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The engineers working on the helicopter of the future



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our opinion

Chop and change

From the flying pancake to the Caspian Sea monster (look them up, they're real) the history of manned flight boasts more than its fair share of bizarre technological dead-ends. But while most of the sector's more eccentric innovations never quite took off, some endured, and perhaps the most notable example of this is the helicopter, the subject of this issue's cover story (p22).

In the early 20th century, as engineers puzzled out powered flight, there was, it could be argued, something of an inevitability to the development of fixed-wing aircraft: the manifestation of efforts to harness the aerodynamic phenomena exploited by natural flyers.

The same can't be said of the helicopter. Indeed, if the wings of an aircraft work in harmony with the elements, the rotors of a helicopter do the opposite: chopping at the air in their noisy battle with gravity. Even the largest passenger aircraft can theoretically glide to a safe landing. But cut the power to a helicopter and it falls from the air.

And yet, more than 80 years after the first operational helicopter took to the skies, the vehicle remains more popular than ever: its unparalleled agility endearing it to pilots, and driving continued growth in sales across a range of sectors.

"More than 80 years after the first helicopter took to the skies, the vehicle remains as popular as ever"

In this issue's special report we take a look at a fascinating concept currently under development by engineers at Airbus that could shore up the helicopter's popularity for many years to come.

Thanks to some ingenious and pretty fundamental changes to the way the helicopter is kept aloft and propelled, the new craft, which enters the mission demonstrator phase this year, promises to be the fastest, most efficient vehicle of its kind ever built and is at the heart of Airbus's stated ambition to "drive a bold vision for the future of rotorcraft".

Elsewhere in this issue we take a look at the way in which the electric vehicle industry is driving the development of batteries for domestic energy storage (p26) and also touch on the career opportunities created by the UK's vast pipeline of planned infrastructure projects (p62). ☺

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ROBOTICS

Good things come in small packages

Product design firm launches one of the smallest-known surgical robots HELEN KNIGHT REPORTS

Cataract surgery is the most commonly performed procedure in the world, restoring sight to 20 million people each year.

But the procedure is currently performed by hand, using a pair of surgical tweezers and a microscope. This can result in complications, as the delicate nature of the surface of the eye means it can be easily damaged.

Now engineers at product design firm Cambridge Consultants have shown that the procedure could soon be carried out robotically, thanks to the development of one of the smallest known surgical robots.

Axisis, developed by the company's engineers to demonstrate the technology's potential, has a body the size of a soft drinks can, and can manipulate surgical instruments of 1.8mm in diameter.

As well as performing cataract operations, the robot could also be

used for other minimally invasive procedures, such as implanting neurostimulation devices, early cancer intervention, and oesophageal and gastrointestinal tract operations.

Existing surgical robots are typically large devices, since they have to control long, straight instruments that must be fed through small holes in the patient, necessitating a large range of motion on the outside of the body, said Chris Wagner, head of advanced surgical systems at Cambridge Consultants.

In comparison, Axisis can manipulate tiny, flexible instruments. "Right now [surgical robots] can handle arteries and blood vessels, but we want to move to the next generation, where they can handle fine nerves and even finer blood vessels," said Wagner.

The robot's instruments are controlled by an actuator consisting of a channel surrounded by four high strength mechanical cables.

"We have high strength cable running through guide channels, which go up through a series of rolling metal

link mechanisms out to the end, where the grasper is located," said Wagner.

The 110µm cables each run through 150µm guide holes. Depending on which of the cables is pulled, the instrument can be moved, up, down, left or right.


"The cables provide tension and articulating force," he said.

In order to ensure the robot could be kept as small as possible, the engineers designed the articulating mechanism to be as efficient as possible, in order to minimise frictional losses. In this way they were able to reduce the size of the motors needed to drive the cables, said Wagner.

