and underpin economic vibrancy once again.

So we asked them.

A summary of their deliberations is clear and sends a consistent message to policy makers – it should be considered as the manufacturers' 'Blueprint for the Future of UK Manufacturing'.

The collective thoughts and opinions can be consolidated into three key areas that complement the aims and objectives set out in the government's Productivity Plan launched in 2015.

Manufacturers believe it is vital that an appropriately skilled workforce for the future be both encouraged and developed. Such a UK workforce will require industrial digital skills to take advantage of the productivity opportunities that come with new technology.

"We urge the government to move swiftly to agree relations with the EU"

Brian Holliday,
Siemens UK

Businesses want to see more than the current 3 per cent level of graduates who pursue careers in engineering and technology, and wish to see greater links between business and the UK's university sector so that existing and new talent is nurtured to help lead a 'new industrial revolution'.

Finally, a renewed and funded focus is required for STEM education so that our schools and colleges start to create the engineers and technicians manufacturing's digital future will need.

Alongside the positive impact of education and skills, manufacturers are also calling for further encouragement and policy support for increased investment in strategically important areas, including easier access to take up new technologies in automation and digitalisation – essential if we are to make the most of the opportunities afforded by 'Industry 4.0'.

There is also a clear wish to see further investment made in critical infrastructure, such as modern transport, energy systems and broadband, as well as a desire for a fresh look at the tax system that could inspire R&D and capital expenditure. Nearly half of those questioned asked for the permanent establishment of R&D tax credits. In tangible terms, the blueprint calls for the setting of a long-term 3 per cent GDP target for public and private sector spending on R&D.

There was a strong belief in the necessity to continue to foster a spirit of innovation in product development and high-value manufacturing.

Educate. Invest. Innovate. These are the key components that could support a national long-term industrial strategy.

Training and educating the workforce of the future, establishing better links between industry and higher education, assisting investment in new technologies such as digitalisation and automation capabilities, and encouraging innovation based on long-term strategic investment, are all considered essential steps for the government to focus upon.

Through targeting policies on three areas of its productivity plan: skills and human capital, economic infrastructure and ideas and innovation, government will, for example, see more investment in digital and smart factories that can tackle the complex production challenges we face. We hope our policy makers are listening. ☺

Brian Holliday is managing director of digital factory, Siemens UK and Ireland



Manufacturers believe it is vital that an appropriately skilled workforce for the future be developed



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The hot topic

Better off out of it?

Unsurprisingly, the implications of last month's EU referendum result have dominated discussion



What an unholy mess, Article 50 was supposedly never going to be required and hence was vague to say the least. What a total cop-out by all concerned. I would have thought before you buy into something, due diligence would require you know how to get out of it – apparently not. I suspect the EU will continue to trade with us, at what price who knows; free movement of people is another 'can of worms' but to think our own democratic processes cause us this many problems gives me grave cause for concern for the ability of our civil servants, who, let's face it, manage to manipulate everything to suit the status quo. I voted Leave as the chemical industry, of which I am part, seems to be suffering dreadfully under EU power.

David Anderson

Europe sells a lot more to us than we sell to them (£60bn last year); who has the better bargaining position in that sort of situation? Armageddon has not happened so far, in fact, nothing has changed as yet, apart from the weather and England's football defeat, of course. If the government does not invoke Article 50 then democracy is threatened. I wish that we had better negotiators than those that exist in our current civil service.

Jack Broughton

If anyone thinks that we will be tariff-free when trying to deal with the EU once Article 50 is

invoked, then I would suggest they belong in cloud cuckoo land.

John Watson

As engineers we deal in solid facts, make decisions based on logic and careful reasoned argument. Unfortunately, democracy does not require any of this and relies on opinion often generated with sparse and inaccurate information, protest votes and tabloid opinionated misdirection. We have screwed up. A tiny majority in a poorly presented argument on the EU have ensured the future employment of an army of bureaucrats who will, I am sure, work tirelessly to sort this mess out. But at what cost to the UK? We should campaign for foreign companies with large numbers of employees in the UK to keep their facilities here. Also, we should be campaigning to continue trade with the EU, without tariffs.

Pete H

Even though I voted Remain, I don't actually think we were doing all that well even as part of the EU. We have a deeper problem in this country when it comes to productivity that goes way deeper than being, or not being, a member of the EU. We need a fundamental re-evaluation of our ambitions as a nation that puts science and engineering at the forefront. This includes what sort of people we want to be running it (we have enough lawyers and accountants already) and how we prepare our young people for the future, especially when it

comes to putting vocational and academic education on a level (and equally valued) footing. I have to admit to having changed my mind at the last moment in the referendum, having originally been a 'leaver'. The thing that changed my mind was a strong doubt that we have either the political leadership or the commercial nous to make it on our own – initial signs post-23 June seem to bear this out.

Ed Neale

Engineers are trained to make pragmatic decisions based on fact. As such, we should counsel with those around us to find and check information. Then we should make decisions based on the likely best outcome. This can be guided by political or personal belief but, and here is the key, we cannot stand by and watch people vote for anything on a wish again. All of the press, and *The Engineer* is part of this, should offer factual content and so advise.

Andrew

If we are to remain out of Europe then I would like to see a lot more emphasis from the government on the fundamental issue of getting Britain back to being a manufacturing nation as we used to be. It will take many years of investment in manufacturing, research and bringing our many innovative ideas to fruition as products made by UK companies. We used to rival countries such as Japan and Germany, but successive governments have forgotten that it is the adding value to and the sale of products that generate true wealth and employment in an economy and not service industries.

Ivan Taylor

Brexit will be a disaster for UK manufacturing and engineering. The electorate were deceived by a distorted campaign of propaganda into making the wrong decision, which is now becoming, by the day, ever more apparent. The result was marginal and the consequences are too severe to ignore. The referendum needs to be revisited after a more informed debate.

Prof Phil Prangnell

I see this as a huge opportunity for a government to actively support manufacturing, building up local business coupled with a global, not just European, trade focus. So much of our home-grown industry has been sold off and financial institutions given political priority. We should specifically use the reduction in 'red tape' to boost SMEs and smaller companies. Having a weaker pound will automatically boost our exports too. Yes, it's going to be hard work, but no one should kid themselves about that.

EdG

How about suing Boris (where's my cricket bat?) and Gove (a pox on your experts) for the lies they uttered during their campaign? Had this been other than a political bunfight, the Advertising Standards Authority would have come down like the proverbial tonne of bricks. The exiters have already reneged on money for the NHS and fewer immigrants.

Michael Kenward



The **secret** engineer

Financial advisers could learn a lot from the engineering sector



One of the hidden perils of being the Secret Engineer is that you earn money outside of the usual accounting system. This additional income has to be declared and consequently the dreaded 'self-assessment' form filled in.

Now, whereas I'm not too shabby on the engineering front I have a real blind spot when it comes to sorting out finances. An appreciation of profit and economy – yes. The ability to look at a form asking for 'pre-taxed acceptable profits outside of sub-clause b as recognised by bylaw 32a' and the like – no. Still, that's fine. That's why I became an engineer and not an accountant.

Therefore the fact that we live in a society where we have to commit to a high personal level of financial self-determination, invariably leading to the consulting of a financial adviser, has always puzzled and angered me in equal measure.

I was trying to think what an engineering equivalent of this would be and I decided the best illustration would be to think of buying a new car. As things stand you will decide roughly what you want and then look at what cars are available for the right price. You may be swayed by a particular brand or image. Perhaps a car company has caught your eye with an advert for one of their models?

The price will essentially be set by market forces although, of course, there is a little leeway for haggling and, unless you have your heart set on something in particular, you will probably end up with two or three options. You will then take them out for a test drive to see what you are most comfortable with and what suits your requirements the most. In reality, this period can be seen as purely being 'fine tuning'. All of the cars, because of those self-same market forces, will be the best that can be produced for that price point and therefore similar. You will then part with your cash and take your prized possession home.

What if the process was run like your finances

though? For a start the cost won't be fixed and you will have to consider potential variables with regard to this over X number of years. In addition, there will be many options available and, given the depth of expertise we are looking to mimic, it will be more than just 'loading up' your potential purchase with blingtastic alloy wheels and a banging stereo (is 'banging' still used in this context I wonder?). Of course, Joe Public's consultant engineer will be there to help decide, for instance, on whether to spend extra money on a galvanised corrosion protection system: "Well it costs more initially, sir/madam, and will affect your return but dependent on the time frame you intend this to run over, is it really necessary?"

Once you have one package determined you will then need to see what offers are also currently available from other manufacturers: "Yes, the Tartan-Bag Gti enhanced security system costs less but in this case I would recommend sticking with the Lardomatic GLS as its klaxon is louder." If you think this is overstating the claim then I will simply ask how many of you have used a financial adviser and how many non-technical people do you know who have asked an engineer for advice before buying a new car?

I just don't get why the services offered by the financial sector aren't inherently easier to understand by the layman, it simply seems like no more than smoke and mirrors to me. All those financial advisers and CEOs of building societies could learn a lot from the engineering sector. Mind you, looking at how much they earn perhaps we could learn something from them?

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The success of the Tomorrow's Engineers programme relies on engineers, employers and educationalists coming together

"If you know a technician or engineer who could inspire a young person we would be happy to work with them"

Paul Jackson

The winning team in the Tomorrow's Engineers EEP Robotics Challenge from Hall Park Academy in Eastwood, Nottinghamshire

In the wake of the EU referendum there have been many calls for unity and collaboration as the UK moves forward. I am concerned about the impact Brexit will have on our universities, about how we will secure the broad range of skills we need to maintain our vibrant and productive industry, and about the economic impact of a departure from the EU. This isn't the time to just wait and see, we simply can't allow ourselves that luxury.

If we are to achieve unity rather than just talk about it we must embrace difference and recognise the positive impact of diversity. That is the case nationally and is also absolutely true of the engineering industry, whose workforce falls considerably short of being representative.

This was highlighted at a recent meeting with the Employer Network for Equality and Inclusion. The diversity and inclusion agenda is not about box ticking, it's about real change. During last November's Tomorrow's Engineers Week we saw that, rather than inspiring them, online images of engineering were actually putting young people off, particularly girls. That still needs to change. A starting point is to use role models with whom young people can identify. If you know a technician or engineer who could inspire a young person into engineering we'd be happy to work with them, from building a case study from their story to giving them the chance to talk directly to a school group.

As a member of the judging panel for *The Engineer's* Collaborate to Innovate awards I'm looking forward to reviewing the entries, particularly those that showcase the positive results of business working with education. Never underestimate what can be achieved through collaboration. We were thrilled to have volunteers from Babcock, BAE Systems, Doosan, Highways, Lockheed Martin, Microsoft, National Instruments, Rolls-Royce and the RAF supporting the Tomorrow's Engineers EEP Robotics Challenge recently. Their expertise and enthusiasm were a real boon for the students involved.

The challenge, which is supported by the Helsington Foundation, saw 100 teams from across the UK design, build and programme Lego robots for a series

of space-themed missions. We specifically aimed to have an equal gender mix and drive participation of students from a diverse range of backgrounds. It involved schools that otherwise may not have worked on such projects and had some unexpected results. One team included an elective mute who has broken their silence as a result of great teamwork. Another saw autistic team members forge new friendships in the group.

The winning team came from Hall Park Academy in Eastwood, Nottinghamshire. At the prize-giving, 12-year-old Hannah said: "We can't believe we've won, we never get any academic achievements at our school. It feels incredible!" That unfamiliar sense of achievement is one to cherish and if the legacy is simply the knowledge that teamwork can lead to success, I don't think we can be too disappointed.

This collaborative effort, where each individual contributes something different, can be seen as a microcosm of what's happening within Tomorrow's Engineers. The success of the programme is reliant on the contribution of engineers, employers, institutions and educationalists coming together to form a sum greater than the individual parts. I hope you'll be a part of that unified approach. ☺

Paul Jackson
Chief executive EngineeringUK



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Building the total network

The revolution that will see billions of connected devices is increasingly driven by industry, and not just the tech companies that once led the way. Andrew Wade reports

The Internet of Things (IoT) is one of those mind-boggling concepts, the scale and implications of which can be difficult to comprehend. At its core, it will involve billions of connected devices and sensors, all sharing data, supposedly making our lives better. Exactly how this will happen is still a matter of debate though, and there are several concerns over how the technology will be delivered, as well as how to make sense of the torrents of data these devices will produce.

When the internet first started gaining major traction in the early 1990s, naturally it was tech companies that led the innovation. Today, the lines between industry and tech are becoming ever blurred, with companies such as Google making waves in the automotive market, and manufacturers moving towards 'smart' factories and supply chains – commonly referred to as Industry 4.0.

