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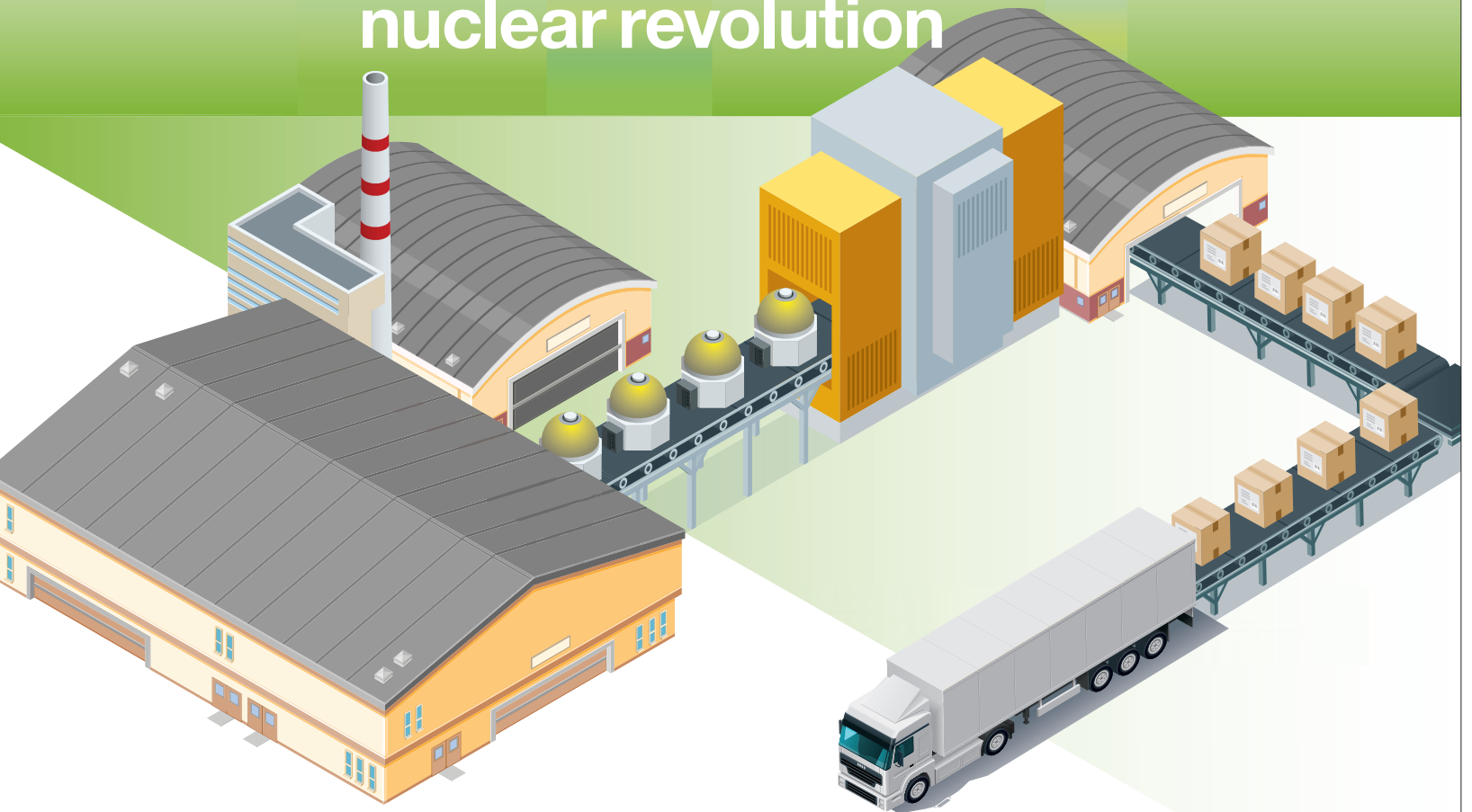
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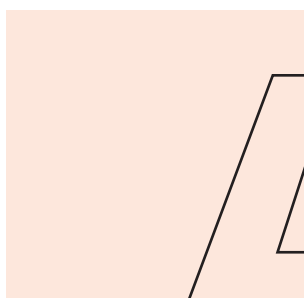
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our opinion

Acid test



As this issue of *The Engineer* went to press we were picking over the implications of PSA group's long-awaited acquisition of GM's European operations.

Most significantly for the UK, the deal has seen the French firm take control of Vauxhall, which employs 4,500 staff at Ellesmere Port and Luton.

Announced in the same month that the government has timetabled the formal triggering of Article 50, the acquisition could prove to be an acid test for the health of the sector post-Brexit.

And although PSA chairman Carlos Tavares has sought to provide reassurance that British jobs will be safe, the change of ownership has prompted renewed calls for government to do everything in its power to support and nurture the domestic supply chain, and make the UK as attractive a destination as possible for overseas investment.

Tavares himself has reportedly talked of the need to develop the domestic supplier base post-Brexit, referring to it as a "nice opportunity" for the UK. While last month, Colin Lawther, head of Nissan's UK manufacturing supply-chain operation, reportedly told a House of Commons select committee that with the firm currently sourcing up to 85 per cent of its components from Europe, China and Japan, investment in supply chain will be key to ensuring its Sunderland plant remains competitive.

"The GM acquisition could prove to be an acid test for the health of the automotive sector post-Brexit"

Given its size and the degree to which it relies on highly integrated international supply chains, it's unsurprising that the UK car industry is making the most noise on this issue. But many of the concerns it raises are applicable to other areas of the UK industrial economy. Aerospace, defence, medical technology and the energy industry will require a focus on domestic supply-chain growth if they are to remain competitive.

In this issue's cover story (p22) we take a look at a sector that's been hard hit by an erosion of expertise over the past few decades – nuclear – and we examine how the UK's burgeoning expertise in small modular reactors (SMRs) could, with the right support, enable the UK to once again play a major role on the world's nuclear stage. It's a reminder that giving industry the best chance of success outside of the EU should be as much about long-term vision as it is about short-term fire fighting. ☺

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TELECOMS

Moving closer to the reality of 5G

Trial of massive MIMO heralds wider Internet of Things utilisation HELEN KNIGHT REPORTS

Highly efficient 5G wireless networks are a step closer to reality, following UK trials of an important technology.

The development of 5G networks could enable faster video downloads, even in large crowds, cars that communicate with their surroundings, and wider utilisation of the Internet of Things.

The trials, a collaboration between researchers at the universities of Bristol and Lund in Sweden, National Instruments (NI) and BT, were held in order to test the potential of massive MIMO (Multiple-Input Multiple-Output) systems.

Massive MIMO systems, which are expected to become a vital component of 5G networks, are capable of sending and receiving more than one data signal simultaneously over the same radio channel.

The systems are designed to increase the data rates possible with wireless technology, while conserving bandwidth and power, according to Mark Beach, professor of radio

systems engineering in the Department of Electrical and Electronic Engineering at Bristol University, who led the research team.

"We re-use the same radio channel, at the same time, for multiple users, connected to the same base station," said Beach.

The technology is based on massive MIMO arrays, which are cellular base stations consisting of more than 50 antennas.

"One massive MIMO antenna array would serve between 10 to 20 users, at the same time and on the same frequency," said Beach. "So just using that technique alone would increase capacity 10- to 20-fold."

In the trials, the researchers tested an array containing 128 antennas, operating at 3.5GHz. The trials were carried out at BT Labs in Adastral Park, Suffolk, both outdoors and inside the company's large exhibition hall, which was chosen to mimic a stadium environment. The researchers tested a technique known as massive MIMO spatial multiplexing, in which separate data streams are transmitted from each of the antennas.

In one experiment, the researchers used 12 streams in a single 20MHz channel to show the real-time transmission and simultaneous reception of 10 different video streams, plus two other channels.

"We carried out a demonstration in which we sent video backwards and forwards across these multiple links," said Beach. "It was pretty spectacular."

The results of the experiments indicate that the technology could offer spectrum efficiencies in excess of 100 bits per second per hertz, 10 times better than the capacity of existing long-term evolution systems.

The system was also shown to support simultaneous transmission of 24 user streams on the same radio channel, with all modems synchronising over the air.

This is believed to be the first time such an experiment has been conducted without cables, said Beach. "It was a significant achievement, because it was totally tether-free," he added.

Future 5G networks would allow multiple users to stream or upload video at the same time.

"Take a spectator event," said Beach. "One of the big problems at the moment is that if everybody tries to upload or download clips individually, there is just not the bandwidth there, so with 5G there would be much more support for social media."

The technology would also offer broadcasters more radio spectrum for outside broadcasts, and could be used to connect up the thousands of low-data-rate sensors and devices in the Internet of Things, he added. ☉

Massive MIMO systems are expected to become a vital component of 5G networks



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COMMUNICATIONS

Drones could have real sense of vision

Project works on highly efficient sensors that mimic the human retina

HELEN KNIGHT REPORTS



Drones could benefit from more accurate image processing

Robots, surveillance cameras and drones could one day detect changes to their environment more quickly and efficiently, using a vision system that is based on the way the human eye and brain process information.

The EPSRC-funded Internet of Silicon Retinas (IOSIRE) project, led by researchers from Kings College London and also involving University College London and Kingston University, is aiming to develop

advanced machine-to-machine communication systems that capture and transmit images from highly efficient vision sensors that mimic the human retina.

Conventional cameras generate entirely new images for each frame, despite the fact that much of the picture remains the same as that of the previous one. This wastes memory, computing power and time, according to the UCL principal investigator Yiannis Andreopoulos.

"If you are processing an image to analyse what is happening in a scene, you often end up throwing away most

of the background information, because you are only interested in particular shapes or objects," he said.

In contrast, recently developed dynamic vision sensors (DVS) mimic the retina by only updating the image at those points where a movement or change in the scene has occurred. When an object moves within a scene it reflects light, which is detected instantly by the sensor, according to Andreopoulos.

This significantly increases the speed at which the sensors can produce video frames, resulting in rates of up to 1000 frames per second compared to 20-30 frames per second for conventional cameras.

"And because it is not recording the background, just any changes in the scene, the power consumption is very low – just 10 to 20mW compared to up to 200mW," said Andreopoulos.

Basic processing of images produced by the DVS camera could be carried out locally by the device itself, to produce information needed there and then.

But certain information could also be transmitted to a server in the cloud, at which point more advanced processing and analysis could be carried out, said Andreopoulos.

This resembles the way the mammalian eye is thought to capture scene information, and then transmit it to the visual cortex where the information is processed to generate the three-dimensional rendering of the scene that we 'see'.

"In a way, this gives us the illusion we see this 3D super-high-resolution world, but there is very little information being captured by the eye, and to a large extent, the rest is 'rendered' in the brain," said Andreopoulos. ©

Newsinbrief

On a cliff edge

Walking away from the EU with no deal in place will leave UK manufacturers in a precarious position that will damage jobs and investment. This stark warning was made by Dame Judith Hackitt CBE, chair of EEF, at the National Manufacturing Dinner in London on 22 February. She said: "Uncertainty and confusion will result in business being left on a cliff edge."

Space invaders

UK scientists will be able to fly to the edge of space to conduct experiments under new powers unveiled by the government. Laws paving the way for spaceports in the UK will allow such experiments to be conducted in zero gravity, which could help in the development of medicines. The powers will also allow the launch of satellites from the UK for the first time.

State the facts

The latest *State of the nation* report from Engineering UK paints a concerning picture over the UK's ability to get to grips with its engineering skills shortage. According to the Engineering UK 2017 report, industry will require 265,000 skilled entrants – including 186,000 engineers – annually to 2024. But with the proportion of workers aged under 25 continuing to decrease there are fears that industry will not meet this demand.

Looking to lead

New insurance rules for self-driving cars and measures to improve the provision of electric vehicle charge points have been introduced as part of the Vehicle Technology and Aviation Bill. These measures are expected to help the UK become a leader in these technologies by removing barriers limiting companies from testing the cars here.

NUCLEAR

UK looks to fusion future after Brexit

Withdrawal from Euratom treaty is part of Brexit

STUART NATHAN REPORTS

Minister for universities and science Jo Johnson has reaffirmed the UK's commitment to nuclear fusion research following withdrawal from the Euratom treaty as part of the Brexit process.

Johnson stated that efforts are being made to ensure the future of the Joint European Torus (JET) project in Culham, Oxfordshire, and participation in ITER in Cadarache, France.

In a statement issued by the UK Atomic Energy Authority (UKAEA), Johnson confirmed that the withdrawal from Euratom is due to the treaty's legal linkage to the UK's membership of the European Union and is therefore an intrinsic part of Brexit.

"The research done at the Culham Centre for Fusion Energy is rightly recognised as world class and it has driven UK leadership in fusion R&D for many years," he said. "The government has no intention of compromising this position following

the decision to withdraw from the Euratom Treaty.

"Maintaining and building on our world-leading fusion expertise and securing alternative routes into the international fusion R&D projects... will be a priority," Johnson continued.

He added that he is already in talks with UKAEA management to look at how this can be achieved following Euratom withdrawal. Both the UK's hosting of JET and its participation in ITER have so far depended on Euratom membership.

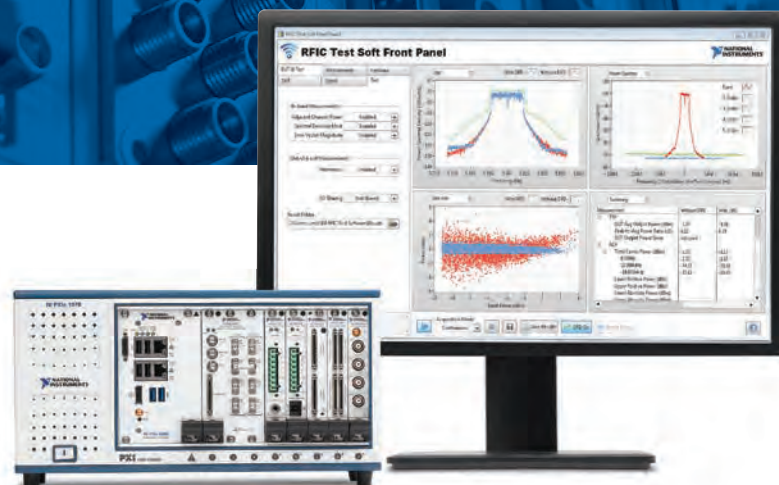
The Institution of Mechanical Engineers (IMechE) has called on the government to take action to protect the future of the nuclear industry in the UK after Euratom withdrawal. ©

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ROBOTICS

Agri-bots develop soft spot for fruit

Robot farmers could soon be keeping a careful eye on strawberries HELEN KNIGHT REPORTS

Intelligent robot strawberry farmers, capable of travelling up and down fields monitoring crops, are being developed in the UK.

Dogtooth Technologies, a start-up company based near Cambridge, is developing autonomous robots designed to harvest soft fruits such as strawberries.

The company tested its first prototype robot in the field in the summer of 2016, and is already working on an improved version. Five of these second-generation robots are due to be operating on a farm this summer.

The company is working with researchers at the National Institute of Agricultural Botany in Cambridge, in an EPSRC-funded project known

"You have got these robots moving up and down the fields with cameras on"

Ed Herbert,
Dogtooth Technologies

as Vesca, to develop advanced computer vision and motion-planning systems, in order to enable the robots to more efficiently locate fruit and determine their quality and suitability for picking.

The robots are each equipped with several cameras, said Ed

Herbert, founder and chief operating officer of Dogtooth Technologies. "You have got these robots moving up and down the fields with several cameras on, and they'll be imaging the crop in minute detail," he added.

"We have got that linked up with high-precision GPS coordinates, which allows us to look at the trajectory of each plant and each strawberry," said Herbert.

By tracking the trajectory of a given plant or section of the farm, it allows

farmers to quickly identify an area of the farm that is more or less productive, or where there has been a sudden drop-off in activity, said Herbert.

"You can look for signs of disease or pest, and that means that you can intervene earlier, reducing the amount of chemicals you need to use, and increasing your yield," he added.

The project is aiming to build a system that has approximately the same performance as a human strawberry picker, but at a cost of £12,000 per robot, when produced at scale.

Strawberry harvesting is manually intensive, and increasingly vulnerable to fluctuations in the labour market.

"But picking is almost an excuse to get cameras in the field," said Herbert. "The real benefit is not in replacing or displacing human labour, it's in all the added information you can get with these really rich datasets we will be collecting." ●



The robots will potentially be able to determine the quality of the fruit

AEROSPACE

Look to the sky for driverless drones in Dubai

Autonomous human flight could start in July 2017

JON EXCELL REPORTS

Driverless passenger drones could take to the skies above Dubai as soon as July 2017, according to the city's transport chief.

The plans were unveiled by Mattar Al Tayar, chairman of Dubai's Road & Transport Authority during a speech at the UAE's annual World Government Summit.

Al Tayar revealed that the city plans to use an autonomous aerial vehicle (AAV) produced by Chinese drone specialist Ehang. "RTA will spare no effort to launch the AAV in July 2017," he said.

Originally unveiled at the 2016 CES show in Las Vegas, the Ehang 184 is claimed to be the first vehicle of its kind to offer autonomous human flight over short-to-medium distances.

Able to fly at altitudes of up to 500m and stay aloft for around 30 minutes, the fully unpiloted eight-rotor aircraft can carry a single passenger weighing up to 100kg.

The firm claims that during use a passenger will select a destination using an on-board touchscreen and an intelligent flight-control system will then guide the vehicle to its destination. The aircraft is said to be able to react autonomously to changing wind conditions and unexpected obstacles, but should it encounter any problems, technicians at a ground-control centre are able to step in and pilot it safely to the ground.