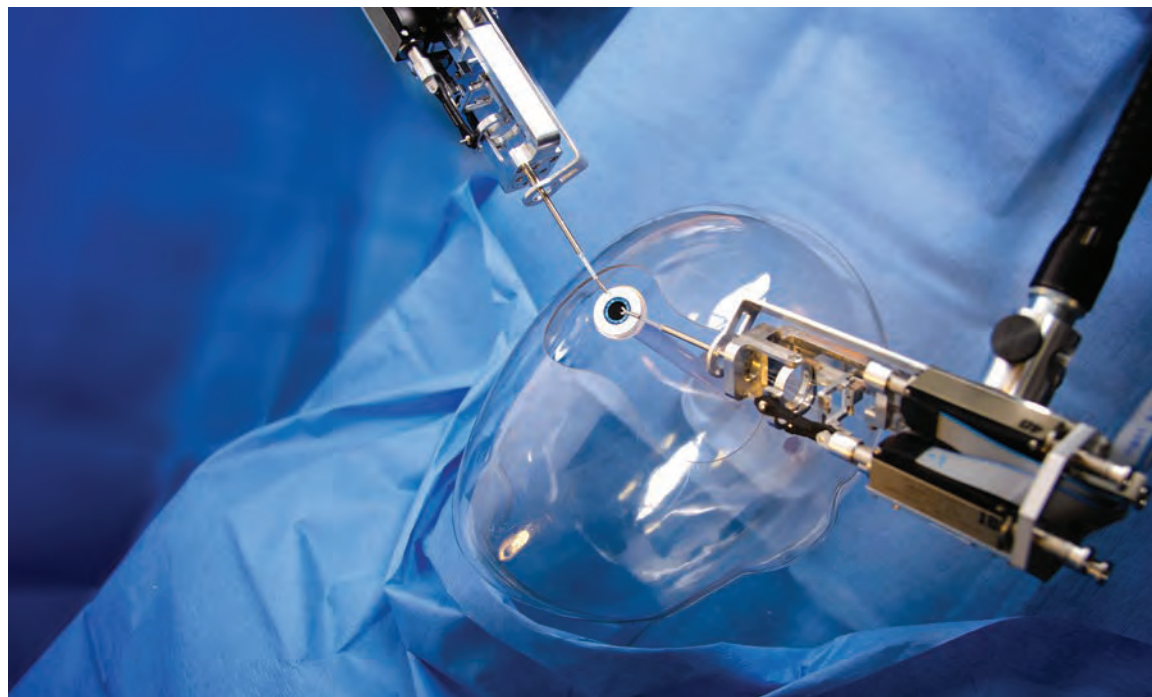
This high efficiency also allows the device to relay forces encountered by the tips of the instruments back to the actuator, meaning it can be used to provide feedback.

"The forces that are encountered by the tip are transmitted up through the cable into the actuator," said Wagner. This means that any forces interacting with the tips of the instrument can be felt by the surgeon operating the device, giving them a sense of touch.

Depending on the design of the instruments used, the robot could allow the size of the minimally invasive access point on the patient's body to be reduced.

Smaller robots also mean surgeons could ultimately work with a range of tools, and get closer to the patient without large equipment getting in their way. 

Smaller robots mean surgeons could ultimately get closer to the patient



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AEROSPACE

Europeans are still moving into space

UK is also set to invest heavily into European space programme STUART NATHAN REPORTS



Funds have been pledged to the European Space Agency

Europe has reaffirmed its commitment to the ExoMars mission, Earth observation and the International Space Station as funds are pledged to the European Space Agency (ESA).

The UK is to invest heavily in space programmes agreed at the ESA ministerial meeting in Lucerne in December 2016. The UK Space Agency is to spend a total of €1.4bn on ESA missions over the next five years. British-built satellites for

Earth observation, navigation, and telecommunications will receive €670.5m of investment, while a climate-change monitoring programme based at Harwell in Oxfordshire will receive €23m. Despite a setback with a crash landing of the experimental Mars lander Schiaparelli in 2016, the ministers also decided to commit €82.4m to the next phase of the ExoMars programme, due to launch in 2020, whose rover component will be built in the UK.

ESA has also committed to taking part in the International Space Station

programme until 2024, which will take it up to the end of the station's proposed lifetime. This means there will be further official ESA astronaut missions to the ISS.

The agency had asked the Council of Ministers of the 22 member states to fund €11bn-worth of projects, and after a day and a half of discussions, €10.3bn funding was approved. The ministers agreed to meet the shortfall of €436m for the ExoMars programme, which is a joint venture with the Russian space agency Roscosmos, with the two leading European nations on the project, the UK and Italy, supplying the largest amounts (€82m and €171m, respectively). The UK put the largest amount of all the nations into climate observation, making it the lead nation in this sector, as well as telecoms and navigation, where it held the lead status prior to the meeting.

Future projects that have yet to be fleshed out include a deep-space habitat, which will orbit the null gravitational point between the Earth and the Moon, and act as a staging point for future lunar missions. Planned as a 'next stage' after the ISS project ends, the habitat is being discussed by ESA and NASA, and earlier this year was mentioned as a target for the next decade. However, this was beyond the scope of the current ministerial meeting.