This blurring of two worlds promises to be a hallmark of the IoT revolution: the physical and the digital melding together, connecting not just people, but also everything around us with which we interact. According to the soothsayers, the result will be a network with many billions of nodes including autonomous vehicles, orbiting satellites, factory machinery, smart homes and connected power grids.

While the possibilities appear almost unlimited, up until now mainstream IoT applications haven't moved much beyond controlling a dimmer switch with your smartphone. Hype and conjecture have been the order of the day, and questions abound on security protocols and power requirements, as well as the new types of interfaces and standards we will use to integrate the real and virtual worlds. However, solutions to these problems are emerging and the potential is gradually being unlocked.

One company looking to lead the way is German manufacturing giant Bosch. With business units dedicated to mobility, buildings, energy, industry, and consumer goods, its portfolio is tailor-made to ride the IoT wave. Bosch is currently testing smart solutions across many of its production plants around the world, establishing best practices and learning through trial and error. According to Dr Werner Struth, Bosch board member and head of industrial technology, these in-house deployments will form the basis for third-party solutions in the future.

"We now have 276 factories," Struth told *The Engineer* on a recent visit to Bosch's Stuttgart headquarters. "There's a huge bandwidth in manufacturing systems, from semiconductor light manufacturing in our Renningen factory, producing billions of sensors a year, to single-piece production of our Rexroth equipment, for example in the new elevator in the Eiffel Tower, or for the Panama Canal [expansion]."

01 Bosch is pioneering smart solutions on its own factory floors

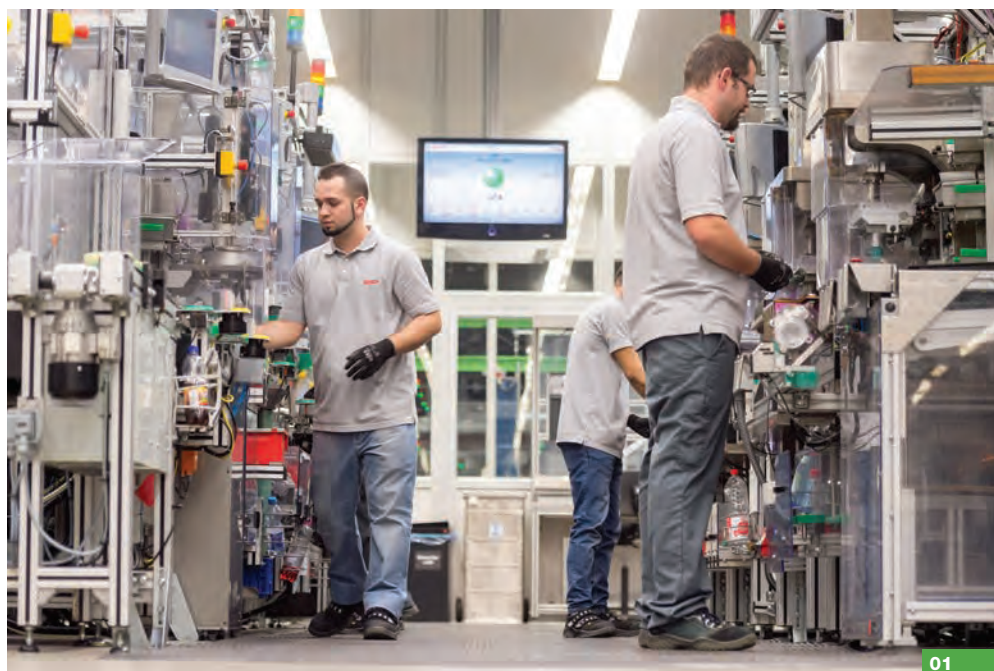
Bosch develops IoT solutions and apps for these various business strands internally, then sends them out to its factories for testing. Only once they are mature will they become available to external customers. The manufacturing facilities at the heart of the company for 130 years have now also become the test beds for the Industry 4.0 architecture of tomorrow, and Bosch sees itself as both a major user and supplier of connected solutions moving forward.

"Now we have our own platform from which we can sell these solutions," said Struth. "It's a very holistic perspective that we take on connected industry."

In total, 150 solutions have been trialled, and many of those are now being rolled out across the company, with plans to make them available to customers over the course of the next 12 months.

"Of the 150, we have 28 that we are developing on a standardised basis for the entire group," said Struth. "These applications will be available for external customers by 2017. The cloud that we have is currently for internal purposes only, just to get a refinement."

Among the first solutions available will be TraQ (Track Quality), a logistics application that uses embedded sensors



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to provide real-time information while goods are being transported. Readings for temperature, vibration, light and humidity can indicate whether sensitive goods such as semiconductors are travelling in optimum conditions. Deviation outside pre-set limits can trigger alerts, and notification of any damage could help minimise impact downstream in the supply chain.

Unsurprisingly, Bosch is also working on solutions to improve factory operations, its Process Quality Manager being one example. Data from machinery is analysed in real time, notifying workers of potential

problems and allowing for predictive maintenance to be carried out. A similar platform for production and building management is also in development, where energy requirements such as heating, cooling and hydraulics can all be viewed and managed centrally.

Perhaps the product with the greatest potential is Bosch's XDK development kit. This is a combination of sensors and software with Bluetooth and WiFi connectivity that users will be able to tailor to their own needs, creating unique IoT offerings. The package will include an acceleration

02 Drayson's CleanSpace Tag uses its Freevolt technology to harvest energy from the air

03 AR can be a bridge between the physical and digital worlds

sensor, a yaw-rate sensor and a magnetometer, as well as temperature, pressure, humidity, noise and light sensors. According to Bosch, the XDK kit will be a "midwife" for a host of new Industry 4.0 applications yet to be conceived.

"We have sensors, we have software and we have services," said Struth. "That from our perspective is somehow unique at Bosch."

Services and software can be hosted centrally and distributed via the cloud, but sensors obviously need to be at the point where you want to collect sensory data. When those sensors are attached to machines in a factory or a vehicle, power requirements are not really an issue. But what about sensors with no freely available power source? What if you want to set up a network of temperature sensors throughout a building, for example, or a motion sensor in a remote corner of an industrial space? >>

"Now we have our own platform from which we can sell these solutions. It's a holistic perspective we take on connected industry"

Werner Struth, Bosch

>> Low-energy sensors like this can of course be powered by battery, but in a future where billions of these devices exist, swapping them out would be the mother of all Sisyphean tasks. An alternative solution has been engineered by Drayson Technologies, the company founded by the Labour peer and amateur racing driver Paul Drayson. Last year it unveiled its Freevolt technology, a rectifying antenna that harvests residual radio frequency (RF) energy from transmissions over networks such as 4G and WiFi. By converting these transmissions into electricity, it can keep them operating indefinitely.

"Companies have been researching how to harvest energy from WiFi, cellular and broadcast networks for years," said Drayson. "But it is difficult because there is only a small amount of energy to harvest and achieving the right level of rectifying efficiency has been the issue until now."

"Whether we live in a big city or an increasingly urbanised area in the developing world, radio frequency waves are being generated all around us, at different levels, all the time. Some of this wireless energy goes unused. At Drayson, we've figured out a way to make it useful."

We saw the first commercial application of Freevolt with the CleanSpace Tag, a carbon monoxide sensor powered by the technology. When paired with a smartphone over Bluetooth, the tag can track the air quality, with a map highlighting potential black spots on your daily commute. Collating data from all the CleanSpace users in a particular area allows a real-time picture of air quality throughout a city to be drawn up, which anyone can access.

CleanSpace is a great example of what Freevolt can do, and also of the potential that the Internet of Things has to fundamentally impact our lives. But much like Bosch's XDK sensor kit, Freevolt's real power will inevitably come from developers who come up with ingenious ways to use it, acting as another "midwife" for the creativity of customers. According to Drayson, tech companies are keen to get their hands on the technology to see what it can do.

"For designers and developers, Freevolt offers a totally new approach to powering the low-energy Internet of Things," he said. "Since the launch at the end of September, we have been inundated with requests from thousands of leading technology companies and innovators to become part of our developer programme."

Whereas Freevolt is designed to sustain low-energy sensor networks with a minimum of human interaction,



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01 Bosch's in-house IoT products are being streamlined for external customers

02 PTC's Jim Heppelmann believes AR can transform how we interact with machines



05

"Freevolt offers a totally new approach to powering the low-energy Internet of Things"

Paul Drayson, Drayson Technologies

there are also IoT applications where humans and machines will be able to interact in entirely new ways. At its recent LiveWorx event in Boston, US software company PTC showcased how it envisages augmented reality (AR) becoming a tool for bridging the worlds of the physical and digital, worlds that are becoming increasingly blurred as technology becomes embedded in almost everything.

"We're in the midst of a fundamental transformation in our world, and in our relationship to the things that are all around us," said PTC CEO Jim Heppelmann. "The things I'm talking about are the things that we create, that we operate, that we depend on, that we entertain ourselves with. They're all evolving from being relatively simple physical objects, to becoming complex physical/digital systems."

"Everything from your watch, to your car, to your home, to your factory, to the infrastructure of the city you live in, is headed down this path... the notion of physical/digital convergence must expand to incorporate the way that

humans experience products, and that's why [we've] spent so much time and energy pursuing augmented and virtual reality in the past year."

Launched at Liveworx, Vuforia Studio Enterprise is PTC's platform for creating these AR experiences. Designed to work with a range of 3D modelling tools, Vuforia allows users to publish animated AR sequences to instruct or inform. It operates in tandem with the company's ThingWorx IoT platform to add an AR component to connected machines, from manufacturing and factory equipment to solar panels and medical devices.

On stage in Boston, Heppelmann and Terri Lewis, Caterpillar's digital and technology director, demonstrated how AR could work in an industrial environment. Using a connected Caterpillar generator set, the pair showed how a handheld tablet could provide an AR overlay on the equipment, providing step-by-step guides for operation and maintenance. (Will Stirling explores this and other uses of AR in *Through the looking glass* on p35).

"When our customers rent our products, they want to make sure it can run," said Lewis. "They want the whole experience of rental to be easy... They can also connect remotely to the product, understand where it's at, know whether it's being used and if it's ready to be used."

Caterpillar is working with PTC on a Beta version of Vuforia, and the live demo showed that AR could have a role to play in this new connected world that is materialising. But this connectivity also raises concerns over security. A generator set that can be controlled remotely is a powerful piece of equipment that could also be hacked remotely.

Security is one of the issues most frequently raised whenever IoT is discussed. According to Gartner, more than 20 billion devices will be connected by 2020, by which point it expects more than 25 per cent of all attacks on enterprises will be via IoT. If every device is a potential weak point, IoT technology inevitably will be held back in some areas.

One possible solution gaining traction is blockchain, the self-regulating, decentralised technology that underpins cryptocurrencies such as Bitcoin. For Bitcoin, blockchain acts as a sort of ledger where money/value can be transferred securely and anonymously across a distributed peer-to-peer network. Every transaction adds a new 'link' to the chain, and the collaborative network of users authenticates each transaction in an automatic, auditable and transparent way.

Recently, however, blockchain's potential for other uses has begun to be explored, and one of the most exciting areas is with IoT. Blockchains could be used to keep ledgers of data exchanges between devices, applications and humans, underpinning transactions and adding a much-needed layer of security.

But blockchain's potential goes way beyond security. It could act as the protocol for devices to become truly independent, performing what are known as 'smart contracts': self-executing protocols carried out by connected machines. Imagine if a vending machine could not only monitor and report its own contents, but also request bids from suppliers and automatically release funds once restocked. The huge potential has prompted companies such as IBM, Dell, Microsoft and Samsung to explore blockchain technology and the role it could play in IoT. But the road ahead will certainly not be straightforward. An organisation holding Ethereum, described by some as a Bitcoin 2.0 with smart contract capability, had about US\$50m stolen through an organised attack, sending the price of the currency tumbling.

Hacks such as these are likely to slow blockchain's infiltration of IoT, but it seems inevitable that the technology will play a fundamental role in the internet's next stage. As billions of devices come online, blockchain could well be the final piece of the puzzle in unlocking IoT's true power. ©

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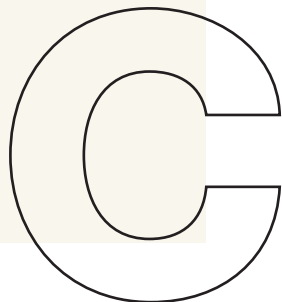


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Cast masters go high-tech

Grainger & Worrall is taking UK casting expertise to new levels. Stuart Nathan reports



Castings are a bit of a Cinderella in many parts of the engineering industry, with automotive no exception. While undoubtedly important, engine blocks, cylinder heads and gearbox housings are not particularly glamorous; engineers generally prefer to talk about the clever moving parts

inside them. Frequently, suppliers are not based in the UK.