Plans to launch the service in Dubai are part of a wider vision to transform the city into a global centre for driverless mobility. The city already boasts the world's longest driverless metro and is also said to be considering the introduction of driverless buses and taxis. ●

The drones could fly up to 500m



AUTOMOTIVE

Off-road ambition

Company believes gap in the market exists following the withdrawal of the Land Rover defender

Chemical company Ineos is branching into automotive with the development of a 4x4 off-road vehicle.

Ineos chairman Jim Ratcliffe believes a gap in the market exists following the withdrawal of the Land Rover Defender, and that "many hundreds of millions" will be invested into developing the vehicle.

The company said it had carried out a six-month feasibility study and that a suitable manufacturing site will be a part of the project's next phase.

Dirk Heilmann, the former head of engineering and technology at Ineos, will run the project in his capacity as CEO of Ineos Automotive.

"This is an amazing project for everyone involved," said Heilmann. "Our job is to create the world's best 4x4 and we are already moving forward with our plans."

Ineos said the vehicle's global target market would include agriculture and forestry workers, explorers and adventurers, as well as traditional Defender drivers. **JF**



Wireless Environmental Monitoring Systems

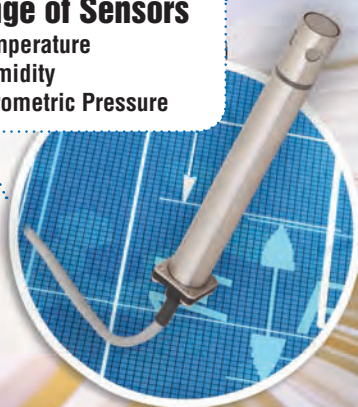
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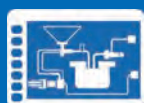


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MEDICAL

New robotic arms are making sense

Sensor technology means prosthetic arms with a greater range of actions HELEN KNIGHT REPORTS

Robotic prosthetic arms allow amputees to perform a particular set of actions by twitching the remaining muscles in their severed limb.

But the range of movements possible with existing robotic arms is severely limited, leading up to half of amputees to abandon their devices.

Researchers at Imperial College London have developed sensor technology for use with robotic arms that should ultimately make it possible to carry out a far greater range of actions using the prosthetics.

The technology, published in *Nature Biomedical Engineering*, detects signals from motor neurons – nerve cells in the spinal cord that control muscles via fibres known as axons – rather from muscle.

This allows more signals to be detected by the sensors, meaning that more commands could then be programmed into the prosthetic limb, according to Dr Dario Farina at Imperial

Sensors could enhance prosthetics



College London, who carried out much of the research while at the University Medical Centre Gottingen.

“We use muscle tissue to connect the nerves that are severed after amputation, so surgically these

“We use muscle tissue to connect nerves severed after amputation”

Dr Dario Farina,
Imperial College London

nerves are redirected into muscle tissue,” said Farina.

Six volunteers underwent a surgical procedure at the Medical University of Vienna in which parts of their Peripheral Nervous System connected with hand and arm movements were re-routed to healthy muscles in their body.

This allowed the team to clearly detect the electrical signals sent from the spinal motor neurons, said Farina. “We establish an interface with the spinal cord, using the muscles to amplify the nerve activity,” he said.

The researchers then decoded some of the information in these electrical signals and interpreted them in computer models.

“We build a virtual arm, for which we estimate the forces at every joint, and then we translate those forces into the command of the robotic limb,” Farina said.

The researchers encoded specific motor neuron signals as commands into the design of the prosthetic, and then connected a sensor patch onto the muscle that had been operated on during the re-routing procedure.

This sensor patch was connected to the prosthetic, enabling the amputees to control the device by thinking about specific arm and hand manoeuvres.

The researchers now plan to move on from laboratory tests towards full clinical trials. ■

AEROSPACE

Flight-deck fix

World’s longest air vehicle is now structurally complete ahead of further test flights

Structural damage to the flight deck of Hybrid Air Vehicles’ Airlander aircraft has now been repaired.

The hybrid aircraft, which at 92m in length is the world’s longest air vehicle, was damaged in August 2016 on its second test flight.

Following repair of the flight-deck structure, Airlander is now said to be structurally complete ahead of the resumption of test flights.

The flight-deck instrument panels, overhead console and all associated wiring have been reinstalled successfully. The company said this was supported by weeks of preparation, which



Hybrid Air Vehicles’ Airlander

allowed large sections to be moved simultaneously and clipped in to place. With the equipment installed, ‘power-on’ has been achieved and on-aircraft testing has now begun.

Hybrid Air Vehicles’ CEO, Stephen McGlennan said the company is looking forward to restarting Airlanders’ test-flight programme but could not specify the exact date for the next flight. **JF**

MEDICAL

Ultrasound has a clear focus on spinal injuries

Technology allows precise location for ultrasound

HELEN KNIGHT REPORTS

Patients with collapsed intervertebral discs could one day be treated without the need for invasive surgery, thanks to high-intensity ultrasound focused onto the spine.

The technology, developed by Prof Constantin Coussios and colleagues at the Institute of Biomedical Engineering at Oxford University, allows the ultrasound to be focused at a precise location.

Chronic lower-back pain can require patients to undergo spinal surgery, which can then lead to complications. Partial disc replacement, in which the degenerated gelatinous core of the disc is replaced by an implant, is less invasive but leaves a hole in the disc, through which the implant can leak out.

High-intensity focused ultrasound (HIFU) is a potential new approach to treat the condition, in which the disc’s core is liquified. But the treatment site is deep within the body, making it difficult to generate a focused ultrasound beam.

The researchers have developed a system in which an ultrasound



Lower-back pain often requires surgery

transducer and receiver on the tip of a needle communicate with an external ultrasound array fitted on the patient.

The system consists of a modular ultrasound device that can be arranged around the patient’s body; an implantable ultrasound device at the tip of a needle; and a control system.

“Once the array is configured and positioned over the skin, the next challenge is to figure out how to best drive the individual elements so as to achieve optimal focusing at the intended target,” said Coussios.

This can be done by firing each element of the array in turn and recording the signals as they reach the sensor on the needle, or by firing the transmitter on the needle and recording it as it is received by all of the array elements, he said. ■



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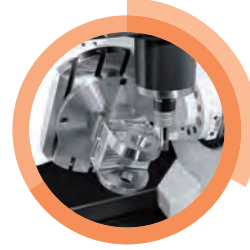


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RENEWABLES

Keep a remote eye on the renewables

Robotic and autonomous vehicles could monitor offshore wind farms HELEN KNIGHT REPORTS

Offshore wind farms and the undersea cables used to transfer power to the shore could be monitored remotely using robotic and autonomous vehicles, as part of a UK-wide research effort.

The £4m, EPSRC-funded project has been set up to improve the way wind farms are managed, according to Dr David Flynn, director of the Smart Systems Group (SSG) at Heriot-Watt University, and a member of the research consortium.

Despite being a 50-year-old technology, there is still no industry and academia-wide consensus on how best to monitor and maintain wind farms, said Flynn.

"On an offshore wind farm you can have 10 to 20 false alarms a minute"

David Flynn,
Heriot-Watt University

"On an offshore wind farm, you can have around 10 to 20 false alarms each minute," he said. "So to give us access to the right information, and to put us ahead of the curve in terms of the lifecycle of these assets, we have developed novel sensing technologies to

inspect these systems in the field."

One technology, which will be developed by Flynn and colleagues at Heriot-Watt, is a dolphin-inspired low-frequency sonar, to be installed on an autonomous vehicle to inspect undersea cables.

The device will travel to places of interest on the cable, such as those known to be particularly vulnerable. It will then emit pulses of sound to generate an image of the inside of the cable. "From that we will be able to understand its condition, and

importantly its remaining useful life," said Flynn.

Subsea cables are extremely expensive, costing the industry millions in offshore insurance claims alone.

"We will impede this green industrial revolution if we cannot get resilience and sustainability into the system," said Flynn. "Investment into offshore wind, as well as wave and tidal, will stop if it cannot become a guaranteed, source of generation," he added.

Other projects being undertaken as part of the consortium include the use of drones to inspect offshore substations, and efforts to address concerns relating to the power electronics and drivetrains within offshore wind turbines, said Flynn.

The HOME-Offshore consortium (Holistic Operation and Maintenance for Energy from Offshore Wind Farms) is led by Manchester University and includes researchers from Warwick, Cranfield, and Durham University. Partners include Siemens Wind, DONG and GE Energy Solutions. ©



Subsea cables power wind farms



AUTOMOTIVE

Sinclair C5 is source of inspiration

Iris e-Trike evokes memories of Sir Clive Sinclair's automotive invention of the 1980s

The infamous Sinclair C5 has inspired a new one-person electric vehicle designed by the nephew of C5 inventor Sir Clive Sinclair.

Known as the Iris e-Trike, Grant Sinclair's creation has a streamlined shape based on the aerodynamic helmets used in track cycling and skiing. It's constructed from a

chromoly steel trike chassis inside a monocoque Quantum Foam EPP (expanded polypropylene) body. The road-legal vehicle is equipped with four LED headlights, a single rear LED brake light, and indicator signal lights.

A 750W-plus mid-drive motor is capable of producing speeds of over 30mph, with the Iris also incorporating an eight-speed pedal bike gearing. A removable lithium-ion battery pack promises a range up to 50km on a one-hour charge. Total vehicle weight, including battery and charger, is 55kg. **AW**

AUTOMOTIVE

McLaren looks for significant weight loss

New composites centre works on future chassis

JASON FORD REPORTS



The next-generation Super Series car

Efforts to reduce the weight of McLaren Automotive's road cars are taking shape in Sheffield with a new Composites Technology Centre based near the Advanced Manufacturing Research Centre.

McLaren Automotive's new facility, expected to create 200 jobs, will develop and manufacture monocoque, monocoque and carbon-fibre chassis for the company's future cars, with monocoques to be built with advanced automated manufacturing techniques developed with AMRC.

The first pre-production carbon-fibre chassis is expected to be delivered to the McLaren Technology Centre in the second half of 2017 using trial manufacturing processes in the AMRC before going into full production by 2020.

Mike Flewitt, McLaren Automotive CEO, said that a fully equipped McLaren car weighs around 1,400kg, adding that the next-generation Super Series car to be shown at this year's Geneva Motor show will be 20kg lighter than its predecessor.

"It's not a huge step but it is heading in the right direction; when you think about the content that's gone in, to take that away is good," he said. "The big challenge is when we do our first... hybrid range of cars... I want them to come in at the same weight. When you think about it, hybrids bring in a penalty of 100/120kg. That's the goal. We want all the benefits that hybridisation [is] going to bring and we don't want any down side in weight."

The new centre – a partnership between McLaren Automotive, Sheffield University's AMRC and Sheffield City Council – represents an investment of nearly £50m. ©

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MEDICAL

Diagnosing CDI in just minutes

Quick diagnosis could potentially speed up treatment and recovery rates HELEN KNIGHT REPORTS



The tests can be done without expensive lab equipment

Patients with hospital-acquired Clostridium difficile infection (CDI) could be diagnosed in minutes at their bedside, potentially speeding up treatment and improving recovery rates, thanks to technology that is being developed in the UK.

CDI causes severe diarrhoea and can prove fatal in vulnerable individuals so tackling it has become a government priority.

In an EPSRC-funded project, researchers at Cranfield University will develop a diagnostic tool for detecting CDI without sending samples for laboratory analysis.

The point-of-care device will use laser spectroscopy to identify specific chemical biomarkers for CDI in volatile organic compounds (VOCs) emitted by stool samples, according to Dr Jane Hodgkinson at Cranfield, a researcher involved in the project.

Tests for CDI involve the use of expensive laboratory equipment, and can mean a wait of up to 24 hours for a result. Furthermore, the tests can only detect the presence or absence of the bacteria, which can be carried in a proportion of the population without causing symptoms, potentially leading to misdiagnosis in patients who carry CDI but have unrelated diarrhoea.

Misdiagnosis can lead to patients being unnecessarily isolated from wards or treated unnecessarily with antibiotics.

In contrast, the new technique can measure the virulence of an infection, by detecting levels of the biomarker. It can also potentially

produce a result in just two minutes.

The technology takes advantage of the fact that different chemicals absorb mid-infrared light at different wavelengths, thus generating a unique signature.

Previous studies by researchers at Cranfield have identified several biomarkers in samples from patients with CDI that appear to be connected with the bacterial infection.

"You can detect these chemicals with exquisite precision"

Dr Jane Hodgkinson,
Cranfield University

So by tuning the lasers to measure at the specific wavelength that these biomarkers absorb light, the researchers hope to detect the presence of CDI, said Hodgkinson.

"You can detect these chemicals with really exquisite precision, in terms of being able to selectively isolate a particular compound and measure its concentration," she said.

To use the instrument, hospital staff would first place the sample in a holder. Clean air would be passed over the sample, causing it to emit VOCs. ©

RAIL

Come together

'Formation flying' trains carry out simultaneous operations during a repair to rails

Joining engineering trains together to complete engineering works faster could help save £250,000 per week, says Network Rail, which has been working on the system.

Network Rail has made use of 'formation flying' trains to carry out simultaneous operations during a repair to rails in Sandy, Bedfordshire, which helped eliminate the gap between completing the works and resumption of full-speed train services.

The repair occurred where a set of switches and crossings were being replaced as part of a rail upgrade plan.

Normally, where track has been replaced, trains run more slowly over



The system could speed up rail repairs

the new track until the ballast has settled. Network Rail typically has to pay compensation to operating companies for the delays this process causes.

However, the company has joined a pair of engineering trains by an umbilical so they ran parallel to each other, simultaneously tamping down ballast and carrying out dynamic stabilisation of the new track in an operation that simulated 200 trains passing over the new switches and crossings. **SN**

ELECTRONICS

Detector could put an end to all the waiting

Voltage detector chip could be used to control sensors

HELEN KNIGHT REPORTS

Televisions that do not consume any power in standby mode, and batteries for sensors that can last up to 10 times longer, could be possible with a new voltage detector chip.

The voltage detector chip, developed by Dr Bernard Stark and colleagues in the Bristol Electrical Energy Management Research Group at Bristol University, only requires a few picowatts to activate other circuits.

In this way it could be used to control industrial, environmental or medical sensors that consume no power when waiting for events to happen. Instead, the chip would switch on the sensor in response to the energy contained in the event itself, said Stark.

The device is based on the same principle

chips used inside computers to monitor power-supply rails to ensure voltages do not dip below certain thresholds.

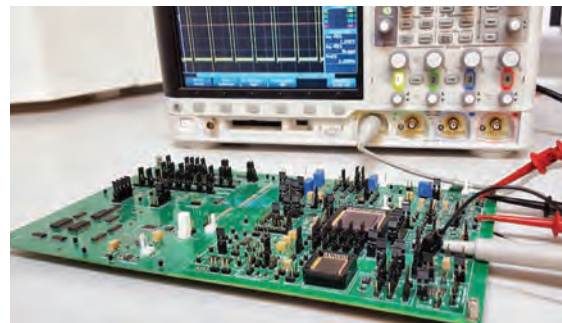
"The chip detects voltage over a certain threshold, in our case 0.5V, and uses almost no power, around 1,000-10,000 times less power than you would need to monitor a voltage rail," he said.

In this way, the chip allows designers to develop circuits that perform continuous monitoring without using battery power and are activated wirelessly. Power management techniques are used to ensure the current is switched off as soon as it is inactive, said Stark.

"Once the voltage detector has triggered and the sensor has given its information, there is no need for it to be burning any power, so we actively switch that power off again," he said.

The technology could allow battery size to be reduced to the point at which they can be embedded into the sensors themselves. ©

The chip only requires a few picowatts



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Towards an ethical industrial strategy

An ethical approach to business practice isn't just a 'nice to have', it is a key factor in long-term economic prosperity

The government has recently published a consultation paper on a new industrial strategy. There will be much debate in coming months about what it should contain, but an aspect that generally attracts little attention is ethics.

Some argue that, with the uncertainties created by Brexit and the election of Donald Trump, ethics are a luxury we cannot afford. But my argument is that we cannot afford not to be ethical. Side-lining ethical concerns, I contend, is contributing to economic problems as well as causing much social and environmental damage.

Let's start with the issue of corruption. No one in the British engineering community will have failed to notice the £671m settlement that Rolls-Royce recently reached with British, US and Brazilian authorities over allegations of corruption and bribery in numerous military and civilian deals. That such practices were allowed to continue over nearly 25 years in such a prestigious corporation casts a long shadow over UK industry. Furthermore, if you're tempted to think that these problems are confined to merely one company, don't forget the settlement of nearly \$450m (£367m) that BAE Systems reached a few years ago with the US and UK authorities, also over allegations of bribery. This is an issue that continues to dog industry but is conveniently ignored in the government's strategy paper.

Indeed, military industrial corporations are often to be found at the centre of ethical controversies. The government has been especially supportive of UK arms exports, with a marked expansion since 2010 – and Saudi Arabia being the largest recipient despite its very poor human rights record. With that nation now leading military action in Yemen – and having been strongly criticised in a United Nations report for “widespread and systemic” attacks on civilian targets in violation of international humanitarian law – the government is under great pressure to suspend these sales. Yet not only does it refuse; in the proposed industrial strategy it plans further expansion. To put financial considerations above basic human rights sets a very poor example that will only come back to haunt us.