ESA's head of human and robotic exploration, David Parker, previously chief executive of the UK space agency, said that the science represented by ExoMars is compelling. "Nobody else is doing the science that is planned for ExoMars, drilling below the surface of the planet for the first time and actually directly looking for signs of past life," he commented. ☉

Newsinbrief

Winds of change

The opening of a new Siemens' offshore wind plant in Hull has been hailed as a major step forward for the UK's offshore wind sector. The £310m redevelopment of Alexandra Dock by Siemens and Associated British Ports will create 1,000 jobs, 700 of which have already been filled. The site includes a factory that will manufacture blades 75m long, and a dockside plant assembling turbine towers 82m tall.

Child's play

Researchers have used graphene to make the children's toy Silly Putty conduct electricity, a development that could lead to extremely sensitive sensors. The research, led by Prof Jonathan Coleman, Trinity College Dublin and in collaboration with Prof Robert Young of Manchester University, potentially offers applications in new, inexpensive devices and diagnostics in medicine and other sectors.

Next-gen manufacture

AECOM and Nottingham Trent University have launched a new partnership agreement, with the aim of developing new products, processes and services for the industrial sector. They said they will jointly pursue research and development opportunities in areas that could include offsite manufacture and the modularisation of production facilities, process optimisation, Industry 4.0, and energy and water use in production.

Carry on Tata

Tata Steel UK will continue operations at its blast furnace in Port Talbot following an agreement with trade unions on proposals to reform workers' pensions. The proposal came eight months after Tata announced its intention to sell UK steel assets.

RENEWABLES

Flying a kite for new investment in wind power

System based around two kites flown up to 450m

JASON FORD REPORTS

Britain's sole player in the kite power market has secured £5m of new investment to support development of its high-altitude wind-power generation technology.

E.ON, Schlumberger and Shell Technology Ventures (STV) have made the investment into Kite Power Systems (KPS), whose power system has two kites that are flown to an altitude of up to 450m. A tether is attached to a winch that generates electricity as it spools out; by achieving flight speeds of up to 100mph in 20mph winds, the kite's tether tension causes the line to swiftly spool out from a drum, which turns a generator to produce electricity.

KPS claims its technology can reduce expenditure of conventional offshore turbines by as much as 50 per cent as its patented power system doesn't require large quantities of steel or specialist installation vessels.

According to KPS, the lower cost means that kite power generation would not need government subsidies and could be deployed in UK and Irish waters, and in waters up to and potentially deeper than 40m found offshore of countries including Portugal, Japan and the US.

This latest investment will support KPS's plans to deploy a 500kW onshore power system at West Freugh in south west Scotland in 2017, leading to a planned onshore demonstration array of multiple 500kW systems within the next three to four years. Thereafter, KPS will develop a 3MW onshore system at West Freugh and then deploy a similar-sized power system offshore. ☉

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MATERIALS

Supercapacitors get supercharged

Research looks at polymer that could have applications in electric vehicles JASON FORD REPORTS

Research into bionic limbs has led to the validation of a material that could lead to very high-density supercapacitors with applications in electric vehicles to biosensors.

The two-year research project was conducted at Surrey University and overseen by Dr Donald Highgate, co-founder of Augmented Optics, the company that commissioned the study.

Jim Heathcote, chief executive of Augmented Optics and subsidiary Supercapacitor Materials, explained that he and Highgate were interested in developing a new polymer "with interesting electrical properties" that could, among other applications, facilitate an ion electron interface in prosthetic limbs.

"Biological systems use ions to transmit signals to muscles through the nerves," said Heathcote. "If a soldier loses a limb, current technology is based on electronics, and prosthetics do not link to the nervous system. An ion electron interface would mean we would be

"An ion electron interface would mean we could have bionics"

Jim Heathcote,
Augmented Optics

able to put a nerve contact device which links to a prosthetic, so you could have biocompatible ionics [bionics]."

The polymers – which are based on large organic molecules composed of many repeated sub-units and bonded together to form a three-dimensional network – were sent to Bristol University for independent assessment.

According to Heathcote, the report stated that the materials were characterised by geometrical capacitances of the order of 0.01 Farad per square centimetre. These values are three or four more orders of magnitude larger than the geometrical

capacitance of carbon electrodes in conventional electrolyte solutions.

"So we've found some materials that are showing 1,000 to 10,000 times the capacitance of conventional electrolytes and supercapacitors," he said. "We've discovered these remarkable properties and now we have to build a supercapacitor so that we can check and verify that the properties reported in the testing translate into some kind of energy density improvement in the supercapacitor."