"People tend to think that castings are just a matter of some metal powder and a bucket of sand, but it's much more complicated than that," Keith Denholm, head of engineering at Grainger & Worrall (G&W), told *The Engineer* on a recent visit. "Of course, we do use those things, but many of the techniques we use to design castings, make moulds and verify quality are as high-tech as anything you'll see anywhere in manufacturing."

G&W operates a foundry in Bridgnorth, near Wolverhampton. A family business now owned and run by the third generation of Graingers (the Worralls were an early part of the foundry's history and remain only in the company

name), it specialises in producing engine castings for the high end of the automotive industry, with customers including McLaren (for which it makes the castings for all of its V8 road car engines), Aston Martin, Audi, Bugatti and Porsche. It also has a specialist division that serves the motorsport sector, where various complex alloys are sometimes used – and developed in-house – rather than the aluminium and iron that are the most common materials it uses. Its customers in this field include Formula One and Nascar teams.

In some cases, G&W supplies components ready to go straight into the production process,

performing the necessary post-casting machining at another site in Telford. Some clients prefer to do this themselves and buy in the raw casting, said Denholm.

One of the most intriguing parts of G&W's production operation is CT scanning, which it began using for motorsport clients and now employs for quality assurance processes. Denholm said the company was the first foundry in the country to use CT routinely, and it has become an integral part of the process, significantly speeding up the mid- and post-production inspection procedures that are a crucial part of high-value automotive manufacturing.

"The traditional way of verifying castings would be to take them out and put them on a table, with the original design drawings up on the wall, then a measurement specialist would literally redraw all the details on the component to check that the specified dimensions were all accurate," Denholm said. "That required a lot of training and really good eyesight, and it gave great results, but a single component could take up to two weeks to measure thoroughly. Of course, there was no way that every part in a production run could be measured, so you'd take a sample."

Production errors were therefore almost inevitable. In contrast, however, CT scanning takes just a few hours; with two machines running 24 hours a day, large items can be scanned overnight.

The company retains the equipment to perform the traditional surface inspection, along with modern co-ordinate measurement machines. But these can provide no details of what may be going on inside the casting, said Denholm.

Instead, parts are now placed into a large x-ray machine, which first performs a quick scan and rapidly identifies those with casting errors, such as large voids inside.

"Without x-rays, the only way you'd be able to find that

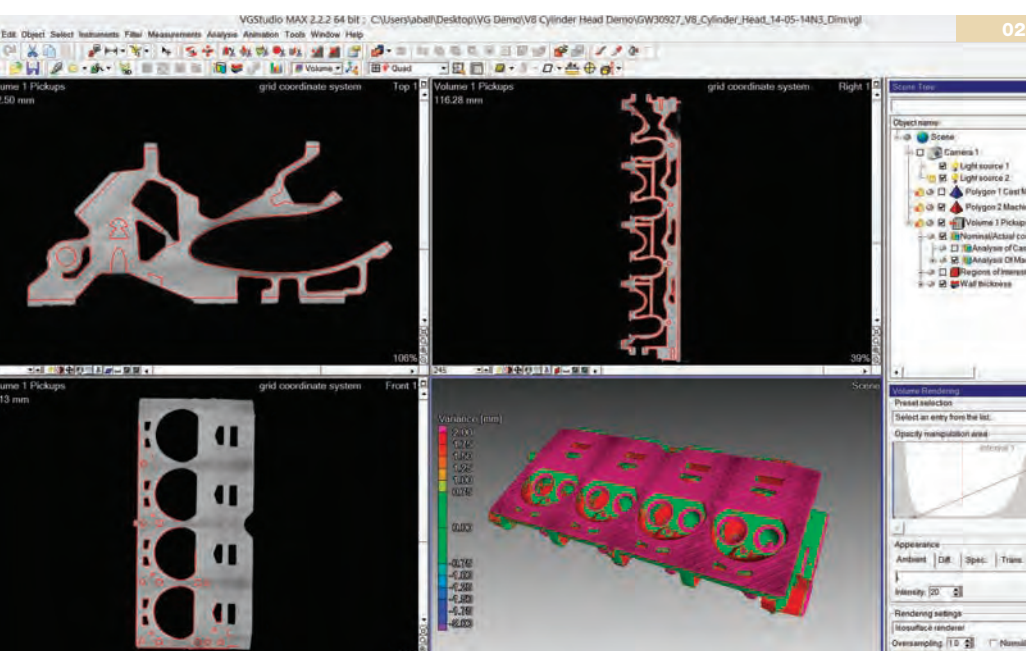
01 G&W makes castings for, among others, BMW, McLaren and Aston Martin

"Many of the techniques we use to design castings, make moulds and verify quality are as high-tech as anything you'll see anywhere in manufacturing"

Keith Denholm, Grainger & Worrall



01



“Systems that can scan in minutes will be as big a development as moving from manual surface measurement to CT”

Keith Denholm, Grainger & Worrall

02 G&W uses CT scanning to inspect its casts in detail

03 3D printing is used to make sand cores for the casting moulds

would be to literally hit the item with a stick and listen for a hollow noise. That is a skill that some people have but it's not 100 per cent reliable,” Denholm said.

The initial scan takes minutes to perform but cannot provide fine detail, such as the precise location of a defect. The entire item is scanned in one go and the resulting image is a two-dimensional shadow.

Next, G&W turns to two identical industrial CT machines, supplied by Yxlon. With the item mounted on a rotating turntable that moves past a fixed linear x-ray source, the machines scan the object in a series of slices, generally 1mm thick although a range of thicknesses is possible, from 0.75mm to 2mm. Each slice takes about one minute to scan.

The raw data from the scan of the entire piece resembles, as Denholm put it, “a spirally mess”.

However, computer analysis of the signal resolves it into a 3D image that can be enlarged and examined systematically by trained operators. Porosities as small as 0.2mm can be located and identified, or foreign objects such as grains of sand from the casting mould.

To assist with these inspections, G&W employs a false-colour system that checks the scan against a 3D image provided by the client, usually taken from CAD files. Areas with more material than specified by the design show up on the scan in magenta; green indicates sections where the measurement is spot on; and areas with less material than specified are coloured blue.

“We want a maximum of magenta and ideally no blue at all,” said Denholm. “When you cast, you always allow for shrinkage as the molten metal solidifies in the mould, so for margin of error you would typically cast slightly bigger than you

want. Moreover, we frequently have to include extra features that are there to help the molten metal penetrate the mould or flow around all its intricacies, and they're not part of the final component.

“The idea is that you machine away any extra material or features to get down to the exact dimensions and surface quality that the client needs for its application.”

The results of this scan not only

give assurance of the quality of a component but remove the need for destructive testing, which wastes material.

They can also guide the subsequent processing of the object. If an area is identified where the material's strength seems less than specified, the location of holes to be drilled in that area can be changed to remain within the tolerances of the assembly, but without weakening the item or causing it to crack when drilled.

Moreover, Denholm added, all the scans are kept on file for the customer so that, “if an item does crack during processing or even in subsequent operation, we can look at the broken part, compare it with the scan and see what the features were in the region of the break that could identify how the crack started or propagated through the material, and make adjustments for future castings”. The scans can also be used to reverse-engineer tooling for older parts that are no longer manufactured.

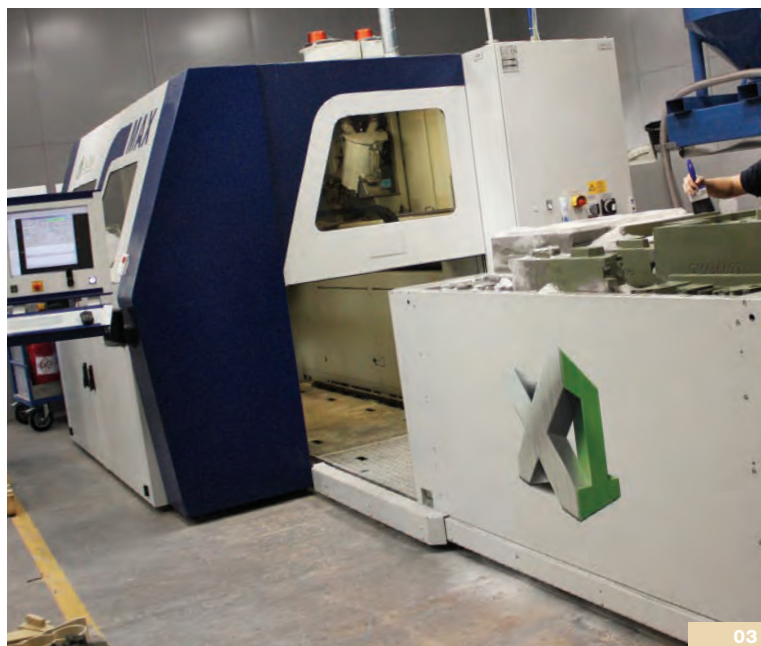
New production technologies also feature at G&W and Denholm was keen to point out the difference between casting and 3D printing, with some suggesting the latter may begin to challenge the industry, especially for smaller items.

“Parts made by additive manufacturing have residual stresses within them because of the way they're made, and those stresses have to be relieved by heat treatment or the parts can distort and break in use,” he said.

G&W uses a form of 3D printing but, rather than for parts, it employs it to make the 3D sand cores – effectively full-size models of the parts it casts, around which moulds are made.

Several types of sand are used, with varying grain sizes – smaller ones for items that require finer detail – and heat tolerances depending on the melting point of the metal or alloy to be cast. These sands are mixed with a polymer resin that coats each grain and sticks them all together when heated. The company has two sand printers of different sizes: the smaller one uses heat to cure the resin; the larger one, added this year, has a cold-cure system and is used to manufacture the large components required for commercial vehicle powertrains and big structural parts. Other new capabilities include metallurgy to develop alloys for specialised applications.

Denholm anticipates more investment in CT to improve throughput. He said: “We're looking at systems that will be able to scan parts in minutes rather than hours; that'll be as big a development as moving from manual surface measurement to CT in the first place.” ©





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Dare devil to care devil

The motor sports engineer and entrepreneur tells Jason Ford of his quest to eliminate the environmental impact of personal transport

H

ugo Spowers intends to manufacture 5,000 cars a year but he has no intention of selling them.

Instead, the charismatic motor sports engineer and entrepreneur proposes a sale of service model that involves the payment of a fixed monthly fee and mileage allowance in return for repairs,

maintenance, insurance and fuel expenses.

This may sound like a risky strategy but Spowers is used to taking calculated risks. While at university, he was a member of the Dangerous Sports Club and was credited with undertaking the first headfirst bungee jump, as well as accompanying a grand piano fitted with skis down the slopes of St Moritz. He followed this by founding Prowess Racing, a venture that designed and built racing cars. The company also restored historic cars but, by the mid-1990s, Spowers had reached the conclusion internal combustion engines should be phased out and replaced with more environmentally benign alternatives.

"I got out, thinking that the only future for sustainable cars was better batteries, which meant basic science, big labs, big companies, big budgets," he said. "Not my sort of world at all.

"I then found out about fuel cells... and realised that the opportunity of this hugely disruptive technology was not through focusing on the basic science of fuel cells to make better fuel cells but by putting the car together in a completely different pattern of relationships, and that is what motor sport is all about."

Spowers went on to found Riversimple, whose aim is "to pursue, systematically, the elimination of the environmental impact of personal transport". In keeping with this philosophy, the company undertook three major R&D and demonstrator projects that led to the Rasa FCEV (fuel cell electric vehicle), with the first engineering prototype revealed in February 2016.

Following a spring launch for Rasa, Riversimple began crowdfunding to match a €2m (£1.7m) EU grant. It also received £2m from the Welsh government in 2015 and plans to make Rasa commercially available in 2018 following a 20-car beta test performed in partnership with Monmouthshire County Council.

The car itself is a two-seat, four-wheel-drive vehicle with a 'well-to-wheel' emissions standard of around 40gCO₂/km and zero tail-pipe emissions thanks to its hydrogen fuel cell.

Rasa maximises efficiency through a combination of lightweight composite materials and a simplified powertrain



01

"We pay the fuel cell company for installed kW/h because we have a shared interest in longevity and low running costs"

containing 18 moving parts. The vehicle's sub-40kg carbon-composite chassis absorbs more energy per unit weight than steel in impact and its low profile helped the prototype achieve 0.224cd in wind-tunnel tests.

Once the car is on the move, hydrogen passes through a proton exchange membrane inside the 11hp, 8.5kW fuel cell, where it combines with oxygen to form water and electricity to drive electric motors mounted in each wheel, each producing 170Nm of torque at 840rpm.