So which industries should be prioritised in a more

ethical industrial policy? Given the rapidly growing threat of climate change and the disproportionate impact this will have on those in poverty, one straightforward answer is the low-carbon sectors. These do indeed feature significantly in the strategy paper. However, the Committee on Climate Change (CCC) – the government's advisory body – has pointed out that current plans fall well short of what is needed to meet our targets for reducing carbon pollution. The planned phase-out of coal and the recent rapid expansion of renewables are very welcome – as is new support for industrial energy efficiency and the development of electric vehicles and energy storage technologies. However, the recent enactment of a string of policies that

“Military industrial corporations are often found at the centre of ethical controversies”

Dr Stuart Parkinson

Sectors with poor ethical ratings, such as oil and gas, are less appealing to young people



undermine the onshore wind and solar photovoltaic sectors, coupled with major cuts to home energy conservation programmes, is causing progress to stall. Not only that but thousands of jobs are being lost in these sectors and fuel poverty – estimated to kill nearly 8,000 people a year – is being exacerbated. And, with the costs of solar and wind technologies falling rapidly, the UK is losing out on the two biggest areas of global investment in the energy sector. It's also striking that marine energy – especially tidal lagoons – and biogas get no mention at all in the industrial strategy, despite their significant promise.

The government instead points to the approval of the Hinkley Point C deal and further nuclear power stations in the pipeline. However, with EDF, Toshiba and other nuclear corporations experiencing severe financial problems exactly because of spiralling costs in their nuclear divisions – and despite the promise of huge subsidies – we would be foolish to rely on their ability to deliver.

The government also continues to champion a new fracking industry, despite its unpopularity and advice from the CCC that climate-change targets would be undermined unless three strict conditions were met.

Arguably, the clearest sign of the inadequacy of the proposed UK industrial policy is the narrow focus on economic indicators to measure its progress. In 2015 the UK signed up to the Sustainable Development Goals: 17 major targets for tackling global social and environmental problems, underpinned by nearly 170 indicators. Nowhere in the government's proposals are these even mentioned, yet industrial policy is a cornerstone of their delivery.

A recent report by PwC found that most younger people were put off an employer if it did not have a good ethical record – with the oil/gas and military industrial sectors having the most negative ratings. This further reinforces the case for the UK to shift, in particular, from an industrial focus on military technologies and fossil fuels to prioritising renewable energy technologies, energy conservation and energy storage.

Some of this shift is already under way. The government's new industrial strategy is an opportunity to advance it. This is not just so we can feel good about ourselves – it would make good business sense as well. ■

Dr Stuart Parkinson, executive director, Scientists for Global Responsibility

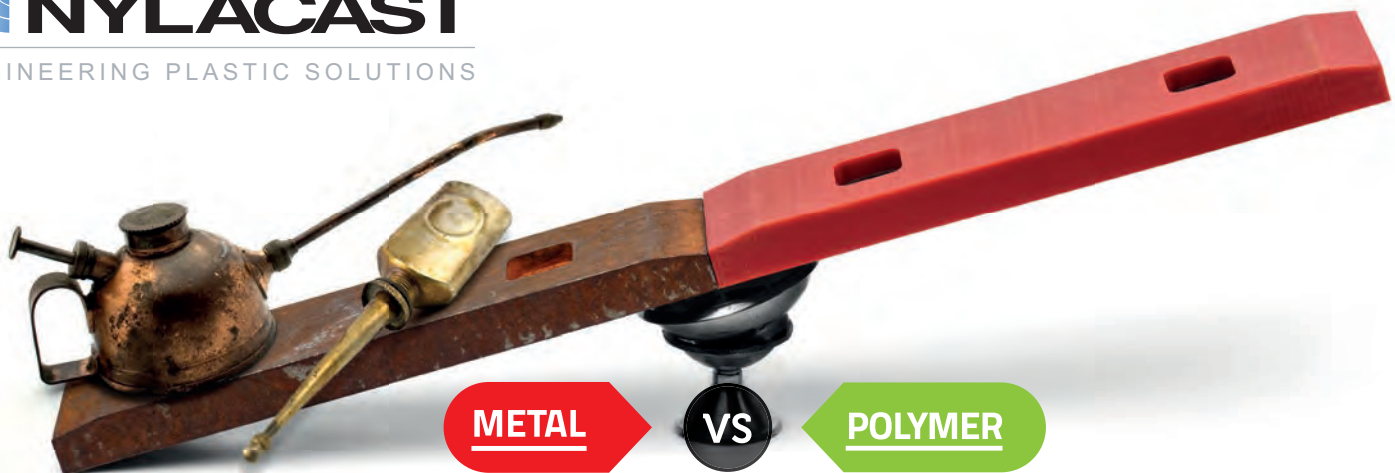
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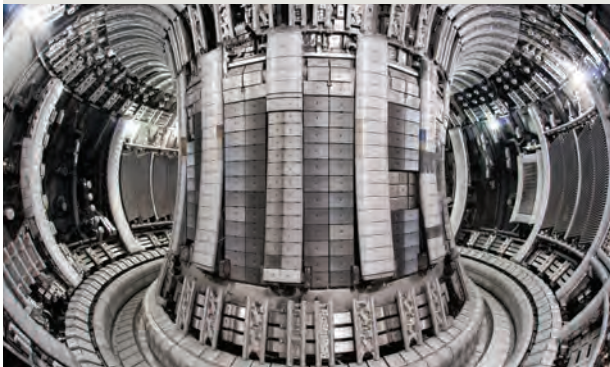
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Thehotopic

Fusion fall-out

The UK's decision to leave EURATOM and its potential consequences for fusion research prompted a heated debate about the potential of fusion power



Fusion must continue to be a major R&D aim, the problems are clear but the solutions are getting nearer: less 'unknown-unknowns'.

Jack Broughton

I have followed fusion research avidly since the mid-1960s, it has been a long hard road, but Kennedy's speech about the Moon-landing project comes to mind. We chose to go to the Moon in this decade and do the other things, not because they are easy, but because they are hard; because that goal will serve to organise and measure the best of our energies and skills, because that challenge is one that we are willing to accept. The problems will be solved one day, maybe soon, maybe not, but to just walk away is an act of unbelievable folly, because one

thing is for sure: when they finally get it to work and we are not part of that club, we will pay and pay and pay forever for our faint-hearted foolishness.

Peter Thomas

Surely, if some real evidence could be presented through the media to all us fusion sceptics that fusion reactors could even power a light bulb, they would have done it by now. Eloquent arguments in favour of funding fusion reactor development should, at the very least, be backed up with some hard evidence that it will actually work, and not in 30 years when the money has been spent.

Norm Williams

Norm Williams obviously hasn't been paying attention. There is ample evidence that great strides are being made towards sustained nuclear fusion, the issue being stabilising the plasma once it has been generated.

Mark Marsha

As a scientist, fusion research is an amazing business. As an engineer, it seems to be a colossal waste of money that is getting nowhere – in the normal world the project would have been shelved years ago as impractical. As a citizen, I want to see my taxes spent wisely. Research on solar cells, wind, wave, geothermal, tidal and energy storage seem far more important – and likely to benefit UK plc more too.

Ian Wilson

We have a long track record of pulling out of projects just as they are about to produce useful results, so I guess I shouldn't be surprised. Fusion has the potential to be as much of a game changer in the energy world as penicillin was in the medical world and, frankly, the amount we spend on fusion research is insignificant. With negative people such as Norm Williams around we would still be using candles.

Peter Thomas

Inyour opinion

Healthy mindset

Last issue's Viewpoint article considered how an engineering mindset might help the NHS

I went to a dinner party a while back where nearly all the guests, including the hosts, were either doctors or surgeons. The conversation went on to what we all do at work and I found myself talking about lean engineering, kaizen, eliminating waste, and so on. The general reaction was one of ignorance of these approaches; incredulity that the NHS hasn't introduced these techniques; and incredulity on my part that they hadn't been used.

Jonathan Bowen

The NHS has a huge amount to learn from the PDM and PLM systems our industries have implemented to add the necessary control, enabling us to function efficiently and effectively.

CC

It isn't just the pure electro-mechanical aspects of engineering. There is process and flow control, communications, to name just a few, and not least the repair and maintenance of equipment and facilities. Having been a recent in-patient I was struck by the lack of process planning and communication between departments. Process efficiency is poor in the NHS.

Nick Cole

Defender returns

Ineos CEO Jim Ratcliffe has announced plans to launch a new 4x4 inspired by Land Rover's late lamented Defender

The Defender is an icon that actually works, so whoever replaces it will have their detractors, but if it works well these people may become its biggest fans.

Chris

Is it going to be difficult to bring a new, rugged, simple, low-cost 4x4 to market? Yes it is. Past history suggests that many have tried and few have succeeded. Does Jim Ratcliffe's background in

chemicals and the imminent arrival of the 'New Defender' make it more difficult? I don't really see any evidence to suggest that it will.

Edward

I am currently re-building my 1940s Land Rover and two things stand out: the uncomplicated simplicity of the machine; and the fact that modern fittings and methods – developed over the intervening 67 years – would make it even simpler. Current safety and emissions requirements should be reasonably simple to accommodate, particularly if the engine and its controls are bought-in.

Richard Jenvey

If PSA buys General Motors Europe, maybe it will close the Vauxhall plant at Ellesmere Port. There's a ready-made vehicle production factory with local labour and an established supply chain.

Richard Grey

If you want to build a new Defender and have limited experience, you should go electric. It would be perfect for the Defender. Four electric motors, one for each wheel, with individual traction control, would provide unbeatable off-road performance.

Alex



The **secret** engineer

Our anonymous blogger considers the perils of an unfocused inventiveness among students

I recently met up with a friend who is a lecturer in an engineering subject and, among other things, we got chatting about a course project that he was involved in. His students had decided to produce a digitally controlled whizz-bang (please excuse the vague terminology but one has to protect the identities of both the innocent and guilty).

Dear reader, the field of whizz-bang technology is well established and extremely lucrative. So if I tell you that industry sees a digitally controlled one to be needlessly

insight that, even if not viable within the project, may provide a start point from which a new product or technology may be derived. Second, it may form a foundation for future projects that become viable as supporting technologies and expertises develop – a case of simply being 'ahead of its time'. Third, if our students find it fun and engaging then let's not kill off their enthusiasm before they become controlled by financial necessity.

The second main issue is that there were never any 'project-management'-type modules when I was ensconced within the educational environment, and, as far as I'm aware, there still aren't. A problem that has an impact due to the perceived wisdom that graduates should either start further up the food chain than non-graduates, or at least should be accelerated out of the primordial soup at the bottom quicker.

You do learn a lot by simply 'having a go with a bit of guidance' but, by contrast, you wouldn't just chuck a lump of steel at someone and point them at a lathe either. Of course, different companies have different practices but a defined grounding in the basics would, I am sure, help. Certainly it currently seems that projects are more focused on technical application than



complicated and expensive then you will understand that it was not considered a viable project outside of academia. My friend also commented on the fractured nature of the project team, this leading to a late submission mainly through lack of communication (although admittedly this may in some cases be the perfect experience for a life in our profession).

There were two main issues that came out of this, the first being a propensity for students to 'invent a problem suitable for a solution that's already taken their fancy'. I initially became aware of this phenomenon when it was referenced with regard to the BMW Z1, a car where you open the doors by dropping them into the sill. A solution that when compared to the staid hinges of old is heavy, complicated and obstructive to entry and exit (the key functions of a door).

There are three reasons I can see for letting students pursue such flights of fancy. First, there is the possibility that this is a new

the activities in support of this.

When I'm looking to take on a freshly minted graduate I look kindly on an applicant if they present a project where they can demonstrate its viability, its potential for viability at the start (and explain why that didn't prove to be the case) or the deep-rooted enthusiasm that it articulates. Equally, I am impressed by a demonstration of their positive management within a project, or at least the application of management techniques that they had been introduced to. Beyond that, it's difficult to know what it tells me beyond what's reflected in their results in individual modules – along with an unfocused inventiveness. This is fine, but it could be so much more.

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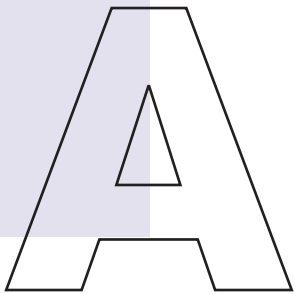
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Stepping on to the world stage

As we renegotiate our relationship with the EU, the UK must be mindful of engineering's important role in its balance of payments



According to the government's timetable, this month should see the UK trigger Article 50, paving the way for departure from the European Union. In order to support government in the negotiations that will follow, the 38 organisations representing professional engineering in the UK came together last year under the leadership of the Royal Academy of Engineering to produce a comprehensive report on the impacts and opportunities for UK engineering created by Brexit. Although we looked primarily at nearer-term actions, we recognised that a more fundamental re-examination of the UK's place in the world was called for. While many factors will influence the UK's future status on the world stage, engineering has the potential to play a very positive role.

Back in 2008-09, I served as specialist adviser to the House of Commons Innovation, Universities, Science and Skills Committee for its inquiry into engineering. Over the course of the year, it was fascinating to see the MPs' view of engineering evolve. The most striking transformation came as a result of the committee's overseas fact-finding trips where they found that, in contrast to its low domestic profile, UK engineering was very highly regarded abroad.

This is likely to be influenced, at least in part, by the fact that many leading engineers across a wide range of geographies have been educated or trained in the UK and continue to hold the UK in high esteem. On a recent visit to Singapore as part of a UK government mission, I saw for myself the extensive links between UK and Singaporean engineering researchers, often forged as a result of longstanding personal relationships.

At a time when the UK is developing its own industrial strategy, Singapore provides an interesting example of a country whose economic strategy is firmly rooted in engineering and technology. The country only made its first significant investments in R&D in 1991, yet now spends 2.2 per cent of its GDP on R&D and has the fourth-highest GDP per capita, providing a compelling illustration of what can be achieved through targeted investment within a strategic policy framework.

While there are many differences between the UK and Singapore, engineering and technology are no less significant to our future economic success. Engineering has been estimated to underpin at least a fifth of UK gross value added and, importantly, accounts for half of all exports. As we renegotiate our relationship with our biggest trading partner, we must be mindful of the significance of engineering-based businesses to our balance of payments.

The wider societal impact of engineering is just as relevant as its economic impact and also has an important influence on our international standing. The academy has long championed the role of engineering in tackling global challenges, for example, producing a booklet of essays on engineering and UN Sustainable Development Goals, in conjunction with our Engineering a Better World conference last year. This theme was then adopted by the global grouping of engineering academies, reinforcing the UK's leadership role in the international engineering community.

In recent years, the UK government has also recognised the potential of

£1.5bn Global Challenges Research Fund. One of the academy's objectives within these programmes has been to build the innovation capacity required to ensure that research outputs drive the development of products and services that address needs in the global south. For example, our Newton Fund Leaders in Innovation Fellowships offer talented researchers from emerging economies intensive residential training in the UK to help accelerate the commercialisation of innovations that can deliver social and economic benefits to under-served communities.

The primary objective of these programmes is to contribute to poverty alleviation in the global south. Nevertheless, they reinforce the UK's role as a thought leader and centre of excellence in innovation. Training talented entrepreneurs from some of the fastest-growing economies in the UK leaves them with a positive perception of the opportunities for growing businesses here, and creates valuable links between UK innovators and their counterparts in strategically important countries.

In redefining the UK's position in a competitive, highly interconnected and sometimes turbulent world, we need to draw on all our strengths. Engineers tend to focus on how we can improve things, so it's natural that we examine the aspects of the profession that most warrant improvement and seek to address these – there is certainly no room for complacency on issues such as skills and diversity. However, it's also important that we recognise that UK engineering has a strong reputation for excellence in many parts of the world, and this can be harnessed to reinforce the UK's international stature and success at this crucial juncture. ©

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



Many leading engineers across the world continue to hold the UK in high esteem

engineering and science to advance the lives of the world's poorest, taking the innovative step of using development aid money – so-called Official Development Assistance – to support research collaborations and capacity building aimed at addressing global development challenges and supporting under-served communities in the developing world (often referred to as the 'global south').

The academy is one of the delivery partners for the £735m Newton Fund for collaboration with emerging economies, with matching funds provided by partner countries, and the

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Taking nuclear to the production line

UK engineers are in the vanguard of efforts to develop compact nuclear reactors that can be produced in a factory and delivered on the back of a lorry. Stuart Nathan reports

Even before the first kilogram of concrete has been poured, Hinkley Point C may be among the last of a kind. Large nuclear reactors, producing electricity on a gigawatt scale, have dominated the sector for years, but their size and complexity are now combining to put their cost beyond the means of most countries.

A new nuclear paradigm, which seems to defy the logic that has dictated increasing the size of power stations, is being tipped to take over. Small modular reactors (SMRs), with generating capacities of up to 500MW of electricity (MWe), are increasingly seen by governments and the nuclear sector as a better option for reducing costs, and unlocking the potential of nuclear for new markets. SMRs can be built in factories and assembled on site rather than having to be constructed as costly one-offs, and this factor, combined with their more frugal use of materials, is seen as key to bringing down the cost. It also allows for a more distributed energy generation model that could be attractive in regions with remote communities and distribution networks not geared to handling large amounts of electricity.

Leading the field in the UK are Rolls-Royce – whose manufacture of nuclear reactors for Royal Navy submarines makes it the only company to have produced, operated and maintained nuclear technology – and US firm Nuscale, based in Oregon and developing technology that originally came from US Department of Energy research supported by Oregon State University. Nuscale has declared an interest in developing manufacturing capability and capacity in the UK.

In technology terms, Nuscale and Rolls-Royce have both opted for pressurised water reactors cooled by light water (LPWR): scaled-down versions of the type of reactor that has dominated the nuclear sector for the past few decades in the US and Europe. The thinking behind this is that regulators both know and understand the technology and therefore are more likely to grant approval in a shorter time.

However, the two designs stem from different approaches to reactor deployment. For Nuscale, flexibility of the nuclear installation is the most important factor, so it has opted for a low-power output module designed to be deployed in groups of up to 12, depending on power requirements. The reactor, with an output of 160MW of thermal energy or 50MWe, is fully integrated, with steam generation within the same housing as the reactor itself; the circuits for the primary coolant (which removes heat directly from the nuclear fuel and is in contact with the fuel rods) and the secondary coolant (used to generate steam and never coming into contact with radioactivity) are both within the reactor containment vessel.

The secondary heat exchangers use helical tubing to keep the volume needed for steam generation as low as possible; the steam generators can be connected directly to a steam turbine with no need for separate bulky and complex steam-generating heat exchangers, as are used in conventional nuclear power. This helical arrangement is one of the major engineering innovations in the Nuscale reactor, according to chief technology officer José Reyes, who was also the main designer of the module. Moreover, the entire reactor module acts as a heat exchanger because it is installed submerged in a water tank to which it can give up heat in an emergency; Reyes claims that, in an emergency shutdown situation, this reactor pond cooling will keep a failed reactor safe indefinitely.

Rolls-Royce, by contrast, opted for a larger power output. Its reactor is sized

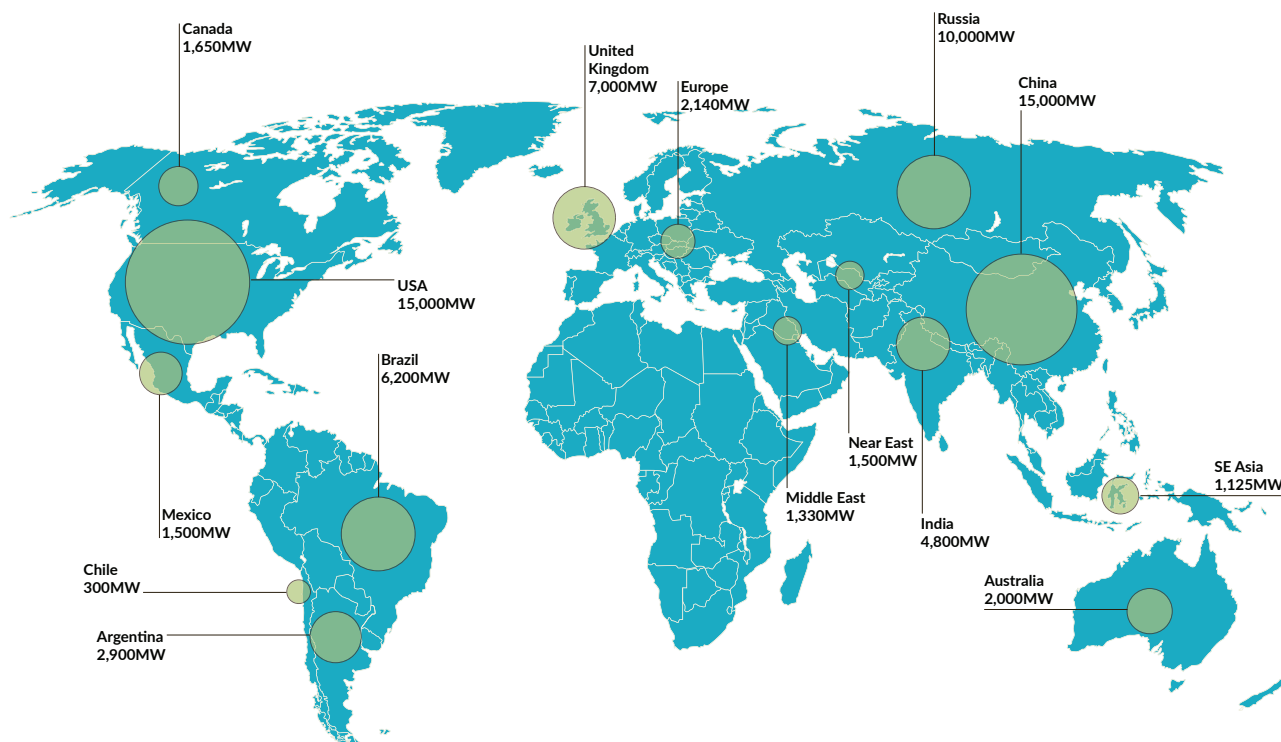
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01 Artist's impression of Rolls-Royce's SMR-based power station

Indepth

Developers work on alternative reactors for the future



02 Estimated market size for SMRs by 2050
Data: NIA

03 Nuscale's reactor module has integral steam generation within the reactor confinement vessel

While LPWRs are likely to be the first SMRs deployed commercially, they are by no means the only type of SMR under development. Several research groups and private companies are also looking at alternative nuclear technologies for their potential in smaller reactors.

These alternative reactors generally belong to the category known as Generation IV. Because they are at an earlier stage of development, they are unlikely to be ready for deployment until the 2030s or 2040s.

One reactor under development by UK private company Moltex Energy is called the stable salt reactor (SSR). As the name implies, this technology uses a flowing molten salt as a key component of the reactor, but it is quite different from the liquid fluoride thorium reactor (LFTR) normally associated with molten salt technology.

While an LFTR uses nuclear fuel dissolved in the molten salt and flowing around the reactor, in the SSR the fuel is stationary and held in fuel rods as in a conventional reactor. The fuel – based on typical low-enriched uranium, or even derived from spent fuel currently treated as waste – is dissolved in a molten salt, which Moltex claims improves the burn-up rate. The fuel rods are submerged in a different molten

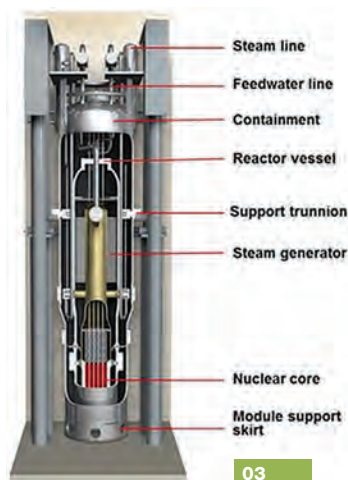
salt, which acts as the primary coolant in the reactor. One important factor in the safety of the SSR is that fission products caesium and iodine, which are produced in gaseous form in water-cooled reactors, remain bound in non-volatile salts within the fuel assembly.

This coolant salt is not pressurised and does not react with air or water, giving it an advantage over molten alkali metals used as coolant in breeder reactors. This, Moltex said, has two advantages: it removes potential hazards and avoids costly pressure vessels requiring specialist foundries, making the SSR more suitable for production in factories.

The output of an SSR can be between 150MWe and 1.5GWe, depending on the size of the reactor core; as the core is modular, multiple modules can be added to produce the required power.

Another UK design comes from U-Battery. This is developing a concept that originated from research at the University of Manchester, the Dalton Institute and the Technology University of Delft in 2008.

The U-Battery is a type of gas-cooled reactor known as the pebble bed. Rather than having its fuel enclosed in rods, its core is filled with spherical fuel pellets known as TRISO (tristructural-isotropic) fuel. Just under 1cm in diameter, these have a kernel of uranium surrounded by a layer of low-density carbon, which is itself enclosed in silicon carbide and an outer layer of high-density carbon.



03

so that a typical installation may have only one reactor, or maybe two. Although it is similar in size to the Nuscale module, its internal layout is more similar to a conventional reactor in operation and therefore needs to be connected to steam generators: two for a 220MW installation and four for 440MW. This, said David Orr, senior vice-president in the firm's nuclear business, in a conversation with *The Engineer*, is deemed to improve the

design's "selectability" because of its similarity to existing LPWR installations.

Because of Rolls-Royce's experience in supplying nuclear reactors for submarines, it's a common assumption that this is the origin of its reactor design. However, Harry Holt, president of Rolls-Royce's nuclear operations, at a recent SMR conference in London said this was not the case.

"Submarine reactors have to do very different things from civil power reactors. They have to be able to accelerate the submarine, which calls for variable power output that a civil reactor does not need, and they have to cope with the stresses of movement," Holt explained. "Also, they are designed to last for the life of the submarine without the need to be refuelled. Civil reactors have to last much longer and are regularly refuelled. We operate a land-based prototype submarine reactor in Scotland and that's given us familiarity with the ONR [Office of Nuclear >>>]

>> Regulation], which will help us with the approval process,” said Holt.

In fact, Rolls-Royce’s policy is to ensure that no defence-related nuclear research transfers to the civil sector, he said. “The SMR was conceived as a separate project and is designed around the market requirements, with an eye to regulatory approval, manufacturability and selectability.”

Another difference between the two companies’ reactors is the way their coolant systems operate. The Nuscale reactor has no coolant pumps in the primary circuit, using only natural circulation. The heat given up to the coolant water by the reactor fuel causes it to rise by convection; then it falls back down to the fuel rods as it loses heat to the secondary circuit. This simplifies the electrical systems needed, with post-shutdown monitoring systems powered by arrays of batteries.

A further innovation is that the pressure inside the containment system is kept at near-vacuum levels, which, Nuscale claims, minimises reactor vessel heat loss, eliminating the need for insulation. It also reduces corrosion inside the vessel.

Despite this, the two reactors are of a similar size: Nuscale’s is 19m long and 2.75m in diameter, and Rolls-Royce’s only slightly bigger at 16m long (with the control rod drive system installed) and 4.5m in diameter. Both are sized to be carried on standard trucks, train carriages or barges; a key consideration for SMRs. They are composed of steel forgings in standard

nuclear-grade materials, which it is anticipated would be produced by external specialist contractors and transported to a factory for assembly. Both companies are working with academics on methods for making the reactor assemblies, with the Nuclear Advanced Manufacturing Research Centre in Sheffield involved in research and prototyping. Reyes noted near-net forging and coating techniques as being of particular interest: these will require regulatory approval for nuclear use, but this can happen within the timescale envisaged for UK deployment by 2030, he said.

Both reactors are designed to be refuelled every two years. The Nuscale module contains a 17 x 17 array of fuel rods. Orr preferred not to reveal the number of rods in the Rolls-Royce design, saying only that it was between 10 and 150. Both use standard light-enriched nuclear fuel in a similar fuel rod to that of a conventional PWR. The Nuscale installation uses a refuelling procedure with the exhausted module physically removed from the reactor pool; in practice, Reyes said, the refuelling schedule would be staggered, with the process probably carried out every year.

A key part of Rolls-Royce’s SMR strategy is that it hopes to be part of a consortium that delivers a whole nuclear power station within a turnkey project. The company is

therefore seeking partners – most likely from China, Germany or the US, Orr said – to provide the other sections of the station that are not part of the nuclear island: notably, the

steam turbines. The UK no longer has a capability to make turbines large enough for nuclear power stations, even the scaled-down ones supplied for SMRs.

Production engineering techniques are key to cost reduction. Tony Roulstone, course director at Cambridge Nuclear Energy Centre, said: “The cost of building nuclear plants is related to their complexity and the work you have to do on site to build them, and nothing the industry has tried has worked. So it’s time to try something else. The manufacturing approach works in every other industry. Nuclear is the only industry in which production engineering is not used.” He added: “It’s only by getting into a factory environment and building these things over and over again that you learn how to bring the cost down.”

Herein lies a potential problem for any UK project to manufacture SMRs. To produce the required economies, Roulstone said, the programme would have to be quite large, making exports essential. This would disadvantage the UK versus countries that could finance manufacture on a much larger scale for their domestic market. ☉

Indepth

North Wales site has nuclear history and potential for new SMR-based power station



There is currently no site in the UK approved for building a power station based on SMR technology. However, there is no shortage of potential sites and Trawsfynydd in North Wales is mentioned regularly.

Situated in the Snowdonia National Park, Trawsfynydd is the site of the only nuclear power station in the UK not to be built on the coast. The twin-reactor Magnox station (above), which closed in 1991 and is now being decommissioned, is on the shore of a large artificial lake created to supply a local hydroelectric scheme still in operation.

The lake is large enough to cool 700MW of reactor capacity, and the site has an existing grid connection and is government owned, making it technically suitable and relatively easy to designate as a new nuclear site. Moreover, said John Idris Jones, chairman of the Snowdonia Enterprise Zone, there are other geographical advantages: with nearby ports and a bypass scheme already planned for the area, it will have the transport infrastructure to bring large components to the site, and North Wales is close to another identified new nuclear site, Wylfa on Anglesey, and to nuclear centres of excellence on Deeside and in Sheffield and Manchester, as well as Sellafield.

Trawsfynydd was identified as a potential SMR site by Parliament’s Welsh Affairs Committee last year, and in 2014 an IMechE report on SMR potential recommended that the site be designated for building and demonstrating SMR technology. The region has been involved with the nuclear sector for decades, is in favour of a new plant and badly needs high-quality, skilled, high-wage jobs.



04 Helical heat exchanger tubes

05 The Rolls-Royce reactor is designed to be transported by road

06 Up to 12 Nuscale modules in a single cooling pool



05

06



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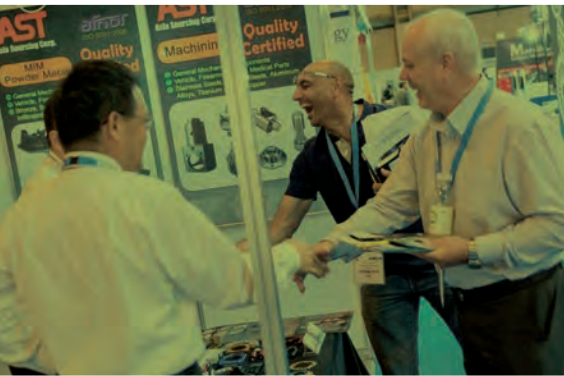
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Roboshop: grocery 4.0

Innovation in robotics and automation is helping online grocer Ocado reshape the world of retail. Jon Excell reports

f prompted to name a UK company at the cutting edge of robotics and automation, few of us would cite one of the country's best-known grocery retailers.

But, as *The Engineer* learned on a recent visit to one of its key facilities, online supermarket Ocado is establishing a reputation as a major technology player: harnessing and developing machine-learning systems, Internet of Things concepts and robotic hardware to a degree that leaves many traditional engineering businesses in the shade.

Founded in 2000, the firm turned a profit for the first time in 2015 and is steadily growing its share in the UK's enormous £179bn grocery market, processing nearly a quarter of a million shopping orders per week from its

three giant customer fulfilment centres (CFCs) around England.

With most of Ocado's big-name competitors losing money on their online operations, this success is no mean feat and is due largely to a relentless investment in technology development that enables it to process orders more rapidly and cost-efficiently than its competitors.

01 The firm plans to trial humanoid robots at its warehouses

The firm's original CFC – a giant automated warehouse in Hatfield (around 20 miles north of London) – provides a startling illustration of what this means in practice.

Covering five floors and crammed with an intricate 25km-long network of conveyors, the facility accounts for 40 per cent of all Ocado orders. At any time, up to 1,000 crates may be travelling along the winding routes, either ferrying products to the picking face (Ocado's version of the supermarket aisle) or carrying shopping orders to one of its many dedicated pick stations, where human pickers are automatically guided to the correct products.

The entire operation is carefully controlled by an overarching software and AI system that automatically plans the picking sequence for each shift, ensures the right products are in the right places, calculates the most efficient route for each crate and even takes account of the real-time traffic data being fed back by Ocado's sensor-rich fleets of delivery vehicles.

According to the firm's head of engineering R&D, Sid Shaikh, it's a world away from other online grocery delivery operations, which typically are simple warehouses, laid out like conventional supermarkets, where human pickers trundle around the aisles collecting products as they go.

And because the approach is so different from anything else in the grocery sector, much of the underpinning technology has had to be developed in-house.

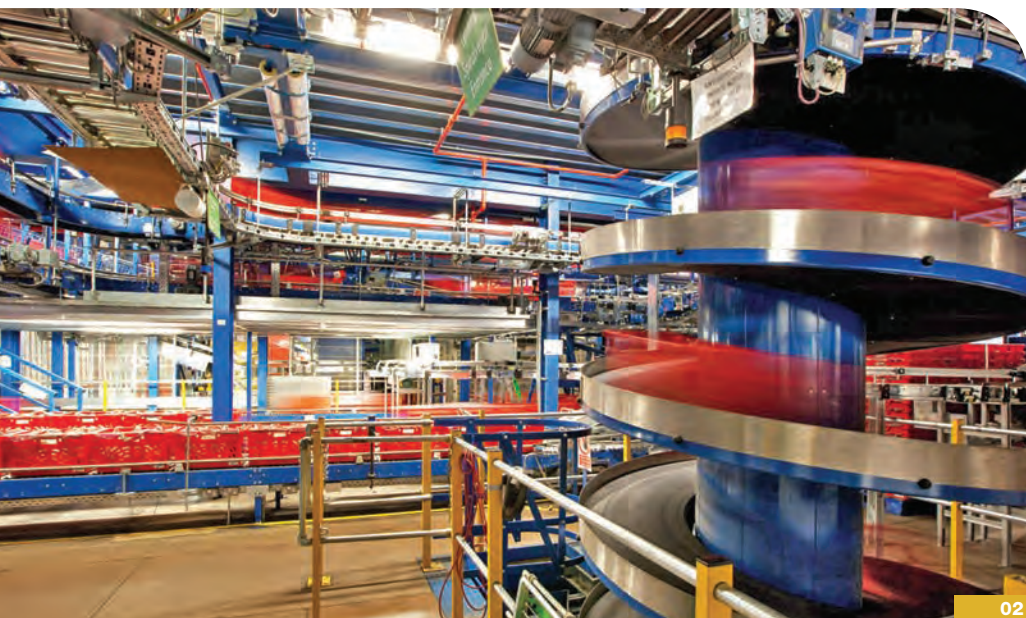
"We wanted to buy off-the-shelf components and integrate them, but nothing met our performance, cost or reliability criteria," said Shaikh. "We tried to buy SCADA and tracking systems but nothing works to our resolution or this level of complexity. We've got to guarantee an end-to-end stream culminating with someone getting their shopping within a one-hour slot. It's effectively a just-in-time system with every single order being different."