When braking, the motors act as a kinetic energy recovery system (KERS) that generates electricity and replenishes Rasa's 120 lithium hybrid super-capacitors. The capacitors deliver more than 80 per cent of the power needed during acceleration, thereby relying on the fuel cell for 20 per cent of the power and enabling it to be sized for constant cruise at 60mph.

"In a normal car, if you want better acceleration you need more power, which all comes from the engine and you end up with a higher top speed whether you like it or not," said Spowers. "Acceleration and cruise are tightly coupled; they're all provided by the engine. In our case, though, they're totally independent variables.

"The decoupling of cruise and acceleration is a critical thing because it leads to the downsizing



02



01 The Riversimple Rasa FCEV with butterfly doors open

02 The Rasa is highly styled and meets fundamental criteria of being both safe and fun to drive

03 The vehicle maximises efficiency through a combination of lightweight composite materials and a simplified powertrain

of various components in the powertrain, and as you downsize those components you can reduce the mass of the structure. We call them mass de-compounding loops: iterative loops constantly reducing the mass, reducing the cost of components and improving fuel consumption all the time."

Each Rasa is designed to run for 15 years and, unlike conventional volume car manufacturers, Riversimple is not looking to obsolescence and high running costs for revenue, a fact borne out in its policy not to acquire some of Rasa's components, such as the fuel cell.

"We pay the fuel cell company for installed kW/h [because] we have a shared interest in longevity and low running costs," said Spowers. "A fuel cell company reckons it can recover 80 per cent of the value, and that's of much greater value to it than to anyone else. The only thing it loses is the membrane, which it incinerates to recover the platinum. It gets 100 per cent of that back."

"It can generate more revenue per stack made and it's got a much more secure revenue stream, just as we have. It also shares the capital costs of the vehicle throughout the value network, rather than them falling on us."

According to Spowers, an investor described Rasa as having been designed for a business model, which is in keeping with Riversimple's aim of capturing 100 per cent of the revenue generated by the car, as opposed to the 40 per cent experienced in the volume car market, output from which has continued upwards since January 2010.

According to SMMT, the demand for new cars in the UK remained stable in May 2016 with a 2.5 per cent growth in registrations. In the alternatively fuelled market, year-on-year registrations for May also saw 2.5 per cent growth, to 203,585 units, with the government predicting 1.3 million hydrogen cars alone on the road by 2030.

The appetite for personal mobility has also led to a step change in vehicle usage with sustained growth in car club membership. More than 22,500 members use almost 700 vehicles in England and Wales, outside London.

For Spowers, this is a key



03

CareerCV

Hugo Spowers
Founder
Riversimple

Education

1978-81 Studied engineering science at Oxford University

1998-99 MBA, Cranfield University

Career

1984-96 Founded Prowess Racing

2001 Founded OSCar Automotive, which became Riversimple in 2007

2016 Revealed first engineering prototype of the Rasa fuel cell electric vehicle

market for Riversimple. He said: "In the long run, we're not wanting to be a niche manufacturer of local cars. But [Rasa] is a local car and it's a segment that the industry doesn't recognise. In a resource-constrained world, we're going to need a much more specific functional segmentation market for people to pick off different vehicle needs for appropriate power-driven technologies and fuels."

Spowers is ready to meet the flexibility of the market through the use of low-rate manufacturing plants, which can be online in two years compared to 10 for a big plant.

"Five thousand vehicles per annum is the maximum we can get through one set of tooling," he said. "Just as with a commercial plant, that defines the size of the assembly facility."

"When you expand, you have more sets of tooling but you don't need to put them in the same place; there's no economic gain. You build another small plant here and there and each one can make a different car that is relevant. It enables you to truly customise to much smaller niches."

By Spowers' own admission the Rasa is far from optimised, but it is highly styled (by Chris Reitz, former Alfa Romeo design director) and, according to Spowers, meets fundamental criteria of being both safe and fun to drive.

"In terms of state of the art, we've got nothing out of the ordinary," he said.

"There's a lot of room for better components that could improve efficiency, the weight and so on. But the big leap forward is through the systems integration and that's the big bite of the cherry that we've taken." ☺



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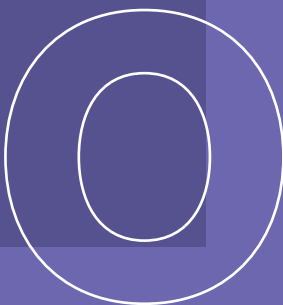
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Something new under the sun

Novelist Jon Wallace considers the science fiction implications of engineering stories that have caught his eye. This month, the dark future of solar power



Our star suffers from a rather reduced role in science fiction. Strange, when it was the centre of entire cultures' foundation tales – the original fantasy fiction – whether as the eye of Ra, as a

luminous disc pulled by Helios' chariot, or as Tonatiuh, bloodthirsty deity of the Aztecs. Sol enjoyed a prized status – as the master of time, the source of life. The bible god's first words are 'let there be light', defining his power by his mastery of the sun.

Even renaissance science granted the sun privileged status, Copernican heliocentric theory placing it at the centre of the universe, the fire around which creation turned. It's only during the last few centuries that our growing understanding lessened it somewhat – from the ruler of the heavens to more of a blip in spacetime, an insignificant G-type main-sequence star (G2V) – one among a vast, unknowable host.

That's not the only reason that sci-fi authors struggle to put it to equal use as the Moon or Mars. As it is unable to support life, the sun cannot play host to adventures (with a few notable exceptions, such as David Brin's *Sundiver* or Arthur C Clarke's 'Sunjammer'). Often it can only play a role in a story through its absence, or at least the threat of it – hence excellent 're-ignition' tales such as 2007's film *Sunshine*, or visions of a gloomy, almost extinguished husk, as in *The Time Machine* by HG Wells.

That leaves little for writers to contemplate but how humanity might put our star's abundant energy to use here on Earth. Here, *The Engineer's* news serves for inspiration, documenting a time of flourishing solar innovation, sparking visions of a future humanity weaned off fossil fuels for good.

Last month, *The Engineer* reported on the transatlantic flight of Solar Impulse 2, an aircraft powered by 17,000 photovoltaic cells, weighing 2.3 tonnes, with a wingspan wider than a Boeing 747. Its pilot, Piccard (that's right, sci-fi fans, Piccard) successfully steered it over the ocean in 71 hours. Sure, that is something of a long-haul effort, but the flight rekindles a Wright Brothers sense of a

pioneering, adventurous age. A little research reveals a world of engineers feverishly working to perfect solar infrastructure: solar cars running on solar roadways; chimneys powering the world on solar generated steam. This is a steampunk civilisation made real, where every surface absorbs and stores the sun's rays, powering a new generation of wearable tech.

The sci-fi author might find much to explore in such a world; the story of some near-future civilisation where substances once created to ward off sun rays now welcome them; where sunglasses power their own augmented reality projections; where our clothes power their own inbuilt watches and interfaces; where even sunscreen can be scraped off and used as fuel. Perhaps, as abundant, free power eliminates borders and nationalities, human beings will explore their solar system with renewed vigour, sustained by the sun's glow – wearing 'photosynthesuits' that manufacture their own oxygen.

For every sunlit, utopian upland there's a shadowy dystopian valley. Airbus is already working on solar-powered high-altitude 'pseudo satellites' for the Ministry of Defence, designed to keep a perpetual, Ra-like eye on us all. We might imagine a story where future Icaruses, sick of being watched, take to the stratosphere on solar-powered wings to challenge mindless drones, shooting them down, occasionally flying too high and sizzling in lethal UV radiation.

In Asimov's story 'Reason', space solar panels are used to beam energy wirelessly to Earth. But what if

the industry were subject to the same capitalist pressures as oil? We might follow the story of one orbital Rockefeller who, near bankrupt, turns his energy beam upon his competition, creating the ultimate monopoly.

Yet perhaps we're thinking too narrowly to limit the sun merely to power generation. It remains an existential force; the severity of its UV rays in part created the races of man. What of a world where science allows each of us to adjust our own melatonin levels, becoming black or white at will? Would it change our sense of identity for the better, creating a bold unified civilisation, or would we find other prejudice on which we could fall back?

And what if the sun chose one day to simply snuff our technology out? Our connected world has yet to encounter a solar super storm. The last one, in 1859, blew out telegraph lines, shocking their operators. What if a future society of brain-implemented humans were struck by a coronal mass ejection? The adult population is wiped out as implants short, causing a mass stroke, and the children grow up alone in ignorance, worshipping the sun once more – as a great, vengeful god.

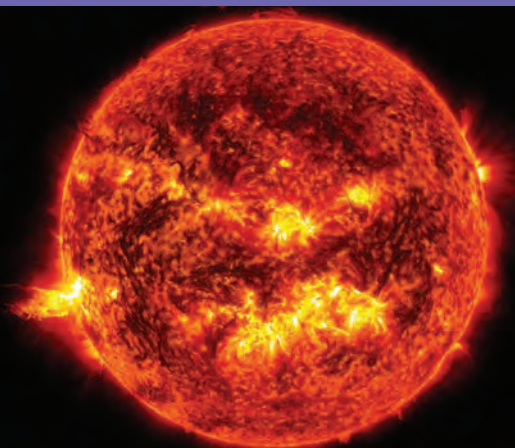
For however much scientific discovery might seem to diminish Sol, we should beware: as sure as it gives, it may also take away. ☼

Jon Wallace is a science fiction author living and working in England. His new novel, *Rig*, came out in paperback and ebook in June

"For every sunlit, utopian upland there's a shadowy dystopian valley"

Jon Wallace

As it is unable to support life, the sun can often only play a role in a story through its absence, or at least the threat of it



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Through the looking glass

Technology allowing problems in the real world to be solved in virtual reality is speeding up the process of servicing. Will Stirling reports

From slow beginnings, augmented reality technology is about to give Britain's engineering maintenance and manufacturing companies a whole new angle, where layers of digital information will enhance productivity and reduce downtime.

Generators, or gensets, are often delivered to a site unmanned, treated as a plug-and-play asset.

But what happens if the genset

does not start? Check the fuel, but then what – does the site manager literally have to read the manual? Caterpillar has devised a solution.

A construction technician can view the genset in situ through a smart tablet's camera, and additional diagnostic information is layered on to the tablet screen. Push the start-up button and icons show there is adequate fuel and battery charge to start it. Turn a knob on the genset, the tablet reveals there is the right voltage for the application required. Now a red warning light on the screen shows that the air filter has gone past its service hours. This tells either the user to change the filter, or the genset leaser that this needs changing before the next rental. Other parameters include service meter hours and charge oil temperature.

This is the result of a six-month beta test programme between software developer PTC and Caterpillar, and demonstrated live on stage by Terri Lewis, digital and technology director at Caterpillar at the PTC LiveWorx expo in Boston in June. Augmented reality technology – where information about the surrounding real world of the user becomes interactive and able to be manipulated digitally – is increasingly helping engineers in real-world operations, such as maintenance, to find and fix problems.

Augmented reality (AR) visualisation allows maintenance engineers, production engineers and users of products to add layers of simulated information, sometimes text or represented in images – a 2D plan or 3D CAD drawing – to enhance and 'augment' that structure's features. This is different to virtual reality visualisation technology.

Today, the UK boasts many virtual reality (VR) suites, which create completely virtual scenarios that primarily help engineers to design components and assemblies quicker, smarter and with lower prototyping costs. Organisations using VR include Jaguar Land Rover, Siemens Digital Factory, Rolls-Royce, the Advanced Manufacturing Research Centre (AMRC) near Rotherham and the Manufacturing Technology Centre. Some of these suites are available for companies to rent.

While AR has been around for several years, hitherto used more commonly in gaming, the defence industry –

think intelligent helmet information displays – and architecture and town planning, it has taken longer to permeate the engineering world. "Many companies are doing research, such as proof-of-concept trials, in this area, but there is a big difference between trials on the shopfloor and making it a standard process," said Chris Freeman, AMRC augmented reality technical fellow. "There is only one AR product that has been certified for real industry application, used by Airbus Group, a tablet-based solution."

Why the slow uptake? Part of the reason is that the technology was a little slow to realise the potential of industry. Google introduced its Google Glass prototype in

01 Augmented reality offers a digital overlay of what you see in reality

2013 but it failed to match the hype and was discontinued. As well as privacy and safety concerns, consumers possibly found they did not need to remain glued to Facebook all day. Google Glass 2 is in development and developers of AR glasses should have come to industry first, said Chris Freeman. "An industry audience could [use this technology to] work with instructions, a form of digital map of the product or project. There is a huge amount of value for business," said Freeman. "Industry will rescue Google Glass, and Glass 2 will be an enterprise-level technology."