It all makes for a climate of fast-paced innovation. And Shaikh, who joined Ocado just over two years ago after >>



"It's effectively a just-in-time system with every single order being different"

Sid Shaikh, Ocado



02

>> holding senior R&D roles at GSK and Cambridge Consultants, clearly relishes the opportunity to have an immediate impact on the wider business.

"When I was at GSK my job was to shorten the drug-discovery time from 10 to three years and I developed tools for research that would achieve that," he said. "But I was very far away from seeing how my machines and systems affected the profit margin of the company because getting a drug to market takes

another 10 years. I moved to Ocado because I wanted to work in production, where you can see what the impact of your efforts is."

Shaikh estimates that the firm has a significant technical lead over its competitors – a 10-year advantage in terms of software and five years in relation to hardware – but, with online grocery retail expected to grow in the years ahead, there is no let-up in the pace of innovation.

The company is in the process of rolling out a form of technology claimed to be one of the most

radical innovations in retail automation yet developed. Instead of ferrying crates along a conveyor system, the new technology, dubbed Ocado Smart Platform (OSP), is underpinned by a concept whereby products are picked by armies of robots from a densely packed three-dimensional grid, or 'hive'.

Products are stored in bins within this hive that are automatically moved to the top level of the structure when required. Teams of robots – linked wirelessly to the system via a 4G connection – scurry across the top of the hive, collecting products and ferrying them to pick stations where the customer order is put together.

This scalable concept dispenses with the need for aisles, reduces still further the reliance on manual labour and, according to Shaikh, lowers the average pick time for a customer crate or 'tote' from around two hours to just 15 minutes.

Remarkably, given how futuristic it sounds, the technology is already in operation at the company's recently opened Andover facility and it will be used at a new CFC currently under construction in Erith, south London.

According to Shaikh, as well as using it for Ocado's own UK operations, the firm hopes to license the technology to large overseas retailers that are looking to set up their own online operations.

Alongside internal R&D activities, the firm is engaged in a number of external collaborative projects. One of the most eye-catching of these is the EU-funded Second Hands project, which is developing a humanoid maintenance robot designed to help engineers carry out repairs and to access areas considered too dangerous for human operators. The firm reportedly hopes to trial the robot in some of its UK facilities.

In a separate initiative – the EU-funded SoMA project – Ocado is working alongside a number of European research groups on the development of soft robotic hands specially optimised for easy handling of damaged goods, such as fruit and vegetables.

The project team has been experimenting with the use of an inflatable gripper, developed by researchers in Berlin, known as the RBO Hand 2. The gripper uses flexible rubber materials and pressurised air to passively adapt the robot's grasp, which enables safe and damage-free picking of items.

Beyond this, according to company spokesman Alex Voica, a range of other innovations are currently under consideration, including the use of drones – rather than fixed CCTV cameras – to monitor the inside of its facilities, and the development of swarming, autonomous delivery vehicles that can be carried to a location within a larger van and then used to speed delivery to individual addresses.

Given all of this automation, one wonders whether, further in the future, Ocado will still have a need for human workers. But while the firm's technological innovations are undoubtedly rendering obsolete many unskilled roles, its investment in technology is both driving growth and creating more high-skilled jobs. In Shaikh's team alone – which two-and-a-half years ago consisted of just himself – the firm employs 36 R&D engineers, and it has given approval for this number to grow to 60 by the end of the year.

Nonetheless, it is a big challenge to find the necessary skilled engineers to continue the sharp upward trajectory technology-wise, partly because of the industry's wider skills gap but also, possibly, because Ocado does not immediately spring to mind as a destination for challenge-hungry engineers. Shaikh hopes this perception will change.

"We're doing some really exciting state-of-the-art development," he said. "We're working with some of the biggest consultancies in the world and we're pushing them hard to the limits. But outside companies don't see us as that sort of place to work." ■

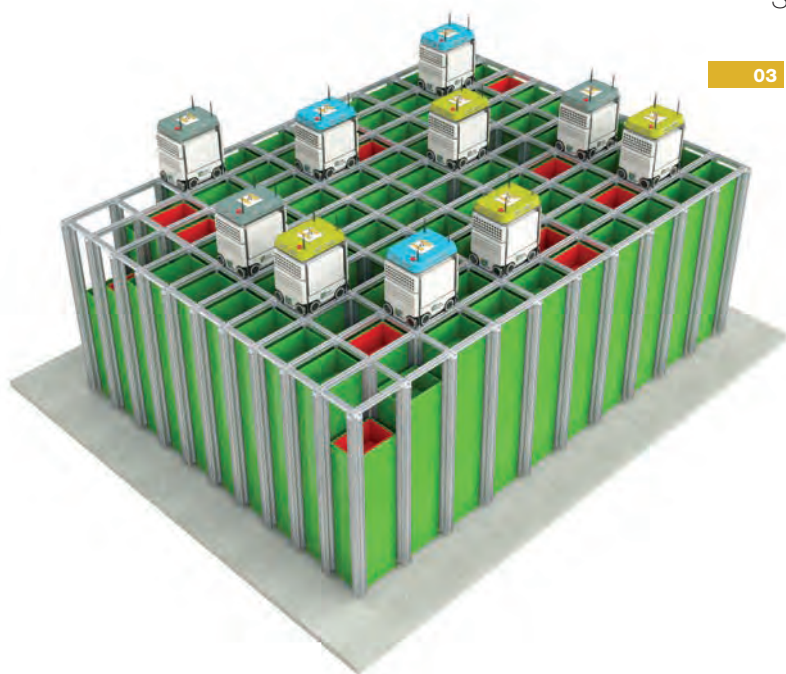
"We're doing some exciting state-of-the-art development but outside companies don't see us as that sort of place to work"

Sid Shaikh, Ocado

03

02 Shoppers' orders being processed at Ocado's heavily automated facility in Dordon

03 The hive: a brand-new concept in retail automation



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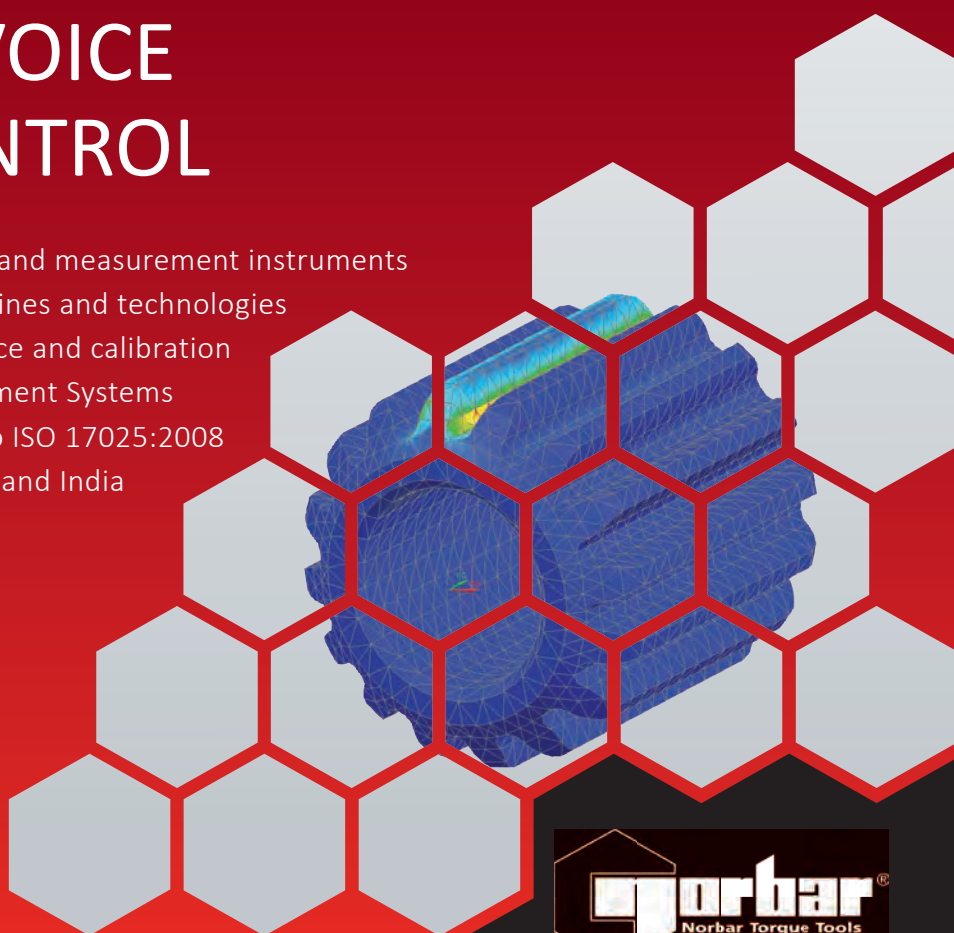
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Diversity heads north east

Hitachi Rail Europe's MD is focused on reaping the benefits of a diverse workforce in the north east. Stuart Nathan reports

The north east of the UK was particularly hard hit by the changes to the industrial landscape of the late 1970s and 1980s. Traditional industries, such as steel, mining and shipbuilding, saw wide-scale facility closures and redundancies, and regional unemployment hit a very high level.

The situation in the region has now improved quite dramatically, with the automotive sector being a particular bright point: Nissan's plant near Sunderland is the UK's largest car factory and the most productive in Europe. The rail industry, whose roots are in the north east, is now a major employer in the region once again with the opening in 2015 of Hitachi Rail Europe's manufacturing hub at Newton Aycliffe in County Durham, which late last year saw the unveiling of the first Intercity train to be built in the plant. Costing over £80m, the Newton Aycliffe factory will employ some 900 people directly by spring of this year, and create many more jobs in the local supply chain as the majority of components for its trains are sourced from within 50 miles of the facility.

Despite the industrial hardships that have hit the area, Hitachi Rail Europe managing director Karen Boswell said that the company had little difficulty in finding people with the right skills to staff the plant. "While the challenges the north east has had from industrial perspective are well known, we have been very fortunate to find the skills that we need to come into Newton Aycliffe," she told *The Engineer*. "We had well over 17,000 applications, and we found some super people from quite a range of different businesses. We not only had a very wide pool to draw from, we really were able to focus on recruiting people with the right attitude and approach, as well as making sure they had the skill level we needed." As the company expands the number of shifts operating at Newton Aycliffe, this recruitment is set to continue.

However, Boswell added, as with the rest of the engineering sector, Hitachi Rail Europe faces a challenge in recruitment for the future, and the company intends to play a major role in ensuring that its pipeline of new recruits remains strong. "It really is a challenge," she said. "There's 87,000 graduate-level engineers a year needed between now and 2020, and the education system is only producing 46,000 of those."

This is one of the reasons that Boswell is passionately committed to increasing the diversity of the engineering workforce. Changing the gender balance is one aspect of



"I absolutely believe, from my experience previously, that creating a diverse industry alongside a diverse workforce absolutely drives business performance"

this: the rail sector is ahead of the engineering industry on average, with 15.5 per cent of its employees female, compared with 9 per cent for the whole sector. But although Boswell is proud of this figure, she is keen to increase female representation and insists that this is not just "diversity for diversity's sake".

"That's a massively uninformed view, just looking at the statistics," she said. "There is so much data out there that diverse businesses outperform in terms of profit and every other metric. Companies in the top quartile for gender diversity are 15 per cent more likely to have financial results above their median for their sector. It's not just nice to do, it's absolutely essential from my perspective." Studies from management consultant McKinsey show that in US companies, every 10 per cent improvement in diversity led to a 3.5 per cent increase in profits. "You can quote similar figures on revenue, and this shows the diversity is something that any business should be thinking about," Boswell said. "I absolutely believe, from my experience previously, that creating a diverse industry and a diverse workforce absolutely drives business performance."

Boswell has taken positive steps to try to narrow the gender gap at Newton Aycliffe, including



01/02 Boswell has taken positive steps to narrow the gender gap at Hitachi Rail Europe

arranging female-only recruitment open days at the plant. "We had over 100 women attend those," she said. "People need to come in and see what the factory environment is like, and see what the manufacture of trains involves in this current day and age, so on the women's open days we encouraged people to bring in friends and even parents to help reposition some of the thoughts in their minds that maybe a manufacturing site such as this

isn't the place for girls and women to work. We got the message across, and ended up recruiting a good proportion of the people who came in."

Boswell is adamant that this is good for business. "You need people who are going to think differently, bring something different to the table," she said. Another aspect of diversity is that Boswell believes it is important for the employees at Newton Aycliffe to reflect the community as a whole. "Skills, I think, is not one strategy; you can't say that people all need to come from one specific sort of background to go into manufacturing; they don't all have to be men, they don't all have to be women, it's a broad range and a broad mix. I really am passionate that where the business is located you have a responsibility to support the local community and thinking about the demographics of the local community is really important as well."

There are several examples of this, she said. At Stoke Gifford near Bristol, where Hitachi Rail has a newly built service depot, the company has a partnership with mental health charity Mencap to investigate how it can support disabled people to work in its teams. Boswell mentions age diversity as something she is keen to tackle. "We have a project working with ex-forces personnel," said Boswell "and, of course, we have Japanese and British teams working together at Newton Aycliffe, and it is really important that we support and ensure the different cultures can work together and socially integrate as well."

Meanwhile, of course, there is a next generation to think of. Boswell mentions "our graduate programme, our apprenticeship programme and the University Technical College [UTC] programme". The South Durham UTC, the first of its type in the north east, was co-founded by Hitachi Rail Europe. Located next to the manufacturing site, its ground floor is entirely given over to a well-equipped engineering workroom, including much higher-specification equipment than would normally be seen in a school, including CNC machines and industry-standard coordinate-measuring machines. "We have a financial and a mentoring relationship with the UTC," Boswell explained. "We don't supply pure teaching services, as it were, but we do supply teaching materials such as drawings and we connect some of our suppliers who contribute machinery that the students are trained on and also supply similar mentoring on those aspects of their learning." Pupils at the UTC can expect to learn how to produce components to the exacting tolerances required by industry, and how to ensure they meet the standards, for example.

CareerCV

Karen Boswell Managing director, Hitachi Rail Europe

Education

Starting her career without attending university, Boswell describes herself as a business turnaround specialist and was the first female president of the 106-year-old Railway Study Association in 2015.

Career highlights

1996–2000 Regional managing director and business development director, Aramark

2000–2002 Head of on-board services, First Great Western, First Group

2002–2005 Managing consultant, Arawak

2006–2009 Deputy managing director and customer service director, First Capital Connect

2009–2015 Managing director, East Coast Mainline

2015–2016 Deputy chair and director, Ansaldo

2016 Current position

2017 Appointed OBE in New Year's Honours

The UTC accepts pupils from schools all over the north east for GCSE and A-level courses which, according to its principal Tom Dower, has caused some friction with other schools in the region. Among its student body is an illustrious name: 17-year-old Michael Stephenson is a descendant of George Stephenson of Rocket fame, and is keen to work at Hitachi. He may have a chance sooner rather than later, as A-level students have the opportunity to work in placements at the neighbouring factory, working on components that will be installed on trains themselves, such as seating and other internals. "We see that as experiential support, rather than teaching," Boswell said.

The company is also developing relationships with existing UTCs in Bristol, Westminster and Chatham, Boswell said, and to support apprentices and graduates is building partnerships with universities around its other facilities in Bristol, Hull and Doncaster. "We are also working with universities in Paris and Rome, as well as with Southampton, Birmingham and Brunel to link up with Japan as well," she said. "This is all part of building our pipeline of future interns and graduates, as well as building relationships with the engineering department heads and course leaders to ensure they support Hitachi staff on site."

Apprenticeships have not been neglected; Newton Aycliffe took on 47 new manufacturing apprentices in its first year of operation at different stages of their development, and will maintain that level in coming years, while Stoke Gifford is also committed to bringing in apprentices on the servicing side, and some of university partnerships will supply the academic aspects of these programmes. ☐



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Romancing the robots

Novelist Jon Wallace considers the science fiction implications of engineering stories that have caught his eye. This month, our continued obsession with all things robotic

There's nothing quite like a robot to help spin a good story. Automations offer sci-fi scribes an opportunity to create our own Frankenstein tales: of cursed human genius and overleaping ambition, and of the creatures themselves, holding up a mirror to

their creator's imperfections.

Some of our most enduring 20th century science fiction characters are Frankensteins: *Blade Runner's* Eldon Tyrell is a depiction of one man's god-like grip over a new species, but the reality of robotic creation is more complex. Our future robots will likely have countless parents and many incarnations. Read *The Engineer's* news on the subject and a picture emerges of a constantly mutating evolutionary process, where a miraculous act of creation, of a single defining robot model, is unlikely. They will take many more forms than human mimic, as engineers turn to all of nature's engineering marvels, not merely the human, in search of inspiration.

The robot tree of life will feature everything from Honda's humanoid ASIMO, Darpa's Bull-like LSSS, the insectoid Titan XIII, through to robots that are little more than objects given life – self-propelling robot suitcases and delivery vans. (Cassie, the curious creature featured in *The Engineer* last month, looks suspiciously like a feeble parent to Robocop's ED209.)

Why then sci-fi's continuing obsession with humanoid robots? Largely it's because of the sci-fi writer's wish to challenge their audience with the questions posed by humanoid counterparts of greater strength, intelligence and lifespan: when do they become us? To what extent will we become them? How like them are we already? And what right do we have to expect obedience from a new cohabiting intelligence?

So it is that robot characters range far beyond Frankenstein's monsters, taking on countless roles including Pinocchio (*Red Dwarf's* Kryten); ruthless infiltrator (*Alien's* Ash and, old perennial, *The Terminator*); comic relief (*Futurama's* Bender) and rebellious slave (replicants); besides objects of both male obsession (Ava in *Ex Machina*) and womanly

power (Number 6 in *Battlestar Galactica*). The less human they are, the less agency robots tend to have in stories, certainly in the case of cinema – faithful servants such as *Interstellar's* TARS and bogeymen such as *The Matrix's* Sentinels. Of course, there are exceptions: R2D2 has probably the greatest role of any robot in fiction (although in C3PO he has a humanoid translator).

Will it be harder to write about robots as they become reality? Certainly our fears these days tend to be more prosaic: of automation leading to mass redundancy, as robots take on every role from accountant and chef to doctor and – dare we say it – writer. What to make of such a future? And

what fiction is there to make from robots that are built for particular tasks?

A future of robo specialists is rich with potential: how would robots accommodate their programming to the compromise of human workplaces and hierarchies? What of journalism, for example?

We could tell the story of a robotic journalist created as the ultimate foreign correspondent, built to explore the badlands of a war-torn nation where it's too dangerous for men to travel. His invulnerable form allows him to penetrate to the heart of the insurgency, but things fall apart as he fails to generate reports that meet his newspaper's editorial slant. Sacked, but driven to realise his programming, he builds his own broadcasting station in mountain caves, broadcasting untrammelled truth to the world. In the process he becomes his home nation's enemy, and soon air strikes rain down, as the war on terror merges with a war on news.

What of robomance? We might well imagine that a future of widely available, affordable robotic partners of each sex is coming. A story could open in a society where the development has almost eliminated petty crime, violence – until religious zealots unleash a robo virus, wiping out the sexbot species and sparking a century of unending conflict among a suddenly frustrated species.

And what of our relations with non-humanoid robots? Men can develop powerful connections with possessions as much as with other people. Perhaps we will see a future of the marriage vow being pushed to greater and greater extremes? One story could follow a man who marries his automated golf bag and buggy. His children take well to their new step-mother, Caddybot 3000, who at least keeps out of their lives, limiting her advice to improving their handicap.

Yes, robot tales will only become stranger. Perhaps that's only natural. There is a weird mix of arrogance and anxiety behind such stories. The certainty that we will create life is often combined with the certainty that it will turn on us. In robotales we writers are, as always, exploring human contradictions: how we struggle to break our programming, and yet cherish it too. ©

Jon Wallace is a science fiction author living in England. His new book *Rig* is out in paperback from Gollancz in April



Robots take many forms: few more frightening than Boston Dynamics' Atlas

Good reasons to go electric

Renault has almost doubled the battery capacity of its electric supermini, the Zoe. Chris Pickering puts it to the test

Could it be that the electric car has finally come of age? Stepping into the new Renault Zoe Z.E. 40 I would be inclined to argue it has. In some respects, this unassuming little car might seem like an underwhelming choice to back up that claim. After all, it takes more than four times as

long to crack the 0-to-60mph sprint as the Tesla Model X we featured last month.

If you look at what's kept drivers from going electric in the past, though, the Zoe now ticks an awful lot of boxes. Renault has virtually doubled its range with the launch of this new 41kWh version, which is good for 250 miles on the NEDC test cycle. That's said to equate to around 186 miles of real-world driving in good conditions – nearly 20 times the length of the average British commute.

This extended range has been achieved without changing the physical dimensions of the battery and with only a 15kg weight increase. It still contains 192 cells arranged in 12 modules, but battery developer LG Chem has managed to pack more active materials into each one. Meanwhile, the surface area of the electrodes has been increased by some 10 per cent and a new cooling system aims to ensure more consistent performance across the temperature range.

The next obstacle has traditionally been cost, but while the Zoe is somewhat pricier than a conventional supermini

01/02 At £23,445 the 41kWh version of the Zoe is comparable to a well-specified Ford Focus

it's an order of magnitude cheaper than offerings from companies such as Tesla. Starting at £23,445 (including the government's Plug-in Car Grant) the 41kWh version is comparable to a well-specified Ford Focus.

That said, over 90 per cent of buyers choose to lease the battery separately (priced at between £59 and £110 a month, depending on the mileage), which drops the purchase price to £17,845. Opt for the entry-level 22kWh version and that figure falls to just £13,995.

Finally, the Zoe comes with a clever onboard charging system, dubbed the Chameleon. This means it can draw the maximum power from virtually any charging point, including the 43kW fast chargers that are increasingly found in motorway service stations. As a result, the Q90 version – more on that in a minute – can fill 80 per cent of its battery in just over an hour. Renault even includes a fully installed 7kW Chargemaster home-charging system with each car.

Of course, this would all be a bit redundant if the Zoe was rubbish to drive – but it's not. The first thing you notice is the lack of noise and vibration as you pull away. Modern combustion engines have become so quiet that their noise often gets lost within the other sounds in the cabin. But take that engine noise away and it suddenly becomes apparent how much it does contribute. Listen carefully in the Zoe and there's the occasional whir of the cooling system and a faint whine from the motors, but that's about it. Even the wind and road noise is well suppressed by small-car standards.





03



04

This particular Zoe has the R90 motor; so named because it's the rapid-charge variant and its total output is around 90hp (92 to be precise). It's a DC-excited synchronous unit developed Continental, which uses copper coils in the stator and rotor, instead of rare earth metals. As a result, it can be used either as a motor, a generator or a transformer.

The Q90 has slightly different windings, which reduces the outright efficiency of the motor – knocking a few horsepower from the peak power figure and around 20 miles off the range – but allowing it to charge significantly faster on a 43kW supply. Somewhat counter-intuitively, this actually makes the short-range Q90 the recommended option for motorway use.

Both versions produce 220Nm of torque from just 250rpm, which means they're more than up to the job of hauling the Zoe's 1,480kg mass. Unlike a combustion engine the torque is there as soon as you touch the accelerator, which makes it feel significantly quicker than the 13.5 second 0-to-62mph time would imply. Overall,

the performance is very similar to that of a traditional supermini.

And the same could be said about other aspects of the Zoe. Thanks to its low centre of gravity it handles neatly (albeit with fairly modest outright grip due to the low rolling resistance tyres). Packaging the batteries under the floor of the passenger compartment also means the boot is larger than average for a car of this size.

Most drivers wouldn't find that it demands any significant compromise compared to a combustion-engined car. The reduced running costs – potentially more than £100 less for every 1,000 miles travelled – would soon start to offset a higher purchase price. Electric cars, it seems, have reached the mainstream. ☺

“The first thing you notice is the lack of noise and vibration as you pull away”



03/04/05/06 The Zoe comes with a clever onboard charging system, dubbed the Chameleon



05



06

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Get new technology first



Tiny pressure sensor could get to work on drones

Sensor can be easily integrated into a multitude of devices. Supplier: Bosch Sensortec



Bosch Sensortec has released its smallest ever barometric pressure sensor, which boasts a host of applications ranging from smartphones and tablets to drones and wearables.

The company, a wholly owned subsidiary of German technology giant Bosch, unveiled the BMP380 at this year's Consumer Electronics Show (CES) in Las Vegas. Measuring only 2mm³ and with a depth of just 0.75mm, the tiny sensor is aimed at the growing markets of gaming, sports and health management, as well as indoor and outdoor navigation.

According to Bosch Sensortec, the BMP380 was designed with flexibility in mind, and can be easily integrated into a multitude of existing and upcoming devices.

Potential applications include stabilisation in drones, where altitude information is used to improve flight stability and landing accuracy. This simplifies UAV steering, making drones accessible to a broader range of users.

Bosch claims the BMP380 can also substantially increase the accuracy of measuring calorie burn with wearables and mobile devices, for example, by identifying whether a person is walking upstairs or downstairs in a step tracking application. The technology could also allow runners and cyclists to enhance their performance monitoring, as well as improve the location and navigation accuracy in smartphones and wearables.

"We are very excited about the opportunities that this sensor opens up for designers to further advance their products," said Jeanne Forget, vice-president global marketing at Bosch Sensortec.

"Our product is unmatched in its scope, precision and footprint, and provides an improvement for outdoor localisation, thereby reducing our reliance on GPS signals."

Bosch has said the BMP380 will initially be available to selected customers in the second quarter of 2017. ●

Optical fibres get to grips with colour recognition

Sensors are able to detect colours very close to a desired object. Supplier: Micro-Epsilon

Micro-Epsilon is offering UK customers a range of colour recognition sensors, including the Colorsensor LT range that operate using optical fibres.

The sensor is connected to an optical fibre that is guided to the measurement target. Colour detection takes place very close to the object, which reduces any environmental effects that could adversely affect the reliability of measurements. More than 2,000 different types of fibre-optic cable are available to choose from, plus a large number of lenses to provide customers with multiple combinations of sensor and optical fibre.

The Colorsensor LT range includes low-cost, entry-level sensors through to high-precision, multi-channel colour recognition systems. The LT range

offers measuring distances from 2–200mm and up to 255 colour memory locations. As well as exact colour, these memory options enable the user to store specific tolerance limits for different applications.

During colour recognition inspection, the sensor compares the colour it has been taught with the colour currently detected. The results are then made available via digital interfaces (RS232 or USB) as discrete values/numbers or NO/NOK statements. The sensors are supplied with their own set-up and configuration software, and a GUI that enables the user to adjust the sensor for different applications.

Using new LED light sources, LT sensors can now be mounted much further away from the measurement

target if required, at distances of up to 900mm.

Micro-Epsilon's Colorsensor OT series of colour recognition sensors

operates by using fixed optical systems. These sensors are able to recognise the colour of objects from distances ranging from 2mm to 800mm.

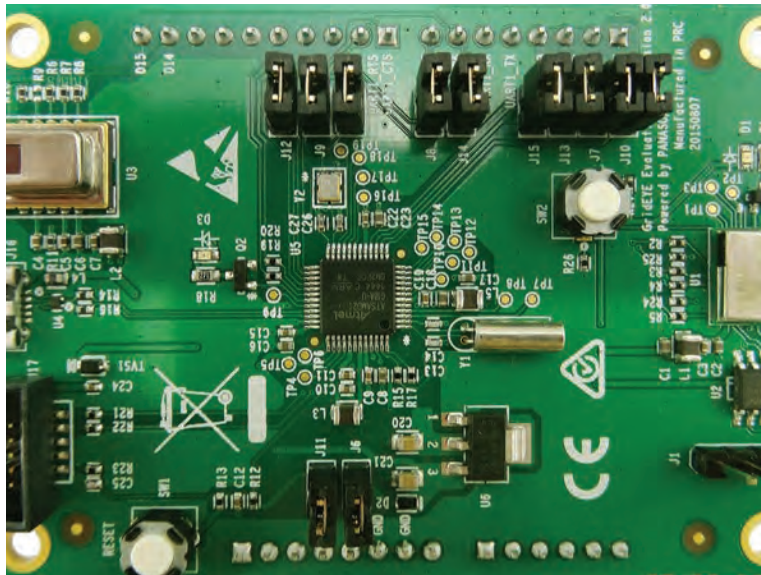
Different models are available to suit different surfaces and materials, including shiny, reflective and structured surfaces, plus versions for recognising UV markings. OT sensors can also recognise colour variations along or between target objects and materials.

Furthermore, OT sensors use nine white-light LEDs, whose brightness can be controlled as required. ●



Moving into the second generation of evaluation

Kit comes with improved sensor and software for fast prototyping of IoT applications. Supplier: Panasonic



Prototype IoT applications could be developed more quickly with a new second-generation Grid-Eye Evaluation Kit from Panasonic Automotive & Industrial Systems.

The new evaluation kit is said to come with an improved Grid-Eye second-generation sensor and improved software for fast prototyping of IoT applications. A further addition to the new Evaluation Kit combines the nanopower PAN1740 Bluetooth Smart module and a microcontroller on one PCB.

Mubeen Abbas, product marketing manager, Panasonic Device Solutions Business Division, said: "We have improved our PC software and are working further to launch people detection, counting and tracking software into the market very soon. We also have an iOS smartphone

app that customers can download for free to test the basic sensor functionality. We are focused on enabling our customers to effortlessly and rapidly test our sensor in different ways for various applications."

The new Grid-Eye Evaluation Kit is based on the AMG8834 Grid-Eye sensor and is claimed to benefit from an improved NETD (Noise Equivalent Temperature Difference) of 0.16°C at 10Hz and of 0.05°C at 1Hz. The detection distance for the new sensor has improved from 5m up to 7m.

With these features, the Grid-Eye sensor enables applications ranging from energy savings in the lighting industry, domestic appliances, safety and security systems, and the medical industry for patient-fall detection and patient positioning.

Further examples include hot-spot detection, human detection inside vehicles for consumer comfort and contactless temperature measurement in industrial applications.

Grid-Eye is also able to detect people and effectively differentiate them from other heat sources such as displays or heaters.

Moreover, as Grid-Eye is an infrared sensor, detection of people is measured almost independent of ambient light conditions. ☉

Laser-ranging sensor has wide application

Suitable for use across robotics, smartphones, drones IoT and wearables. Supplier: STMicroelectronics

Geneva-headquartered STMicroelectronics has released a new laser-ranging sensor with applications across robotics, smartphones, drones, IoT and wearables.

The VL53L1 module measures 4.9 x 2.5 x 1.56mm. It incorporates the company's proprietary FlightSense technology, which uses the Time-of-Flight principle to detect proximity and range. The sensor features a new lens system, a 940nm VCSEL invisible-light source, a processing core, and a SPAD photon detector. According to STMicroelectronics, the addition of the optical lens system increases the photon detection rate to boost the module's ranging performance.

"ST has already shipped hundreds of millions of Time-of-Flight sensors, which have been designed by OEMs

into over 70 smartphone models as well as many other consumer devices," said Eric Aussedat, general manager of ST's Imaging Division.

"The third-generation FlightSense product uses improved performance to support new applications, including human-presence detection, while continuing to improve sensor performance for existing use cases."

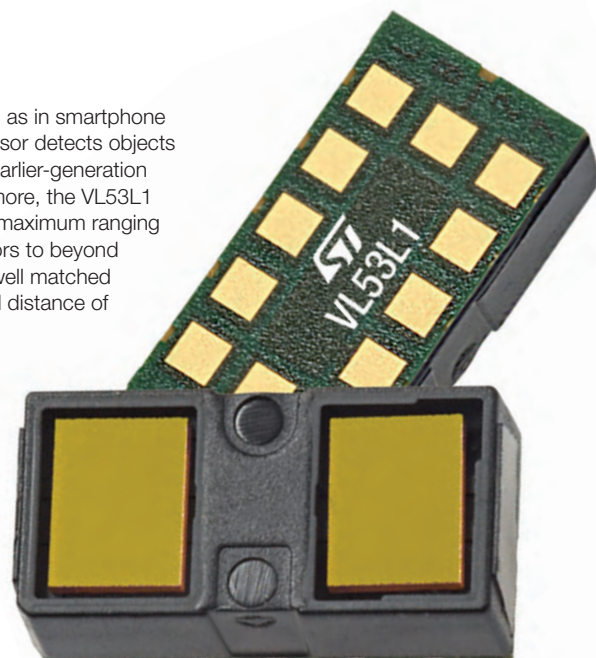
An embedded microcontroller manages the complete ranging function and runs the digital algorithms to minimise host-processing overhead and system power consumption, helping to maximise battery life for mobile applications. For high-speed applications, the VL53L1 can perform a full measurement operation in as little as 5ms.

ST claims that for autofocus

applications such as in smartphone cameras, the sensor detects objects twice as fast as earlier-generation devices. Furthermore, the VL53L1 has doubled the maximum ranging distance of sensors to beyond 4.5m, making it well matched to the hyper-focal distance of widely used 21-megapixel camera optics.

The new design architecture can detect multiple targets within a scene and also allows manufacturers to sub-divide the

SPAD sensing matrix into custom-defined zones. These small zones can then provide spatial ranging information that the customer application can use for dual-camera computation in stereoscopy, as well as simple depth-map use cases. ☉





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High-end education is on the agenda

Conference features hot topics such as Brexit, Industry 4.0, additive manufacturing, automation, skills and the Apprenticeship Levy



The first raft of speakers has been confirmed for The Engineer Conference, a high-end, free educational programme that runs during Subcon, the Advanced Manufacturing Show and The Engineer Design & Innovation Show from 6-8 June at the NEC, Birmingham.

BAE Systems' director of strategic technology Andy Wright and Prof Sam Turner, the newly appointed CTO at the High Value Manufacturing Catapult, will present two of the conference's keynote addresses.

"The Engineer Conference is the ultimate opportunity for visitors to Subcon in June to gain critical insight into the newest industry trends, to keep up to date and hear the latest thinking from leading minds at the forefront of advanced manufacturing," said event director Gordon Kirk.

"We're really excited about this summer's conference: we will deliver a programme showcasing inspiring projects and the latest thinking from engineering design, manufacturing and supply chain development, giving the audience key recommendations and practical advice that can be applied directly to business strategy."

Covering hot topics such as Brexit, Industry 4.0, additive manufacturing, automation, skills and the Apprenticeship Levy, 17 speakers have been announced to date from companies including Jaguar Land Rover, Ocado and Siemens.