While VR is used for design engineering, a good example of how AR will benefit manufacturing is just-in-time. A day-to-day example of just-in-time is satellite navigation technology. The driver needs the information at precisely the right time or the instructions will be useless. In manufacturing, job cards that are currently printed can be >>





02

>> automatically sent to the operator, contextualised to the job, so they do not need to collect paperwork.

"AR has a lot of synergy with lean manufacturing, and the drive towards a paperless environment," said Freeman. "We are looking at how AR can help to improve that means of information delivery. For example take a job card, walk up to a machine, scan your barcode and it will auto-load the right job for you for that day or shift." The implication is that operator-specific information is superimposed on the manufacturing cell using the AR glasses.

As further evidence of the unstoppable connectedness of everything, software developers are now using augmented reality to link engineering design and the Internet of Things. The idea, said PTC CEO Jim Heppelman at the launch of Vuforia's Studio Enterprise at LiveWorx 2016, is to "fundamentally change the way we experience things in the enterprise. We are on a mission to democratise AR and make it mainstream for customers of CAD".

The Internet of Things gives companies an insight into how their products behave while in use, helping manufacturers to service products, predict when they will fail, allowing them to engineer them better. AR provides a way to visualise that information, and context is key.

"AR provides a digital overlay of what you're seeing in the real world, and the value of AR is highest when you have physical proximity," said Mike Campbell, executive vice-president of Vuforia Studio at PTC. "It is less valuable to a design engineer than to a service technician or, for example, an oil-well operator, someone who is standing right in front of the machine."

And AR technology will speed up the servicing of products. Boeing and the University of Iowa recently did a study on AR. Experienced and inexperienced service technicians were given traditional paper documents, the same documents on a tablet and then the AR documentation. It achieved similar results for completion but the AR group completed the task 30 per cent quicker, and their 'first-time fix' rate was faster by up to 90 per cent.

Cranfield University and partners including BAE Systems, Rolls-Royce and the UK Ministry of Defence, launched a national strategy for through-life engineering services in July to encourage more companies to develop product service strategies for a global market estimated to be worth £1tn. Cranfield has a VR and AR suite and its overseas masters students are now completing engineering courses remotely, using the AR facility virtually through a high-speed internet connection.

"Augmented reality provides a digital overlay of what you're seeing in the real world, and the value of AR is highest when you have physical proximity"

Mike Campbell, Vuforia Studio, PTC



03

02 The technology has taken longer to permeate the engineering world

03 AR significantly speeds up the time taken to complete a task

But beware the trough of disillusionment. As with all new technology, there is a peak time when AR will be ready to 'plug-and-play' for manufacturing applications.

Siemens Digital Factory in Congleton trialled AR technology for operating its electronic products and opted to buy the Vuzix M100 Enterprise glasses. "We found it useful for applications such as translation – when you view a hazard label in German, what you see through the glasses is the English translation in real-time," said Carl German, product engineering manager at Siemens Drive Technologies in Congleton. "But unless it was font size 70 or close, the glasses struggled. So while it was suitable for a demonstration in practical terms it was not something you could use for manufacturing operations."

Siemens wants to see refinements in the capability of the vision and battery life, but expects to see more companies deploy AR visualisation on the factory floor, the oil rig and the building site very soon. ©



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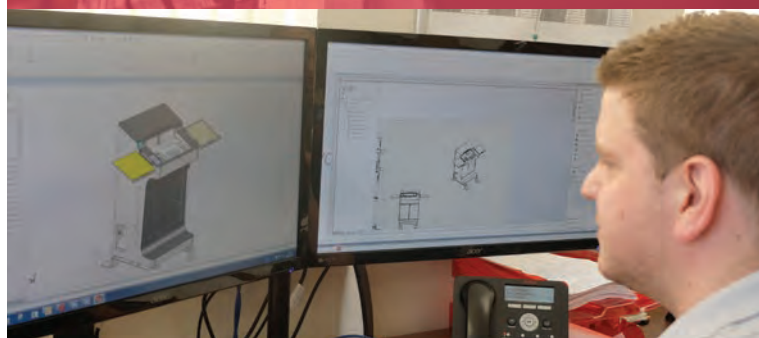
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Simulation is the name of the game for General Electric

Ansys teams up with GE in order to reduce development lifecycle time. Supplier: Ansys

General Electric has extended an agreement with Ansys that will see the industrial giant using Ansys' engineering simulation solutions across even more of its portfolio.

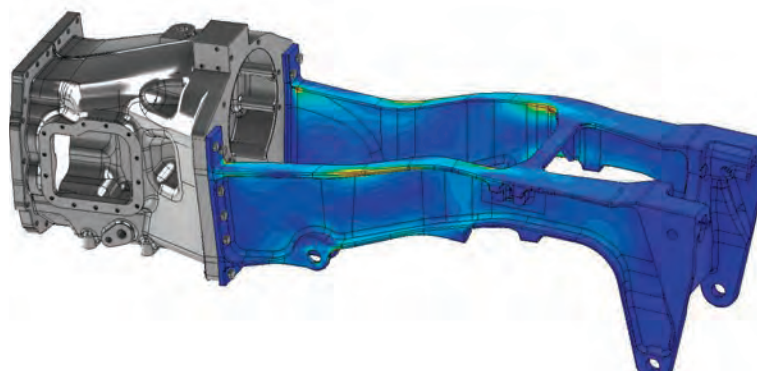
An earlier deal between the two saw GE reduce lifecycle development times by up to 33 per cent on some products using Ansys' Simulation Driven Product Development tool. The new agreement extends upon development and into operations, a key element of GE's Predix Industrial Internet platform.

Predix is a cloud offering designed specifically for industrial data and analytics across industries such as aviation, transportation, oil and gas, and healthcare. Customers use the platform to create Industry 4.0 applications that turn real-time operational data into insights to

improve decision-making and increase machine efficiency.

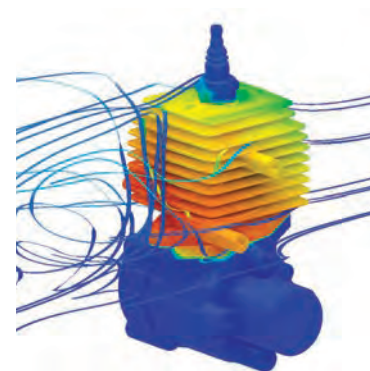
"The industry is in the midst of a revolution in manufacturing and product innovation," said Walid Abu-Hadba, chief product officer at Ansys.

"With our new agreement in hand, GE and Ansys will help to usher in this new age of Internet of Things and Industry 4.0, enabling organisations to innovate like never before while delivering on their promise to offer the most robust and reliable products."



GE Power Engineering will also use Ansys' engineering simulation software to pilot "simulation as a service", enabling companies to analyse the performance of smart machines in real-world operating conditions, then make predictions about future performance. Combining simulation with analytics should help reduce risk, avoid unplanned downtime and speed up new product development.

"By collaborating with Ansys, we're better able to deliver the most advanced products to power the world and support the GE Digital Thread strategy," said John Lammas, vice-president, gas power systems technology and chief technology officer of GE Power. ©



CAD engineering gets an augmented slice of reality

Vuforia Studio Enterprise will allow users to add an AR component to CAD creations. Supplier: PTC



Boston-based software company PTC has introduced an augmented reality (AR) tool to its suite of CAD engineering products.

Unveiled at LiveWorx, PTC's annual showcase event for customers and media, Vuforia Studio Enterprise will allow users to add an AR component

to any of their connected CAD creations, ranging from factory equipment to medical devices.

Vuforia is designed to integrate with the company's own Creo 3D CAD software, as well as PTC's ThingWorx IoT platform. However, PTC said the tool will also be able to function in tandem with other popular CAD programmes.

"Vuforia Studio Enterprise ushers in the era of augmented reality for the enterprise by delivering a set of components that allows practically anyone to create an augmented experience, with no coding knowledge required," said Jim Heppelmann, president and CEO, PTC.

"By integrating 3D CAD data from tools such as Creo and IoT data from ThingWorx, Vuforia Studio allows

organisations to easily develop augmented reality experiences that enable enterprises to better create, operate, and service their connected products."

According to PTC, Vuforia will not require deep programming knowledge or expertise in AR technology. Users will be able to use data from existing 3D assets and combine it with sensor data from connected devices to create animations and sequences. An example of Vuforia in action at LiveWorx showed how a Caterpillar generator could be overlaid with information on a tablet, instructing the user how to use the equipment and informing them of any issues.

"PTC is poised to capitalise on the immense potential of augmented reality in the enterprise with Vuforia Studio Enterprise," said Vernon Turner, vice-president of IoT at IDC.

"The applications for augmented reality in the enterprise are practically limitless, and a powerful tool such as Vuforia Studio that combines augmented reality, Internet of Things services, and 3D modelling will register as a standout option as organisations build out their augmented reality strategies." ©

Sheet metal subcontractor takes advantage of CAM

Specialist CAM software helps precision metalworker nest a range of parts. Supplier: Vero

The UK's largest sheet metal subcontractor, KMF Precision Sheetmetal is using specialist CAM software from Vero to nest a range of parts for several customers on the same sheet.

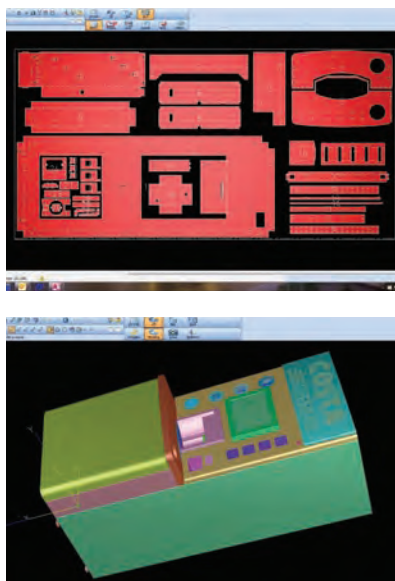
Operating from a 120,000-square-foot facility in Staffordshire, KMF ships around one million piece parts every month. Programming manager Stephen Gardener said the Radnest function within its Radan sheet metal CAD/CAM system from Vero Software saves time and reduces scrap.

"It plays a large part in our day-to-day business, and we use it in two different ways. First, it consolidates large assemblies where we want to produce an exact amount of parts to match the Bill of Materials. A number of our assembly jobs consist of 100 or more parts, and the Project Nesting

function means we can nest different materials and thicknesses on different-sized sheets. These would typically be saved as a project, with all nests saved under one job number.

"And, second, it gives us the ability to nest small batch quantities. If a customer wants five-off, we can nest them on sheets with components for other customers. But if we had to run a full-sheet program for just five parts it could leave us with about 20 per cent waste."

KMF has used Radan for many years to drive its range of Trumpf punch presses, punch/laser combination machine tools, and lasers. But a manual press brake operation for the bending process caused a considerable bottleneck



with a typical set-up taking around 45 minutes. He said that investing in Radan's specialist Radbend module for programming press brakes has slashed set-up time by at least half. It also means it can frequently set up a job using just one part, saving four or five parts on one set-up.

Overall, KMF runs Radraft, Radan 3D, Radprofile and Radpunch on a number of Trumpf machine tools, all fed with Stopa tower systems, and two of them using a ShearMaster to cut sheet skeletons. The CNC shop comprises three fully automated punches, two punch/laser combinations, and two lasers.

Its process with Radan begins by importing the 3D data, then determining the material properties and producing a flat development with bend allowance, which is sent straight to the profiling or tooling stage. "At this point we can also use Radraft to alter any details or features before tooling, and then add either laser profile or punch tools. We'd use auto tooling in both cases, and tweak manually if necessary, to optimise the tooling. Nesting ensures best sheet utilisation, and Radbend produces programs for the press brakes, either straight from the model or by Radraft's 'fold-from-flat' feature." ©

Siemens has clear vision for virtual reality project

Virtualis virtual reality systems are installed in digital factory facility. Supplier: Virtualis

Siemens UK has installed Virtualis virtual reality (VR) systems and software at its digital factory facility in Congleton, Cheshire. Siemens embarked on its virtual reality project with a clear vision of what it wanted to achieve: simulating and optimising assembly processes; effective factory planning; efficient design concepts and reviews; and lean work-cell design.

Simon Charlson, mechanical team leader at Siemens, researched the system and software. "Our first thought was a multi-walled cube, but the product review and lean cell design teams are up to 10-strong, so we went for a bigger Virtualis ActiveWall with a projected wall and floor combined with optical tracking for group and collaborative activities and a head-mounted-display-based Virtualis ActiveSpace for immersion."