- Al Gane, advanced manufacturing facilities manager, Jaguar Land Rover
- Sam Shaikh, R&D, Ocado
- Alan Norbury, CTO, Siemens UK
- Ann Watson, CEO, SEMTA (engineering sector skills body)
- Chris Richards, EEF senior business environment policy adviser
- George Nikolaidis, EEF senior economist
- Dan Knowlton, KPS
- Rachel Eade, OBE, RED
- Desi Bacheva, project design engineer, HiETA Technologies
- Neill Briggs, technical director, Briggs Automotive Company
- Carl Perrin, director of the Academy of Manufacturing Excellence, Coventry University
- Marc Saunders, director – global solutions centres, Renishaw
- Michael Ward, CTO, Advanced Forming Research Centre
- Birmingham City University/Meridien
- Phil Reeves, VP consulting, Stratasys

"The Engineer conference is the ultimate opportunity for visitors to gain insight into the newest trends"

01/02 The event features three shows that are co-located together

The full conference programme will be announced at the end of March and visitors are recommended to register their interest to receive instant updates.

The co-location of Subcon, the Advanced Manufacturing Show and The Engineer Design & Innovation Show will create the engineering and manufacturing event of the year in the UK, providing a one-stop destination for the complete manufacturing cycle from concept to component, bringing together design engineering, product development, in-house production and outsourced supply chains.

Commenting on the value of the three events running alongside each other Tom Mongan, general manager at Subcon Laser, which is exhibiting at the show, said: "When the three shows first ran together two years ago, it ranked among the best events I have ever exhibited at. We were inundated with good-quality visitors and exceptional leads. It works very well having Subcon alongside the Advanced Manufacturing Show and The Engineer Design & Innovation Show because it brings together subcontract buyers, production engineers and designers under one roof. I have every expectation that this year's event will be at least as good, if not better." ©

**You can find out more about visiting and exhibiting at the three shows at: www.subconshow.co.uk
www.advancedmanufacturingshow.co.uk
www.theengineer-designinnovationshow.co.uk**



Taking care of a survivor

A First World War cruiser needed an overhaul to carry out its duties as a floating museum

In October 2016, HMS *Caroline*, a ship owned by the National Museum of the Royal Navy, was undergoing a hull refurbishment in dry dock at Harland and Wolff in Belfast. HMS *Caroline* is a decommissioned C-class light cruiser that saw combat service in the First World War and served as an administrative centre in the Second World War. HMS *Caroline* was launched and commissioned in 1914. The ship is usually open to the public as a museum, being the only survivor of the Battle of Jutland in the First World War (1916). Due to the refurbishment, she is currently closed to the public.

Originally designed for 20 years of service, HMS *Caroline* has now been operating for over 100 years. It had been 30 years since HMS *Caroline*'s last overhaul, and numerous compartments, fuel tanks and storage areas below the waterline had been taking on water. This had resulted in scores of leaks when the ship entered dry dock, not to mention a very pitted surface.

In this overhaul, welding was limited to areas of the hull that had no leaks, and that were robust enough to withstand hot works. The client was looking for a long-term repair, capable of bonding to a poor substrate and with rapid-cure

times as the project's dry dock was already booked for another ship repair. Belzona materials were specified by marine surveyors, and the application was carried out by a specialist subcontractor, SPP Engineering Services. For this application, two Belzona epoxy materials were chosen as a means of providing an effective, long-lasting repair: Belzona 1111 (Super Metal) and Belzona 1212.

Prior to the application of the repair material, the substrate was grit-blasted, then cleaned. Forced heating of the working area was used to keep the substrate and material above a temperature of 10°C. Due to the size of the project and the short working window, a team of mixers, runners and applicators were utilised.

Belzona 1111 was first used to fill in badly corroded areas. This material was also originally specified for sealing

leaking rivets in internal fuel storage tanks, but the poor condition of the substrate in the tanks required a surface-tolerant solution.

As Belzona 1212 can be applied onto oily surfaces and even underwater, the material was chosen as the best alternative to Belzona 1111. This material is effective at displacing contaminants from the substrate via a strong electronic affinity with the metallic substrate, allowing the epoxy to penetrate the profile and create a strong mechanical bond. In the end, only 6kg of Belzona 1111 was used at deck level, and over 100kg of Belzona 1212 was utilised to seal the leaks due to the substrate conditions. The ship floated back to moorings before Christmas, with no leaks or delamination.

One of the applicators on site said: "We would only approach such a highly complex and unusual project with full technical and site support from a trusted supplier such as Belzona. The systems selected for this project had to be of the highest-possible technical performance, as this ship will be a high-profile floating museum open to the public."

This project illustrates the versatility and use of Belzona products while providing a long-term solution to both problems. The high bond strength and no shrinkage characteristics of the materials made them a suitable choice for this repair. The application was completed without using hot work thanks to Belzona 1111 and Belzona 1212's cold-curing characteristics.

Once complete, HMS *Caroline* will be returned to her home of Alexandra Dock in the Titanic Quarter in Belfast and is scheduled to reopen to the public in 2017. ©



01/02 The century-old steel hull of HMS *Caroline* was badly pitted and would not withstand much welding
03/04 After applying the epoxy coating, the ship is now ready for the next phase in its long life



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An additive schooling

3D-printing technology is increasingly being used to inspire a next generation of engineers. Helen Knight reports

T

eaching children to understand a new concept or idea can take more than just a textbook or lecture, they need to use all of their senses.

Now, with the growth in the use of 3D printers in schools, this approach is increasingly being used as a way to enthuse young people about engineering, by offering them something they can see, touch and feel.

By allowing them to rapidly design, build and test their own objects, the technology can give young people an insight into engineering and technology that a picture in a textbook or words on a white board cannot.

As 3D printing has become more widespread, and more affordable, the technology is increasingly being used in secondary schools, and even some primary schools.

Schools can now buy an entry-level 3D printer for £500 to £1,000, while companies are offering free resources to help teachers to use the technology in their classrooms.

The Create Education Project, for example, which was originally set up by 3D-printing machine specialist Ultimaker (GB), but is now an independent organisation, has been set up to help schools integrate the technology into the curriculum by providing teachers with free resources, lesson plans and presentations. This includes a guide for including 3D printing in the primary-school curriculum.

The project runs a loan scheme, in which schools are offered the use of a 3D printer for a month

or more. In return, all teachers are asked to describe their experiences with the printer in a blog post, or to share a lesson plan they have created for their class, according to the project's Chris White.

"The best way to show schools what they can do is to give them real social proof and inspire them by showing what is possible," he said.

The organisation also runs events such as 3D-printing workshops to encourage young people into STEM, including a recent challenge for secondary school girls in Lancaster, designed to encourage them to consider careers in medicine and engineering. The girls were challenged to design and make a 3D-printed model of an animal cell for use in teaching.

Similarly, Renishaw, the UK's only manufacturer of 3D-printing machines, regularly runs workshops for local schools at its Miskin site near Cardiff. These workshops teach pupils how to draw using computer-aided design (CAD) software, and allow them to print their own small object, such as a name badge or keyring.

The site houses five 3D printers that schools can use for their design and technology lessons. Pupils can also watch Renishaw's 3D printers producing healthcare products such as dental frameworks and facial implants. This helps them to relate what they have learnt to practical applications in industry, said Simon Biggs, education liaison officer at Renishaw. >>

"The best way to show schools what they can do is to give them real social proof and inspire them by showing what is possible"

Chris White, Create Education Project



01

01 Schools can now buy an entry-level 3D printer for £500 to £1,000

>> “The Wales site is where we actually make the metal 3D printers, so schools can visit here to see the link between the classroom-based desktop plastic 3D printers and the metal printers we make here for industry,” he said.

Using 3D printing allows pupils to go from an idea, to a design, to producing an object, quickly and easily. This helps them to learn about the process of design, said Biggs, who was himself previously a school teacher.

“The technology is able to bring ideas to life very quickly,” he said. “In my time as a teacher I saw that some of the ideas they would design on paper would be too complicated to make in the traditional way, but using a 3D printer they could use their drawing and computer skills to design it, and the machine would create it for them very quickly.”

Pupils can also spot mistakes more easily when studying and touching a physical object, which helps them to develop their problem-solving skills.

“If, when they go to use their object they find there is a problem, they can go back to their CAD drawings, change the design, 3D print it again, and quickly overcome it, whereas previously it would have taken them a lot longer to even find the problem,” said Biggs.

The increasing use of 3D printing in schools, and its success in enthusing young people about design, technology and engineering, can be seen in some of the entrants to this year’s Big Bang Competition.



02

02/03 Additive technology is able to bring ideas to life very quickly for students at school

The competition, run by EngineeringUK, asks teams of secondary school pupils to come up with their own science or engineering project, with the winners announced at the Big Bang Fair at the Birmingham NEC on 16 March.

Entrants to this year’s competition include a project by a pupil at Holmes Chapel Comprehensive School in Cheshire, in which he designed his own combination 3D printer and CNC mill, capable of printing plastics, milling metals and cutting circuit boards.

Similarly, a team at Robert Gordon’s College in Aberdeen developed its own stereolithographic 3D printer, said

EngineeringUK’s chief executive Paul Jackson. “They found a design in a journal, developed it, optimised it and carried out a material analysis,” he said.

Another team at Queen Elizabeth’s School in London used 3D printing to build a safety helmet for the construction industry, which is equipped with a sound alerting unit to indicate local noise levels.

The use of 3D printing by teams entering the competition has grown significantly in recent years, according to Jackson.

“When we started the Big Bang competition in 2009, I can’t think of any examples that we would have seen of that nature, and that is not a very long period for such a dramatic change,” he said. “It’s great to see young people taking advantage of these tools.”

Indeed, in the space of just five years, 3D printing has gone from a technology that the Department of Education began piloting in 21 schools, to a mainstream teaching tool, said Jackson.

The technology can be a very effective means of inspiring young people in relation to engineering, particularly those who would not have previously considered it as a potential career, he said. ☺

“Using a 3D printer they could use their drawing and computer skills to design it”

Simon Biggs, Renishaw



03



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Digitisation looms larger than ever

Hannover Messe 2017 will enable manufacturers to get to grips with a number of emerging technologies set to transform our world

Industry 4.0, self-learning robots and sustainable energy solutions are all expected to loom large at this year's Hannover Messe.

Running from the 24–28 April, this year's event – the largest of its kind in the world – will feature 6,500 exhibitors and is expected to attract around 200,000 visitors

With Industry 4.0, integrated energy, digital twins, machine learning, predictive maintenance, smart materials, and networked and collaborative robots (cobots), companies

of all sizes today have a multitude of high-tech products to choose from.

According to Deutsche Messe managing board member Jochen Köckler, this year's show will enable manufacturers to really get to grips with these key emerging areas.

"Challenging people to 'think outside the box', highlighting all the various ways in which digitalisation can add value, and opening up new markets – that's what this year's Hannover Messe is all about," he said.

One aspect of industry 4.0 that will feature prominently



01/02 Industry 4.0 and robotics are set to be key themes at this year's Hannover Messe show



at the show is predictive maintenance. Digitised production processes generate vast quantities of data that is then analysed by various upstream and downstream systems. In the not-too-distant future, manufacturing systems will incorporate machine-learning technologies that analyse this data centrally and feed the results back to the production machines in question, thereby enabling them to learn and self-optimize.

With plenty of current debate around the impact of automation on people's jobs, the event is also expected to illustrate how Industry 4.0 technologies will help make factory workers' duties more interesting and varied, and will help educate manufacturers about the need to invest in upskilling measures to prepare their workforces for the factory of the future. "In tomorrow's agile, flexible factories, employees will be experts in the use of virtual reality, augmented reality, smart glasses and tablets. All of these exciting new digital factory tools will feature prominently," said Köckler.

So-called Cobots – collaborative robots able to work alongside humans – are another theme expected to attract plenty of attention. Simple to operate, self-learning and connected to the cloud, this next generation of industrial robots is thought to represent one of the most cost-effective ways of embracing the benefits of Industry 4.0

Another key theme is a concept described by the organiser as 'Integrated Industry', the idea that the goods produced by smart factories will stay connected with their manufacturers throughout their service lives, supplying a constant stream of valuable data.

This data will enable the manufacturers to develop additional web-based services and to pursue new business opportunities outside the confines of their traditional industries.

"The biggest value-adding potential of digitalisation lies in the development of completely new business models and in the markets these business models tap into," said Köckler.

Digitisation is also transforming the energy industry. Without this, it will not be possible to make the switch from today's outmoded centralised power plants to modern, highly efficient energy systems that are based on renewables and distributed generation structures. Under the 'Integrated Energy' banner, leading providers will highlight the changes the energy industry will undergo, as well as the individual technologies that will play a critical role in this transformation. ©

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Work management without the guess work and administration

Agility, the Asset and Maintenance management software from SoftSols, now seamlessly manages work with the new 'end to end' solution, AUTOagility. Sponsor: SoftSols Group

Maintec 2017, (21st to 23rd March at the NEC) will see SoftSols Group showcase the brand new intelligent work capture and deployment solution AUTOagility.

Based on over 30 years' experience in managing work across a variety of sectors; AUTOagility uses dynamic, behind the scenes rules to ensure the right detail and quality of information is captured for each work request and then automatically deploys it to the most appropriate resource for completion.

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Visit stand M300 to see AUTOagility plus the other the latest features from Agility. David Hipkin, SoftSols Group MD, will also be taking part in the Maintec Dialogue session on IoT on Tuesday 21st March.



Rapid insert moulding and overmoulding services expanded

Proto Labs has expanded its services.

Sponsor: Proto Labs

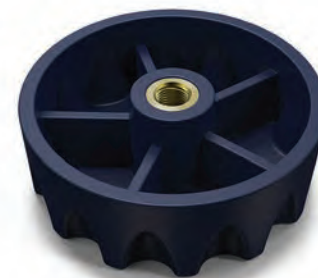
Leading digital manufacturer, Proto Labs, has officially launched insert moulding and overmoulding, supported by a fully automated quoting and manufacturing process, across its global business.

Rapid overmoulding and insert moulding processes produce custom prototypes and on-demand production parts in 15 days or less. They use aluminium moulds that offer cost-efficient tooling, and moulded parts that can be manufactured from a range of thermoplastic and liquid silicone rubber materials.

With overmoulding, the production of the substrate parts is a standard injection moulding process involving

an aluminium mould with no heating or cooling lines running through it. Cycle times are a bit longer, which allows Proto Labs moulders to monitor fill pressure, cosmetic concerns, and the basic quality of the parts.

When the total run of substrate parts are moulded, overmould tooling is then assembled to the press. The substrate parts are placed by hand into mould where each part is overmoulded with either a



thermoplastic or liquid silicone rubber material.

Insert moulding is a similar process but instead uses a preformed part – often metal – that is loaded into a mould where it is then overmoulded with plastic to create a final component. When the run is complete, parts (or the initial sample run) are boxed and shipped shortly thereafter.

Lose weight, gain £s with engineering plastics

Plastics are proven to lead to significant cost savings. Sponsor: Nylacast



The use of engineering plastics developed by Nylacast are proven to increase overall equipment without compromising on quality, strength or performance. In fact, the use of Nylacast plastics can also lead to significant cost savings and lower whole life costs.

Nylacast plastics are lightweight, 1/7th that of steel, corrosion resistant and low friction. These inherent properties result in improved performance, reduced and eliminated maintenance need or machine downtime and no or less replacement. Apply these advantages to one bush on a piece of equipment and its questionable, however, when applied to multiple applications and critical components on one piece of equipment it can lead to significant weight savings, cost savings and product improvement.

Typical applications range from washers, bushes, spacers and wear parts through to sheaves, pulleys, spooling shells, gears and many custom components. If you can think it, Nylacast can help create it from concept and raw chemicals to end solutions.

Nylacast manufacture materials in house and offer a range of services including full traceability, material certifications and customisations, product testing, semi finished products, machined applications and end solutions integrating a range of materials.



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Torque transducer ensures precise measurement results

New T12HP reduces set up times and optimises testing. Sponsor: HBM Test and Measurement.

HBM is pleased to announce the arrival its new digital T12HP Torque Transducer, which dramatically reduces set up times and optimises testing.

Setting the standards for dynamic measurements in test stands, the new T12HP digital torque transducer provides unprecedented precision, particularly in terms of temperature stability.

Eliminating the impact of temperature influences on the measurement result, due to a TCO value of 0.005%, the T12HP also features a



FlexRange™ function, which enables users to run a more detailed analysis in any partial range, from the full measurement range.

Unlike other technologies currently available on the market, the new T12HP from HBM enables different measurement tasks to be expeditiously performed using a single characteristic curve, eliminating the need to switch to a second measurement range.

In addition to its excellent technical performance features, CAN, PROFIBUS, EtherCAT and PROFINET interfaces also ensure easy integration of the T12HP torque transducer with different test stand concepts. In addition, as the measurement flange is installed directly in the drive train, this makes it maintenance free.

Meeting the market requirements for increasingly flexible and efficient test cycles, the new T12HP fully complies with the demanding requirements for high accuracy, high dynamics and high resolution and is available from HBM with different nominal (rated) torques, ranging from 100 Nm to 10 kNm.

KD1: The first Windform SP 3D-printed driver clubhead

Additive and subtractive manufacturing combined to create golf driver. Sponsor: CRP Group

Krone, the world leader in custom engineered golf equipment, was determined to create the world's most advanced high-performance golf equipment.

Krone selected CRP Group for the project to provide guidance on how to combine the use of Additive Manufacturing and High-Precision CNC machining.

By partnering with the Italian-based group, Krone was tapped into a network of companies that provide a wide range of custom solution. Two specific divisions within CRP Group were placed on the project team: CRP Meccanica and CRP Technology.



The collaboration led to the creation of KD-1. It is a composite driver clubhead where the different materials have a specific function and structural competence.