Siemens Congleton facility produces variable-speed drives for motors. Its customers come mainly from the automotive sector, machine building (OEMs), pumps and fans and the airport industry. The drives control the speed of the motor, increasing efficiency of operation and decreasing power use. Although there are only five decentralised

product ranges and four cabinet-based systems, the inherent modularity of these drives, plus the many different frame sizes, mean that there are thousands of potential product configurations. "It is costly to create the tooling to manufacture a new product," said Charlson, "and mistakes tend to be expensive. We are now working with our suppliers to bring their virtual tooling into our design reviews. We are finding that this agile development is resulting in great communication between mechanical, electrical and design engineers and is shortening lead times."

Adrian Webster, Siemens' layout planning engineer, said: "VR removes the big issues early on and lets us concentrate on simple refinements. Typically, we build a mock-up of a new cell on the factory floor. Previously, we would need to leave it there for four weeks to resolve all the issues. Now, we are finding two days of digital review, plus just one week on the factory floor, solves all the issues. VR is excellent at fostering multi-disciplinary communication. The people who have input into new designs are diverse: production engineers, test engineers, production operatives and production leadership." ©



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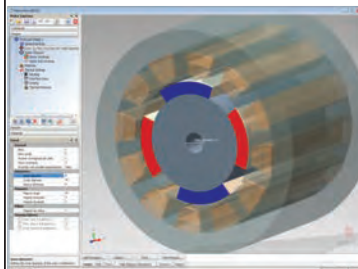
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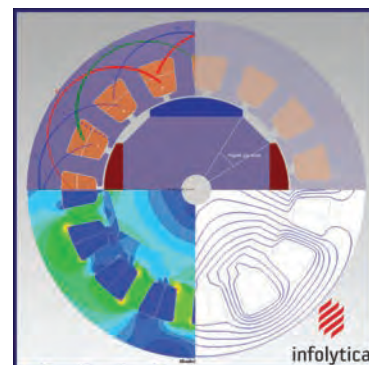


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Put your head in the cloud

Manufacturers fear cloud technology, but connectivity is currently a far more serious issue than security. Helen Knight reports

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anufacturing Execution Systems (MES), designed to manage operations on the production line, have come a long way since they were first introduced. Once designed to manage a single production line, some systems are being used to oversee multiple factories. Now MES are undergoing a new transformation, moving away from hardware and software that must be installed on the shop floor, and up into the cloud.

California-based 42Q, a spin-out from electronics manufacturer Sanmina, recently announced it has launched what it claims is the first fully cloud-based MES. The system does not require the purchase of new software or server hardware, according to 42Q. Instead, companies can simply log in and configure the system to begin operating.

Meanwhile, the German communication and automation systems specialist Hilscher recently announced it had formed a partnership with SAP to provide access to shopfloor sensor and actuator data via its netIOT Edge Gateway on SAP's HANA Cloud platform and Asset Intelligence Network.

This is a cloud-based hub designed to allow operators to access to up-to-date maintenance strategies, manuals, and other equipment-related information from manufacturers. At the same time, manufacturers can

automatically receive machine usage and failure data from operators.

Conventional systems have long been used to keep track of real-time information from the shop floor, including data from both equipment and staff. They are typically used for everything from tracking inventory to monitoring quality control. But, according to Andrew Hughes, principal analyst at LNS Research, by moving MES into the cloud, the different elements of a manufacturing business can be more easily connected.

"Historically, MES have been part of the factory, controlled by the operations people, while the (business) systems were run by the IT department," said Hughes. "And there has always been a problem with the interface between the business systems and the plant systems."

Cloud-based MES can offer executives instant access to data and analytics from the shopfloor, giving them a greater understanding of what is happening on the production line, and where improvements are needed.

One of the key differences between traditional MES and cloud-based systems is that companies will no longer be buying an asset, including all the hardware, software, licences, and responsibility for ongoing maintenance that asset entails. >>



01 Cloud-based systems can offer executives instant access to data and analytics from the shopfloor



02 Systems must be able to respond quickly to changes on the shopfloor

03 The cloud can facilitate the integration of different types of technologies

“In IT departments, cloud computing has become the norm, because they have seen the cost benefits it brings, but when operations people see the word ‘cloud’ they worry about security”

Andrew Hughes, LNS Research

>> Instead, companies will be buying a service, said Lina Huertas, technology manager for intelligent automation and informatics at the Manufacturing Technology Centre.

“You buy the functionality, so you won’t normally have to have anything to do with maintenance, or updates, that will all happen in the background,” she said. “What you pay for is functionality by time, or, in some cases, you pay for different levels of functionality.”

For some companies this can mean their expenditure is reduced, as they will no longer need to make a large one-off capital investment, but instead will simply pay for the service as they use it, Huertas said. “It may be also that you can access the functionality for just a few months, for example, if you just want to try it or need it for a short project, and that makes a big difference in terms of investment.”

In this way, the use of the cloud should open up access to MES to companies that might not previously have been able to afford them. The cloud could also make it easier for different technologies to be integrated together, in the same way that an ecosystem of apps formed around smart phones and tablets, said Huertas.

“If they develop in the right way, in an open way so that they can be easily connected to other systems, then they have the potential to start forming ecosystems,” she said.

But if manufacturers are to begin adopting cloud-based MES, there are issues to be addressed. First, companies will need to overcome their fear of putting shopfloor data on to the cloud, according to LNS Research’s Hughes.



“In IT departments, cloud computing has become the norm, because they have seen the obvious cost benefits and greater flexibility it brings, but when operations people see the word ‘cloud’ they worry about security,” he said.

However, Hughes said the considerable efforts the major cloud computing suppliers have put into security in recent years means most are far better protected than many production plants are today.

Hughes said that factories, in particular, tend to dislike software upgrades in general, with many running on outdated and unsupported versions of Windows simply to avoid changing their systems.

This means the only way many companies can protect themselves is to keep their factories off the internet altogether, with closed firewalls between them and the outside world. But Hughes argued that that will not work in today’s data-driven world, saying that the issue of connectivity is of greater concern. That is because putting your MES into the cloud means the reliability of your internet connection becomes paramount. If the connection between the plant and the cloud is lost, the plant may simply shut down, unless suitable contingency plans are in place.

Finally, the speed of the connection between the shopfloor and the cloud-based MES, and how responsive the system is to changes on the production line, is also extremely important, said Hughes.

“If you have a problem with a piece of equipment and cannot make a work order, you might have to re-route [staff and equipment] to make a different product, and that would mean rescheduling manually at the MES layer,” he said. “So is the system responsive enough to do that?”

MES suppliers are identifying ways to address some of these challenges. 42Q delivers a triple redundancy ethernet connection to customers’ factories, and installs two separate internet connections to the cloud, alongside a back-up wireless link.

“Cloud-based MES is going to get bigger, and people will begin see the benefits of not having to manage their own infrastructure and software release programme,” said Hughes. ☐

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Indonesia in pursuit of decent drinking water

Developing a system of manganese removal. Supplier: National Instruments

The Indonesian ministry of health has used National Instruments' CompactRio control system hardware and developer system to develop and control a manganese-removal system to render tap water suitable for drinking. The system uses supervisory control and data acquisition (SCADA), a user interface employing animation, logging of alarms, trending functions for data, and security.

Manganese occurs naturally in groundwater, but may also result from industrial pollution; its levels in drinking water must be controlled, even though it's a vital trace mineral in the human diet; excess can cause a syndrome with symptoms similar to Parkinson's disease. In Indonesia, the maximum allowed level is 0.4mg/litre, but samples from the Pantai Indah Kapuk region were found to be in breach:

35.9 per cent of samples were not suitable for drinking at all, and 21.1 per cent exceeded the limit.

Manganese is removed in Indonesia by filtration, using an ion-exchange process with a highly porous material coated with manganese oxide as a filter medium; this oxidises the manganese in the water, allowing it to be retained as the water is pushed through under pressure. Chemicals have to be injected into the filter medium, either intermittently or continuously, to ensure the oxidation reactions keep going.

In the process, control by a National Instruments cRio-9073 real-time controller and a SCADA system based on the Labview software suite, three pumps feed raw water into filter tanks, with the pressure at the inlet and outlet points both monitored. When the differential pressure reaches a set point, the filtration valves close, the pump speed slows down and a dosing pump performs the chemical injection.

The control system uses a water-quality sensor to measure the pH, oxidation reduction potential, conductivity, turbidity, chlorine, and manganese levels before and after the water passes through the filter tank. It also uses a security feature to halt the system if it is damaged. ☐

Hose pumps aid Euro toilet paper producer

Peristaltic hose pumps get to work on coating chemicals. Supplier: Watson Marlow



A large European manufacturer of toilet tissue and paper towels is using a range of peristaltic hose pumps from Watson Marlow Fluid Technology Group in its production processes. The pumps include Qdos models that are currently performing dosing operations.

The main mill at this high technology paper plant consists of two machines being used for the production of paper and eight converting machines.

The paper production company found electromagnetic diaphragm pumps on its coating stations were starting to prove problematic.

Not only were there issues of back pressure, which meant that valves were getting blocked, engineers also reported that maintenance was becoming a long, complicated and dangerous process.

The three diaphragm pumps at this station were replaced with three Qdos30 Universal+ chemical metering pumps for the necessary coating chemicals. The advantages of Qdos30 Universal+ pumps include the absence of valves and the fact that the chemicals remain completely confined within the Renu pumphead, which ensures operator safety. Maintenance is also quick and tool-free, thereby minimising production downtime.

With flow rates up to 500ml/min and 7b (bar) pressure, the Qdos30 Universal+ is reportedly enhanced by offering the flexibility for automatic and manual control together with configurable 4-20mA input and output, thus allowing connection directly to the process controller.

The company has reported that it is "very happy" with the Qdos pumps as they provide complete peace of mind, safety and cost savings. Use of coating chemicals has reduced significantly.

The performance of the Qdos pumps has been so impressive, that the company has also adopted six further Qdos models on the dryer protection station serving the two paper production machines, and three coagulant dosing pumps for treating water in the company's flotation units.

The company is planning a third production line, with the goal of producing 90,000 tonnes of paper per year using Watson Marlow dosing pumps. ☐

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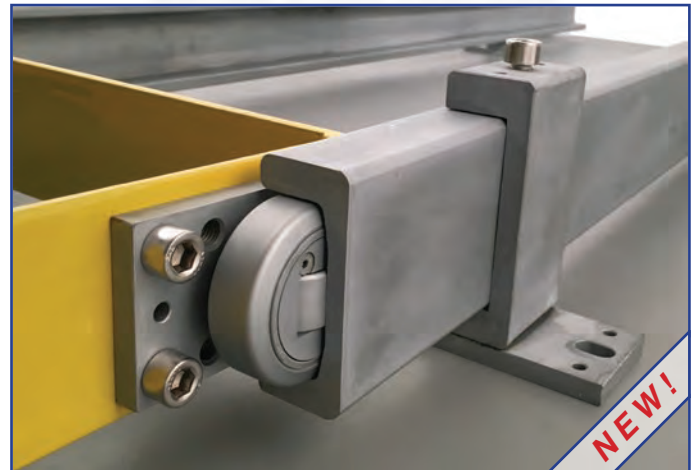
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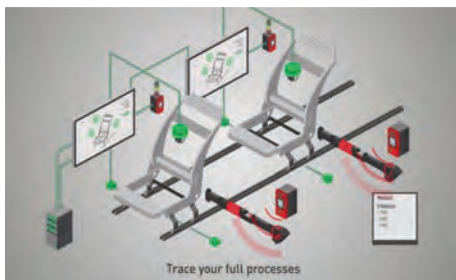


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Compressor control is critical for refinery oil production

Software enables detection of a rotating stall and enhances surge detection. Supplier: GE

For one GE customer, increasing crude oil production at a refinery by 7 per cent required meticulous attention to detail when switching compressors.

To complete the modification and achieve the desired increase in output, the customer replaced the existing wet gas compressor in the fluid catalytic

cracking unit (FCCU) with a new Dresser-Rand motor-driven compressor package.

However, any compressor loss due to surge or trip damage would shut down the FCCU, and, in turn, the entire refinery. Challenges also emerged from conflicting control loops across multiple systems and lack of integration with the process control and vibration monitoring system.

To help overcome these issues, GE customised a comprehensive measurement and control product, providing the refinery with the OptiComp BN compressor control and vibration monitoring system.

OptiComp BN – an enhanced option for GE's existing OptiComp compressor control software suite – enables detection of a rotating stall and enhances surge detection in

combination with Bently Nevada 3500 systems. Patented algorithms combined traditional anti-surge measurements with mechanical measurements, such as radial and axial vibration and axial displacement.

The process measurements are readily available in most compressor installations meaning no additional instrumentation is required. In radial vibration measurements, vibration frequency is filtered to detect onset of rotating stall (incipient surge), which typically precedes a full surge. Axial displacement is a reliable indication of the compressor surging.