The KD-1 body structure has been manufactured by CRP Technology's 3D Printing and Additive Manufacturing department utilizing Laser Sintering and the innovative Windform SP Additive Manufacturing material. Windform SP is a highly ductile material with top mechanical resistance. It is used where there is high stress fatigue even in time as type vibration or shock without the risk of breaking. The elasticity helps to absorb these mechanical stress.

The body has 4 Helicoil® M4 inserts at the end to fasten the weight.

The KD-1 face (the striking surface of the head of the club) is made in Ti6Al4V: it has been CNC machined from solid and sand blasted to clean external surfaces by CRP Meccanica; the hosel was also produced in Titanium as well.

The weight is also CNC machined in brass from solid and sand blasted by CRP Meccanica.

New connectors withstand both static and dynamic loads

Introducing a new range of modular heavy-duty connectors. Sponsor: Bosch Rexroth



Bosch Rexroth has introduced a new range of modular heavy-duty connectors, bringing even greater flexibility to the use of machine frames made from aluminium strut profiles.

The new 180x180 dynamic load connectors have undergone extensive testing by the Fraunhofer-Gesellschaft for the safe absorption of both high static and dynamic loads. They increase the deployable radius across a broad spectrum of applications and form an additional module for the implementation of needs-based machine frame solutions.

The use of the new connectors is both simple and versatile: a connector can be applied at any position, making processing of individual strut profiles unnecessary. Connectors are also available for 90x90, 90x180 and 90x360 focus profiles, with the fastening set available as an accessory.

During design and set-up, users are supported by a calculation programme integrated into the Rexroth MTpro planning software, which is suitable for the planning and design of the complete assembly.

The plastic cover cap and cover profile range has also been extended, with users able to select from black units for their ESD conductivity – suitable for electronic applications – or grey variants for a restrained overall appearance to enable a focus on customer-specific design elements.



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In hot pursuit of a low-carbon future

Motorsport companies are looking to recruit engineers from other sectors to implement greener technologies. Evelyn Adams reports

From the invention of the mid-engine single-seater in the 1960s to the creation of Cosworth's DFV engine a decade later, the UK has always been a world leader in motorsport. The industry boasts an intoxicating mix of speed, precision and beautiful design – and for engineers looking to transfer their skills, there has never been a better time to join.

Described by some as the jewel in the crown of British engineering, the sector currently employs more than 50,000 people in the UK, and generates a total of £11bn of sales each year. Around 4,500 firms are

actively involved in the UK's motorsport and high-performance engineering industry, and 87 per cent export their products or services.

For these figures to grow, however, the industry must stay relevant. That means embracing low-carbon technologies that are a far cry from the gas-guzzling glory days of racing. In recent years, the industry has had a makeover, placing a greater focus on efficiency and 'green' technologies that can be transferred to road cars. The Formula E series, for example, is the first full electric-powered race series, while Formula One and Le Mans prototype cars have been using hybrid systems for years, requiring a whole new set of skills.

Motorsport companies are now looking to recruit

engineers from other sectors to help them move towards this low-carbon future. "The hunger driving new technologies such as autonomous vehicles, energy capture and re-generation, and the need to attract a younger audience through new communication pathways, is driving the industry to look outside at other successful sectors such as gaming, software, simulation and IT," said Chris Aylett, chief executive of the Motorsport Industry Association (MIA).

Shaun Clayton, Prodrive's human resource manager, agrees that, given the scale of the challenge, help is needed from non-traditional sectors. "Motorsport can often be the proving ground for technologies, while teams are always looking for new ideas that can give them an edge over the competition," he said. "At Prodrive, while motorsport experience is undoubtedly very helpful, we are always looking for people in other sectors that can bring a different perspective and give us that competitive edge."

"We also have an Advanced Technology division where we use our motorsport approach to develop innovative technologies for clients in the automotive, aerospace, marine and renewable energy sectors. Here we are always looking for engineers who can bring skills from other industry sectors to work on projects as varied as the Land Rover BAR America's Cup yacht to the latest hybrid vehicles and vehicle interior systems."

"Motorsport teams are always looking for new ideas that can give them an edge"

Shaun Clayton, Prodrive



03

The challenge isn't for the faint-hearted. A Formula One (F1) car moves from idea through to completion within just 24 months. It uses more than 11,000 parts – 80 per cent of which will be redesigned during the course of a season. To produce such a large turnover, Clayton said that there are two key qualities that an engineer from outside the industry can bring to motorsport. First, there are the direct technical skills learnt from developing what are the highest-performance vehicles in the world. The second quality is what Clayton described as "the motorsport approach to working".

"In motorsport we are used to working to short timescales and unmoveable deadlines – a race starts when it starts and if you are not ready you miss it – there is no opportunity to push back a launch date," he said. "This mindset and approach is increasingly something that many businesses in the automotive and aerospace approach us for and something they want to instil into their own teams of engineers."

For more than 50 years, the UK has been responsible for more motorsport innovations than any other country. And now, given its focus on a low-carbon future, chances to innovate are even greater. For instance, Le Mans has an entry called 'Garage 56' in which a team can throw out standard regulations and create a concept car using new, innovative technologies. Deltawing is perhaps the most famous of the entries for its energy-efficient design that looks like a cross between a fighter jet and the Batmobile.

Innovations from designing winning cars are also used in other industries. For example, the healthcare industry is using some of the lessons learned by McLaren Applied Technologies (MAT) in F1. Meanwhile, Williams has taken motorsport expertise in energy-efficient technologies into sectors such as public transport.

For engineers with a talent, skills and the right attitude, opportunities exist across a range of specialisms. "There is a real shortage of skilled, experienced engineers within the industry at present and there is an opportunity for new blood," said Aylett. "Unfortunately, the new blood rarely comes suitably equipped with the vital practical, 'hand' skills essential to employers."

"The industry is taking on apprentices, students from university technical colleges and universities to develop their workforce. Motorsport companies are always looking for the next idea, spending 25 per cent of their turnover in research and development. Design engineers, composites, simulation engineers, powertrain engineers and HV battery specialists are in demand to name a few."

Most of the jobs exist in an area known as Motorsport Valley. This describes an area around 80 miles wide stretching from the south west of Birmingham through

Northamptonshire and Oxfordshire. However, many firms also operate from elsewhere in the country such as London, East Anglia and Leeds.

"Automotive is very different to motorsport," said Aylett. "Motorsport demands a passion and commitment seldom seen in other industries. The problems experienced at this week's Grand Prix will be solved before next week's event, to be replaced by yet more problems demanding speedy resolution. Time management is an essential skill that simply complements the problem-solving capacity and capability demanded of the competitive racing environment."

"No race was ever delayed waiting for a car to be readied." ©

"The problems at this week's Grand Prix will be solved before next week's event, to be replaced by yet more problems needing resolution"

Chris Aylett, MIA

01/02 As competitions such as Formula E demonstrate, low-carbon technology is key to the future of motorsport

03 Firms such as Prodrive are helping to drive the application of composites

02



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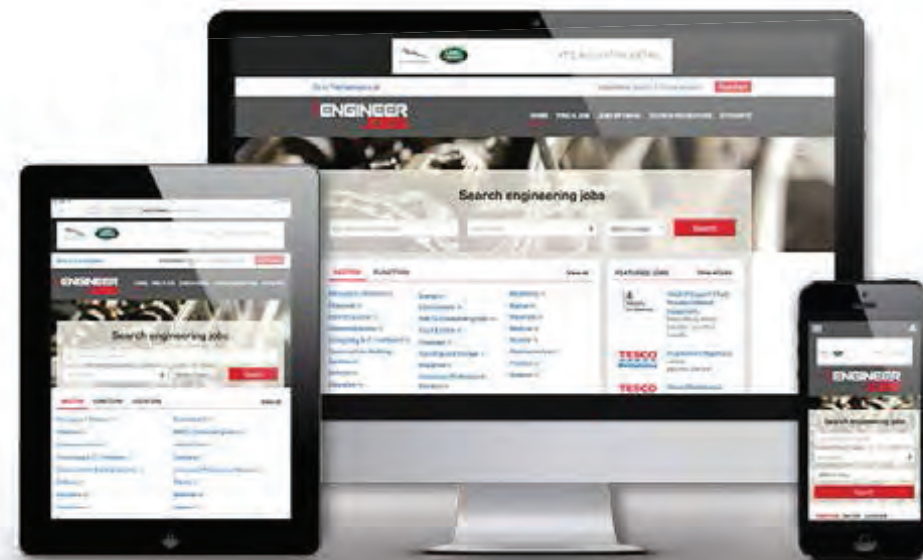
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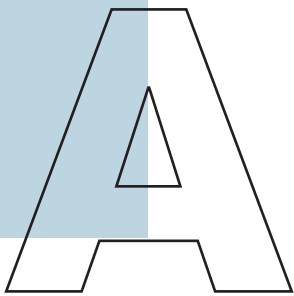


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Mar 1878

Eventful journey

The coming of the Cleopatra's Needle obelisk to London was a far from straightforward enterprise



Almost 140 years ago this month, an iconic antiquity appeared on these pages. Having arrived into London in January 1878 after a tumultuous journey, Cleopatra's Needle was the centre of much attention. By March, a decision

had been made on the location where it was to be sited, much to the chagrin of our predecessors.

"We regret that, in defiance of good taste, it has been decided to erect the obelisk on the Thames Embankment," wrote *The Engineer* in 1878. "We have spoken so frequently and so strongly on the selection of a site, that we shall not further refer to the subject now."

We've been unable to ascertain exactly what ignited the protests of our forebears, but the issue appears to be one of form rather than function.

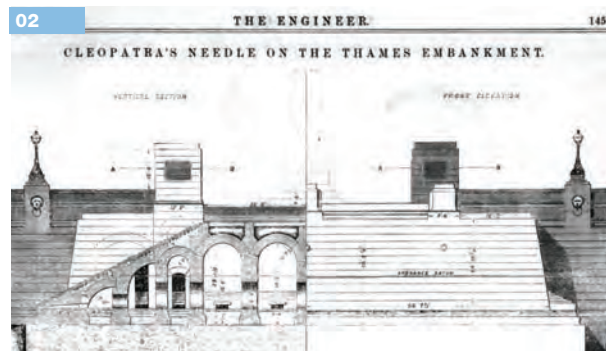
"It is well to know... that no objection can be urged on engineering grounds to the position secured on the Embankment; in other words, there is no fear that the monolith will tumble into the river, bringing a large section of the Embankment with it."

No reference was made on these pages to the Needle's history, which is a combination of the colourful and the tragic. Constructed during the reign of the 18th Dynasty Pharaoh Thutmose III, its red granite originated in quarries near Aswan. It was first erected in the Egyptian city of Heliopolis around 1450BC, but it was not until 200 years later that the monolith was inscribed with its distinctive Egyptian hieroglyphs, an addition made by Ramesses the Great to commemorate his military successes.

One of a pair – the other today sits in New York's Central Park – the obelisk was moved to Alexandria by the Romans in 12BC, where it remained for almost two millennia. In 1819 it was presented to the UK in recognition of Nelson and Abercrombie's respective victories in the battles of the Nile and Alexandria. However, the British government of the day declined to transport the 70ft artefact to London.



01



02

"Transporting the monolith, weighing 224 tons, would turn out to be a deadly endeavour"

The Engineer

An effort to do so was undertaken in 1877 under Sir Erasmus Wilson, a well-known surgeon and dermatologist. But transporting the monolith, weighing 224 tons, would turn out to be a deadly endeavour. After being dug out of the sand, the Needle was placed into an iron cylinder that was 28m long and 5m wide, designed by the English railway engineer John Dixon. This ill-fated vessel, dubbed the *Cleopatra*, was equipped with a mast and rudder, two bilge keels and a deck house, and was intended to be towed to London by a ship called the *Olga*.

But on 14 October 1877, a storm in the Bay of Biscay sent the *Cleopatra* rolling uncontrollably. Six men were sent from the *Olga* to rescue the crew of the iron vessel, but their boat capsized and all were lost. Their names can be seen on a bronze plaque attached to the Needle's mounting stone. The *Olga* was eventually able to pull alongside the *Cleopatra* and evacuate the sailors, with the cylinder and its precious cargo left to the mercy of the sea.

It was spotted four days later by Spanish trawlers, and brought to the port of Ferrol in Galicia by the Glasgow steamer *Fitzmaurice*. After repairs were carried out, the *Cleopatra* was eventually towed back to the Thames by the paddle tug *Anglia*. The diagrams from 1878 show how the Needle was secured to the Embankment after its journey.

"We give above [see illustration] a section of the river wall at the Adelphi Stairs, with the base of the Needle shown in dotted lines. From this it will be seen that a very large base is provided, and that the water stairs act as a buttress or relieving wall. The arched vaults are to be filled in solid with cement concrete. The only place where danger is to be apprehended is in the subway, the river haunch of the arch of which may be exposed to a considerable additional strain."

The obelisk was finally erected on 12 September 1878. A time capsule was enclosed in the pedestal containing an array of both everyday and unusual items. These included a set of photographs of attractive English women; a baby's bottle; a box of hairpins; a translation of the hieroglyphics; samples of the cable used in the Needle's erection; a portrait of Queen Victoria; and a history of the monument's journey to London. Good luck to future generations figuring out the meaning of all that. **AW** ©

01/02 Cleopatra's Needle was eventually secured to the Thames Embankment in September 1878

Word of the issue

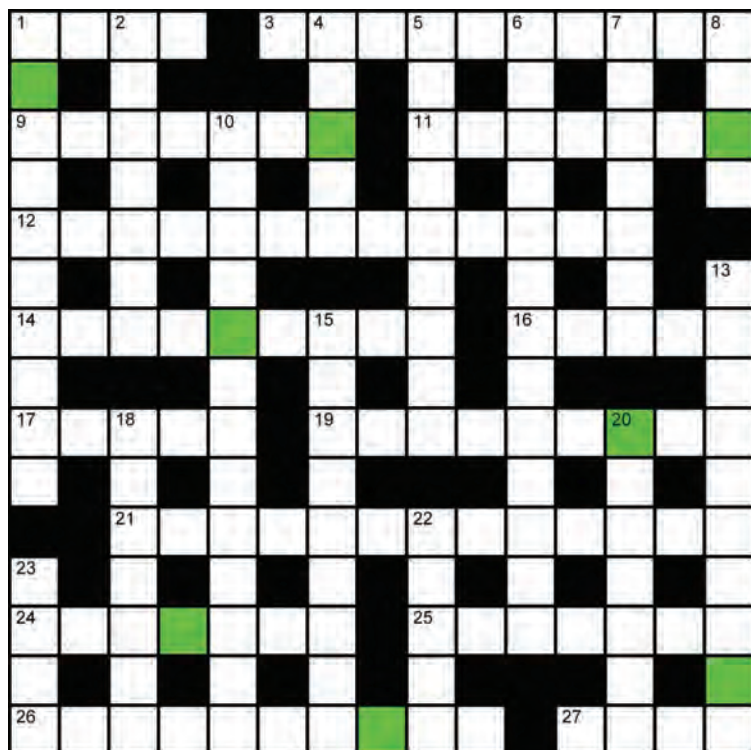
Anthony Poulton-Smith explores the origins of the word 'turbine'

Words such as 'turbine' and 'turbo' are inevitably associated with the modern era. Yet these are simply adapted from earlier examples. However, they still relate closely to modern forms in meaning. First coined as recently as 1838, 'turbine' is French and taken from Latin turbine or 'spinning top, eddy, whirlwind, that which whirls'. Not used in its modern sense until as recently as 1904 when referring to a gas turbine, although the concept of water falling on a wheel to make it rotate had been used since pre-history as a watermill. Clearly related to 'turbo', we may only think of this as the abbreviation for 'turbocharged', yet it has been used centuries. Indeed this comes from the Latin where turbo referred to a child's toy, a 'spinning top'. Taking this just a single etymological step further, only changing a single letter brings us to turba meaning 'turmoil' and even 'crowd', and has also given us the adjective 'turbid'.

Big picture



The last Concorde to fly has completed its final journey to Aerospace Bristol, a new £19m museum that opens in Filton this summer. Engineers from British Airways and Airbus conducted the move, in which Concorde Alpha Foxtrot was manoeuvred into a new purpose-built hangar.



Prize crossword

When completed rearrange the highlighted squares to spell out a way to change electromagnetic wave characteristics. The first correct answer received will win a £20 Amazon voucher. Email your answer to jon.excell@centaur.co.uk

Across

- 1 Long thick piece used in construction (4)
- 3 Cover something tightly with heated plastic (10)
- 9 Withdrew money with a written order (7)
- 11 Smallest possible quantity (7)
- 12 Person politically undecided (8,5)
- 14 Small glass lamp (5,4)
- 16 Any system of principles (5)
- 17 Follow in consequence (5)
- 19 For a limitless time (9)
- 21 Area within a town that has some distinctive features (13)
- 24 Soldier's temporary camp (7)
- 25 Assume a reclining position (3,4)
- 26 People who change location (10)
- 27 Minute particle (4)

Down

- 1 Put excavated material back into a hole (10)
- 2 Lasting through all time (7)
- 4 Was dressed in (3,2)
- 5 Property consisting of houses and land (9)
- 6 Force exerted by a moving body (7,6)
- 7 Deep regret and guilt (7)
- 8 Flow intermittently (4)
- 10 Most modern, very latest (2-2-3-6)
- 13 Polyvalent element used to strengthen and harden steel (10)
- 15 Not conforming to approved standards of behaviour (9)
- 18 Lubricating fluid secreted by a joint membrane (7)
- 20 Elevated post affording a wide view (7)
- 22 Tanker ship (5)
- 23 Lie adjacent to another (4)

February's highlighted solution was Actuator. Winner: **Nigel Hill**

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