According to GE, the control system integrated the following auxiliaries: it monitored the lube oil system and dry gas seals; sequenced the compressor from start-up to operational mode to shut down; and provided data for trips, alarms, and vibration monitoring.

With the GE solution in place, the customer found that triple modular redundancy fault tolerance provides enhanced reliability. Similarly, the solution provided a seamless interface for the distributed control system and multiple layers of security built in for compressor protection, plus advanced anti-surge and performance control capabilities. ©



Process control for full traceability

Suite designed for use in production environments. Supplier: Desoutter

Desoutter Tools, a manufacturer of pneumatic and hydraulic tooling, has now launched a process control suite, PivotWare. Designed for use in the production environment, PivotWare ensures full traceability for quality assurance of users' products.

Working within Desoutter's Infinity Process Control, which uses touch-screen panels, PivotWare is scalable and designed to be simple to modify. One user, according to Desoutter, started using the system on a single station with no networking and then deployed it step-by-step throughout their facility until all of the 350 steps in their process was networked. This is because station configurations are held locally so can operate with or without networking. It also means that network or server failures do not impact

traceability, and a problem in one station will not affect the others in the process.

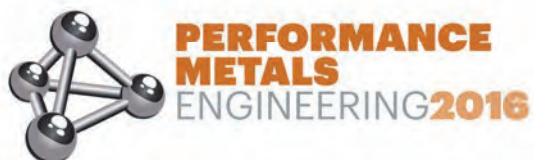
"Traceability of production processes and all related data provides assurance for the quality of each product," said Desoutter. "A robust system should minimise downtime and therefore any loss of production, should offer complete ownership to manage the facility when and where you need it most, provide quality assurance for each product not only in the manner in which it was produced but in the data held for future reference captured along the way." The system also has a standardised hardware and software approach, which the firm claims allows the true cost of ownership and return on investment to be easily calculated. ©



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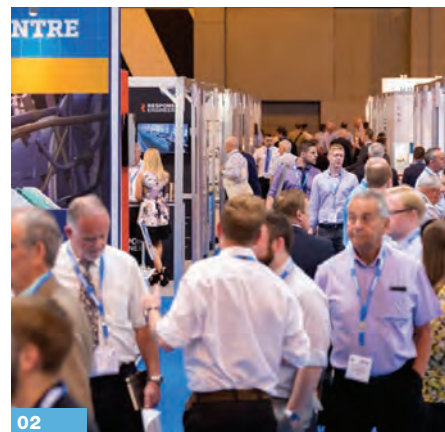
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Subcon attracted a host of top procurement professionals, making it the perfect place to meet potential buyers



02

This year's Subcon show, which took place on 7-9 June at the NEC in Birmingham, was attended by senior buyers from companies including Jaguar Land Rover, GKN Driveline, Rolls-Royce, Terex, Babcock International and Cummins. The show, which saw a year-on-year footfall increase of 6 per cent, welcomed a host of procurement professionals, including representatives of top aerospace organisations such as Meggitt and Rolls-Royce, automotive companies including GKN Driveline and Jaguar Land Rover, as well as manufacturing heavyweights Cummins, Caterpillar, Terex and Babcock International.

Sourcing manager at Halifax Fan, Kevin Garbutt, said: "It was really helpful to meet a substantial number of potential suppliers face to face in one arena. The

more traditional methods of networking and sourcing activity are far more time-consuming."

Steve Nesbitt of Jaguar Land Rover agreed and said of the show: "It was a useful event at which to meet a collection of potential supply and development partners, to enable a better, more efficient future-state solution set, for component manufacturing through to complete end-user products."

One of the new initiatives for Subcon 2016 was the Buyers Programme, which allowed participants to plan their appointments ahead of the event and attend exclusive networking events.

Managing director of exhibitor GWR Fasteners, Jude Robinson, said: "Through the Subcon Buyers Programme appointment scheme we had a request from a very large company to meet us and find out what our capabilities are. They were quite impressed with what we can do and, if a deal materialises from this meeting, it could significantly increase our turnover."

Dean Munkley of Qimtek, which sponsored the programme, added: "Overall we loved it. We met lots of people – good people. We had more than 200 leads in total and generated three times the cost of the show in potential business."

The quality of visitors was key, said Tony O'Brien, sales director at DVR. "Overall we are very pleased. I believe the quality of people that came to see us was better than at other events. An event that focuses on subcontractors attracts buyers who are looking specifically for this kind of service."

This view was underlined by Davinder Lotay, owner of Cheshire-based electronics manufacturer Altimex, who said Subcon was "an excellent exhibition for subcontractors".

Robinson concluded: "We were really impressed with Subcon. For us the footfall was pretty good, particularly on the second and third days."

"The quality of visitors was excellent and we spoke to people who were interested in both our manufacturing services and our standard fasteners. There were people there we wouldn't have seen otherwise. Some of them were companies not far away from us that hadn't heard of us and were interested in us quoting for them. Some of these leads have already come to fruition."

Business development and portfolio director for Centaur Engineering Live Events, Grant Burgham, said: "Once again Subcon demonstrated that it is a place where real business gets done."

"Subcon delivered a focused offering for buyers and gave our exhibitors the chance to show their capabilities to senior procurement professionals that they would not otherwise get the chance to meet."

Subcon, the UK's leading event for contract and subcontract manufacturing, returns to the NEC on 6-8 June 2017, when it will once again run alongside The Advanced Manufacturing Show and The Engineer Design and Innovation Show.©



01

01/02 This year's show, attended by senior buyers and procurement professionals, saw a 6 per cent year-on-year increase in footfall

"We generated three times the cost of the show in potential business"

Dean Munkley, Qimtek

Working on precision for the medical devices industry

Index C200 system bought after decision to machine parts from stainless-steel bar. Supplier: Geo Kingsbury

A major contract to produce a variety of precision components for the medical devices industry led Portsmouth subcontractor DKW Engineering to invest in a new turn-milling centre.

Supplied by UK agent Geo Kingsbury, the German-built Index C200 system was bought following a decision to machine the parts from stainless-steel bar rather than stainless-steel casting.

DKW managing director Nick Iacobucci also spotted the design of the components being produced could also be changed to omit insertion of a pin into the component, doing away with an assembly operation. And as an added bonus, the higher surface finish achievable would eliminate the need for polishing.

Iacobucci initially approached three



potential suppliers of turning centres that would be capable of producing the components, which range up to

65mm in diameter. Gosport-based Geo Kingsbury was the chosen supplier, as it demonstrated that an

Index C200 turn-milling centre could produce the parts to the required dimensional tolerances down to $\pm 0.05\text{mm}$ and achieve 0.8Ra surface finish.

Moreover, the new process route allows the components to be produced in one hit rather than the previous five operations, helping to promote accuracy and reducing work in progress.

The bottom line is that the manufacturing cost per part is only 8 per cent more expensive when using solid bar rather than castings, but the yield of good parts is more than double.

Overall, cost and lead-time per part are reduced considerably across the range of nine different flowmeter components currently being produced. As the value of each part is several hundred pounds, savings are substantial.

"Two turrets can operate at either spindle and three tools are in cut simultaneously during large sections of the cycles, which include a lot of balanced turning and milling," said Iacobucci. "Repeatability is excellent, partly due to the Index system of W-groove quick-change tooling and also as a result of refrigeration and filtration of the coolant." ©

Vibrations are good technique in the heat-affected zone

Vibratory bowl used to stress-relieve case hardening around component edges. Supplier: PDJ Vibro



Factories with metal-cutting machines invariably use vibratory finishing equipment to remove burrs and sharp edges from components. If parts have been laser-cut from sheet metal, however, deburring and surface enhancement are sometimes secondary. The main purpose of the rumbling action can be to stress-relieve case hardening in the heat-affected zone (HAZ) around the component edges.

One sheet-metal subcontractor that exploits this technique is Rotherham-based ESP Laser Cutting, which part-exchanged its decade-old PDJ Vibro vibratory bowl in January 2016 with a new model.

The HAZ on sheet-metal edges caused by a high-temperature laser beam is problematic for several

reasons, especially on components over 10mm thick, although all material gauges are affected. First, it can complicate fabrication by distorting the weld. Second, it prematurely wears milling cutters and drills if the parts are being machined around the outside. Additionally, paint and other coatings such as zinc tend to flake away, necessitating costly rework.

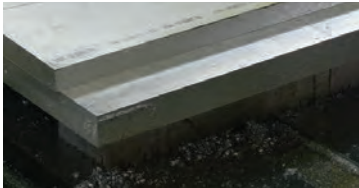
All of these problems are resolved if parts are processed in a vibratory bowl. The maximum size of laser-cut component that can be accommodated in the PDJ Vibro EVP-RA 315 circular, 385-litre bowl at ESP is 400 x 400mm. Above that, if parts need to have their edges stress-relieved, they are shot blasted.

An alternative is to laser cut sheet with nitrogen as the assist gas, rather than oxygen, which is effective at reducing the HAZ on stainless steel and to a lesser extent on mild steel up to 6mm thick. The only sheet material that is not unduly affected by case-hardening during laser profiling is aluminium, but even these components do not escape the vibratory bowl as flashes need to be removed. Similar happenings can occur with other materials due to the laser cutting machine's settings. ©

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Flying above the doom and gloom

As Britain deals with a Brexit hangover, the UK civil aerospace industry says there are some grounds for optimism. Evelyn Wright reports

It's been a couple of weeks since the country's vote to leave the European Union, and British engineers are still attempting to unpick the implications. For those in the UK civil aerospace industry – a sector long considered to be a shining beacon of British manufacturing – the impact remains unknown. But manufacturers say there are reasons to be optimistic, and, for many, it is business as usual.

Today, the UK aerospace sector is the second largest in the world, employing more than 110,000 people directly, as well as 126,000 people in the supply chain. It provides an annual turnover of £29bn with three-quarters of revenue coming from export sales. Airbus predicts global annual air traffic growth of

4.7 per cent over the next 20 years. In anticipation of this, companies have ramped up their investment in the UK over the past few years.

That's unlikely to stop in the short term, according to Mark Edwards, director of aerospace and automotive at engineering recruitment firm Matchtech. For engineers looking to enter a career in the aerospace sector, the roles will continue to be as exciting and diverse as ever. "As a broad industry, with many forward-thinking companies striving to lead the way in terms of technology and luxury, aerospace is without doubt one of the most challenging sectors to work in," he said.

If David Cameron has his way, a two-year formal process for a withdrawal from the European Union will not begin until October. In the meantime, companies will need to ramp up

their skills base to make sure the UK remains competitive on a global stage. This means recruitment will remain high – and many companies have already reaffirmed their commitments to major projects in Britain.

Boeing made a 40 per cent increase in expenditure with UK suppliers between 2013 and 2014. It currently has 2,000 employees at sites across the UK and has been hiring at a rate of one new employee per day. Airbus, meanwhile, has increased production rates for A320 wing sets in the UK to 42 per month from 35 a few years ago with a target of 50 per month by 2018. When it comes to recruitment, Boeing claims major firms state they are not cutting down on staff.

"Boeing remains committed to our customers worldwide, including in the UK and across Europe," said Matt Knowles, communications director at Boeing. "Our partnership with the UK dates back to the 1930s and we have doubled our direct employment and supply-chain spend here since 2011. We will continue to grow our business in support of airlines and armed forces to meet their varied needs with our world-leading products and services. We have an ongoing job to do in the UK, delivering for our customers. That does not change."





02

Ahead of the vote, Airbus warned employees that it would have to 'reconsider' future investment decisions in Britain in the event that it leaves the European Union. Following the results, chief executive of Airbus, Tom Enders said: "The world will not stand still, nor will Europe... I hope the divorce will proceed with a view to minimising economic damage to all impacted by Brexit. Britain will suffer but I'm sure it will focus even more now on the competitiveness of its economy vis-a-vis the EU and the world at large."

He has since softened his comments saying: "Britain remains a member of our family. Our sites in the UK are among the most efficient and competitive sites in Airbus and competitiveness is the key word for our industrial presence in the UK but also in France, Germany and elsewhere in the world."

A similar statement was made by Warren East, chief executive of Rolls-Royce, before Britain went to the polls. He warned that a Leave vote could result in the company putting some of its investment decisions, such as a new £65m aero engine test bed on hold. After the results were announced, Rolls-Royce said it would remain committed to the UK.

"It is important to remember that Rolls-Royce is a global company: two-thirds of our revenue and three-quarters of

our order book is generated outside the European Union, so the UK's decision will have no immediate impact on our day-to-day business."

Mark Edwards, director of aerospace and automotive at engineering recruitment firm Matchtech, is confident that Britain will bounce back, and engineers will remain in demand in the civil aerospace sector. "Manufacturing and quality are the most in-demand skillsets. Recruiting for the latter is more difficult due to a greater skills shortage," he said. "Companies are seeking quality engineers with a highly niche skillset and, consequently, have started to consider engineers from other sectors... such as automotive. However, the most common requirement is for design engineers within growing sectors of the market such as cabin interiors, mechanical components and systems."

In times of economic uncertainty, it pays to focus on a wider area of expertise as not all specialist engineers in the sector are in such high demand, added Edwards. Stress engineering is a skillset that has changed from being the most in demand to becoming saturated, with many people that had previously been contracting finding themselves out of work. "This has left a high number of highly skilled engineers seeking employment in a market with very few stress requirements available," said Edwards.

"For stress engineers and employers, Matchtech's advice would be to look at other suitable roles to which skills can be transferred. For example, we have seen stress engineers successfully move into certification, technical publications and design due to product knowledge, technical report-writing skills and high levels of engineering competency."

Whatever the future of the UK, the civil aerospace sector has long been an industry that has global connections – not just European ones.

Engineers who are considering a career in the aerospace sector may be rocked by the current uncertainty affecting the mood in the UK, but with so many companies reaffirming their commitment to Britain, job prospects may not look as bleak as many first assumed. ©

01 Airbus has a strong presence in the UK aerospace manufacturing sector

02 The UK aerospace is the second largest in the world, employing 110,000 people directly

"The UK's decision will have no immediate impact on the day-to-day business of Rolls-Royce"

Warren East, Rolls-Royce

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NORTHERN MANUFACTURING & ELECTRONICS
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Hit the north for manufacturing

Visitor numbers are expected to build for this year's iteration of the Northern Manufacturing & Electronics show in Manchester

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orthern Manufacturing & Electronics, the north's top manufacturing technology and electronics show, returns to Event City, Manchester on 28–29 September.

The event has evolved consistently over its three-year history, and is again expected to build both visitor and exhibitor numbers for 2016. A key highlight of the exhibition is its RoadRailAir zone, targeting the region's important supply-chain strong points in the automotive, public transport and aerospace manufacturing industries. Last year's

exhibition pulled in almost 2,900 industrial buyers from across the country, with automotive and aerospace manufacturing being particularly well represented.

Northern Manufacturing & Electronics has speedily grown to be a key event for the north's engineering professionals. Further growth this year will enable visitors to Northern Manufacturing 2016 to meet an even wider variety of vendors, ranging from regional specialists to leading international corporations. Firms including Amada, LCL Electronics, Igus UK, Bystronic, Olympus, Nikon Metrology, Yamazaki Mazak and Trumpf are some of the more recognisable names represented. The event mirrors the style of the popular Southern Manufacturing & Electronics Show, which now ranks as a leading annual engineering exhibition in the UK, attended by many hundreds of companies, in particular, some of the most popular machinery and industrial equipment brands in the world.

Together with drawing in major global manufacturers, the show's regional focus



and easy accessibility from over the north, the Midlands, Scotland and Northern Ireland, helps it to perfectly represent the needs of the local firms it serves. However, as a result of its distinctive blend of machinery and production equipment, components, electronics and sub-contract services, Northern Manufacturing has proven immensely popular with visitors from across the complete spectrum of manufacturing enterprise.

Technology trails guide delegates around the show, allowing them to make the most effective use of time at the show. Subcontract services represented include 3D design, electronic assembly, sub-contract manufacturing, tool making and production equipment. Several big-name machinery makers will run live demonstrations throughout the two-day show, offering potential customers the chance to measure up the hottest machining technologies side-by-side at a single event.

Business services also are widely represented at Northern 2016. STEGTA, the training and apprenticeships facilitator, will be available to review visitors' apprenticeship and training needs. Countless additional specialisms will also be represented, with industrial cleaning, stock-control solutions, waste management, consumables, health and safety equipment, design services, manufacturing software and 3D printing being just a few examples. Just about everything necessary to operate an engineering enterprise more cost-effectively and efficiently, is easy to hand within a single event.

The free seminar programme is yet another very popular attraction. Over a lively two-day programme, presenters from both trade organisations and commercial enterprise will speak on a wide variety of technical and operational themes in a series of hour-long sessions running over the two days of the event. As with the show itself, admission to the seminar sessions is free of charge, making this an outstanding chance to enjoy world-class presenters taking a look at some of the newest ideas in manufacturing, engineering and industrial management.

Entry to Northern Manufacturing & Electronics 2016 is completely free to business visitors, and Event City offers 3,000 free on-site car parking spaces, with easy access by road, rail or air. To register online for tickets simply visit www.industrynorth.co.uk or call 01784 880 890. Visitors can follow all the latest news from the show at linkedin.industrynorth.co.uk, or on its dedicated blog page at <http://blog.industrynorth.co.uk>. ☐

"It has speedily grown to be a key event for the north's industrial buyers"

01/02/03 Visitors can meet a wide variety of vendors, from regional specialists to international corporations at Northern Manufacturing & Electronics

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from the archive | **lovell telescope**

Dish of the day

Six decades on, Jodrell Bank's colossal moveable dish is still one of the world's most powerful telescopes

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latest addition: a steerable dish radio telescope that at the time was the largest in the world.

Known today as the Lovell Telescope – in honour of its chief proponent, the late Sir Bernard Lovell – the construction garnered attention for several reasons. “This enormous instrument is of special interest, not only for the uniqueness and promise for the astronomer but also because of the engineering problems that had to be surmounted to design and build it,” wrote *The Engineer* in 1957. “Civil, mechanical and electrical engineering techniques are all involved in the successful operation of the radio telescope, sometimes in an original manner.”

With a moveable dish 76.2m (250ft) in diameter, the Lovell telescope is today still the third-largest telescope of its type, as well as a Grade I-listed building. In 2006 it won a BBC competition as the UK's greatest ‘Unsung Landmark’. But what are now its storied history and place in the national consciousness were, of course, unknown to our predecessors all those years ago, whose focus was primarily the telescope's construction and operation.

The article went into detail: “The bowl... is carried on two towers by trunnion bearings; it can be turned on those bearings through 180 deg. The towers are mounted on bogies on a circular rail track so that the whole structure can be rotated. Driving and control mechanisms are installed in such a manner that the telescope can be pointed at any given star and can be driven to follow the path of the chosen star till it disappears below the horizon.”

Despite aluminium alloy initially being offered as a possible construction material, the consultants ultimately chose to build the entire telescope from steel. Steel provided the highest strength/cost ratio

and had a low coefficient of expansion, meaning that reasonable accuracy of the dish's shape could be maintained. It was also judged the best material to help overcome one of the telescope's key challenges: the wind.

Stability in wind was a key consideration and the telescope had to be steady enough to maintain the bowl's accuracy in moderate winds of 30–40mph. The first designs of the telescope “allowed deflections of several inches – say 6in or 7in”. However, the iteration that was ultimately built meant that “any deviation of the skin of the paraboloid from its true shape [was] intended to be kept down to about 1in”.

The bowl itself was constructed from more than 7,000 stiffened steel plates of 3ft by 3ft, welded to purlins. The purlins were bolted together and attached to the main structure of the telescope, enabling alignment of the shape of the bowl by adjusting the bolted connections. According to this magazine, detailing of the steelwork was “unusually onerous” due to both the structure's unusual shape and the high degree of accuracy required.

“An idea of the complexity of this aspect of the work may perhaps be given by referring to the

purlins. There are 2,200 angle-iron purlins carrying the surface of the bowl. Each had to be curved to different diameters in two planes, so that a purlin lay truly on the surface with one side of the angle iron parallel to it.”

If necessary, the bowl could be fully inverted, with the intention that the telescope could be placed in this position whenever the 62.5ft aerial mast needed to be changed. As for the bowl's surface, a synthetic flat white paint was specified in order to “prevent a serious concentration of heat”, as well as “encourage a high degree of diffuse reflection of the sun's rays, so that the steel membrane itself does not get too hot”.

Of course, much work has been done in the intervening 59 years to maintain and upgrade the telescope. Since 2010, the dish has been protected from pigeons' and other birds' foulings by two breeding pairs of peregrine falcons (one in each of the telescope's two support towers). An indication of the structure's endurance, however, is the fact that, since 1957, just two of the original 64 drive wheels that help it track stars across the night sky have needed to be replaced. They certainly don't build 'em like they used to. **AW** ☉

“Civil, mechanical and electrical engineering techniques are all involved in the successful operation of the radio telescope”

The Engineer

The new Lovell Telescope in 1957. Both design and construction involved hugely complex engineering



Word of the issue

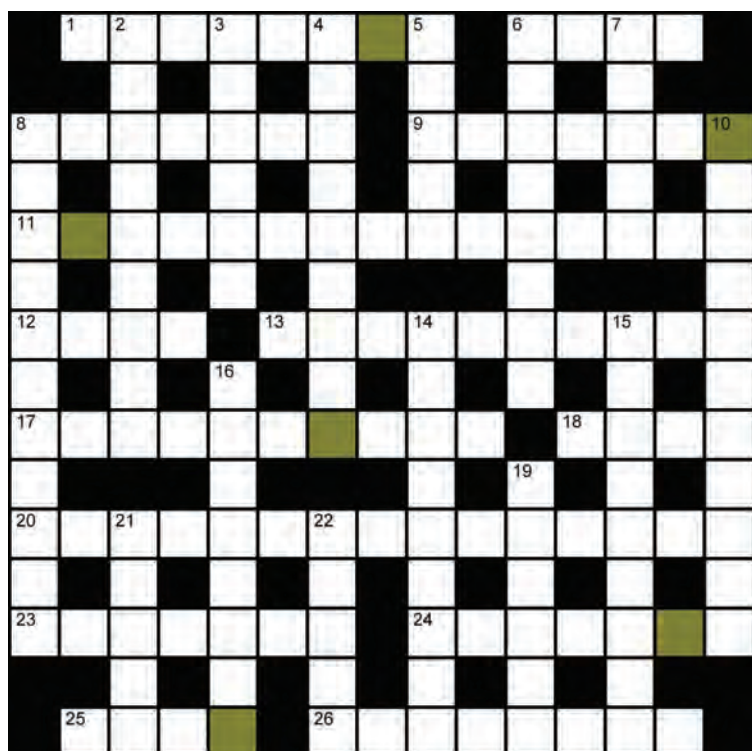
Anthony Poulton-Smith explores the origins of the word 'tram'

The tram is making a comeback. While Blackpool has always been synonymous with this mode of transport, Newcastle, Glasgow, Nottingham and Birmingham have added to the growing network. The first trams were horse-drawn, seen in 1807 along the Swansea and Mumbles Railway. Later, steam and, eventually, electricity powered this passenger transport. But what of the word 'tram'? No surprise to find it predates everything associated with the tram excepting the invention of the wheel. This word came to Britain from both the Scandinavians with *traam* and Middle Flemish *tram* each referring to wooden beams or shafts – such as the handles on barrows – and from the French *la trame* 'crossbeam'. When 'tramway' came into use, originally referring to the tracks laid for coal trucks, the suffix 'way' leading to 'tram' being used for whatever travelled along the same.

Bigpicture



NASA's Space Launch System (SLS) has successfully fired up for its second qualification ground test at Orbital ATK's test facilities in Promontory, Utah. This was the last full-scale test for the booster before SLS's first uncrewed test flight with NASA's Orion spacecraft in late 2018.



Prize crossword

When completed rearrange the highlighted squares to spell out a short stretch of railway track. The first correct answer received will win a £20 Amazon voucher. Email your answer to jon.excell@centaur.co.uk

Across

- 1 Place for plane to land (8)
- 6 Warm and snug (4)
- 8 Walking heavily and firmly (7)
- 9 Showing off (7)
- 11 The quality of disagreeing (15)
- 12 Busy or occupied with (2,2)
- 13 Generator that produces alternating current (10)
- 17 Close together in a line (4,2,4)
- 18 Heavy ductile magnetic metallic element (4)
- 20 Software that controls a computer (9,6)
- 23 Lasting for ever (7)
- 24 Depending on free oxygen (7)
- 25 An upright in house framing (4)
- 26 Pulled back (8)

Down

- 2 Gave evidence of (9)
- 3 Thin and bony (6)
- 4 Looks upon (7,2)
- 5 Paved area near house (5)
- 6 In an awkward, tactless manner (8)
- 7 Move smoothly along a surface (5)
- 8 Portable paraffin cooking device (6,5)
- 10 Of a particular style of cookery (11)
- 14 Feeling piqued (9)
- 15 A rotatable platform with a track (9)
- 16 Came into possession of (8)
- 19 Composite of mixed origin (6)
- 21 Eliminate a substance (5)
- 22 Relative by marriage (2-3)

June's highlighted solution was fuselage. Winner: **Julian Gable**

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