If successfully translated, the development could lead to very high energy density supercapacitors that make it possible to recharge mobile phones, laptops or other mobile devices in seconds. The technology could also impact aerospace, energy generation, and transportation, particularly in electric vehicles where recharge times could be slashed and vehicle architecture rethought to accommodate smaller power sources.

Commercial partners are now being sought to further develop the material's potential. ☉



Electric vehicle recharge times could be slashed

ENERGY

Cleaner gas turbines are on the cards

Study looks at combustion of methane when it burns

STUART NATHAN REPORTS

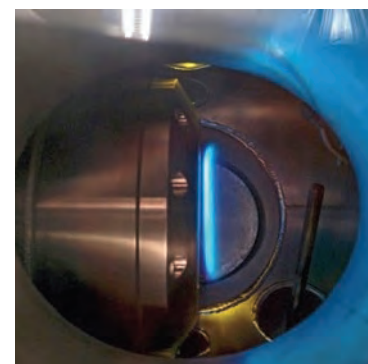
A study of the combustion of methane and the compounds formed when it burns could lead to the development of cleaner gas turbines for power stations, according to researchers from the King Abdullah University of Science and Technology (KAUST).

By-products from complete combustion are non-toxic carbon dioxide and water vapour. However, if the hydrocarbon is not completely combusted, then toxic products may form, including soot.

One technique used in power stations to ensure clean combustion is to apply an electrical field across the flame; this reduces the production of pollutants, although the mechanism for this is not clear. Researchers at KAUST studied exactly what compounds are formed when methane burns in air.

Led by Aamir Farooq, the team set up a McKenna burner, which produces a flat flame from a stream of methane, oxygen and argon. Above this it set a molecular beam mass spectrometer, with which it hoped to detect positively charged particles in the combustion products. There are fewer of these than there are of neutral atoms and molecules, but tend to be reactive and therefore undesirable.

"Controlling the charged particles allows a leaner, higher air-to-fuel mix, flame to be burned at lower temperatures, providing a more efficient combustion of the fuel and a reduction in the production of pollutants," said Farooq. ☉



AEROSPACE

Unmanned in the Jetstream

Test flight will trial the capability of aircraft's autonomous technologies

A Jetstream 31 aircraft is being used as a testbed for the next phase of BAE Systems' unmanned aircraft trials.

Over 17 test flights from Warton, Lancashire, to Inverness, the company will test the capability of its autonomous technologies to control the Jetstream via satellite link. Two pilots will be on board to operate the

aircraft for take-off and landing, along with two engineers to assess the performance of the unmanned systems.

Support on the ground will come from a flight test observer and an unmanned air vehicle commander, as well as air navigation service provider NATS.

The Jetstream is fitted with an antenna that detects transponder signals from other aircraft. A cockpit-mounted camera links to the onboard computer systems and enables the aircraft to 'see' potential hazards even in the absence of signals. It can also recognise different cloud types and, when required, adjust course to avoid adverse weather. **AW**

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MEDICAL & HEALTHCARE

Test could help to curb baby deaths

UK firm develops tool in fight against NRDS, which affects premature babies HELEN KNIGHT REPORTS

A life-threatening condition that affects half of all premature babies born before 32 weeks could be detected by a diagnostic test being developed in the UK.

Neonatal respiratory distress syndrome (NRDS) is the most common cause of death in premature babies, and is caused by deficiency of surfactant in under-developed lungs.

The condition, which also affects 1 per cent of babies born at full term, prevents the lungs absorbing enough oxygen, and can lead to complications such as chronic lung changes and bleeding in the brain.

The syndrome can be treated with administration of surfactant. However, the treatment can damage a baby's sensitive airways if given incorrectly.

Now, a highly sensitive test that uses a near-infrared scanner and machine learning to detect surfactant levels in babies' gastric fluid has been developed to predict those that will go on to develop NRDS.

The tool, being developed by Stevenage-based SIME Diagnostics, takes about five minutes to produce a result, according to chief executive Povl Verder. It was recently published in the journal *Acta Paediatrica*.

Verder said: "Babies may seem fine at birth, but then if they are left for a couple of hours they can suddenly

become ill with respiratory distress syndrome, where they are not able to absorb enough oxygen."

The test is non-invasive, using a sample of waste gastric fluid that doctors routinely remove by suction from premature babies in order to clear their airways, Verder said.

A near-infrared light source is targeted at the sample, causing the molecules within it to vibrate. Each type of molecule will vibrate at a different frequency.

"The light source will generate a

"The test can be done with minimal training, using a tablet computer"

Povl Verder,
SIME Diagnostics

biochemical signature of everything in the sample," Verder said.

A cloud-based machine-learning system is then used to analyse this signature, to identify the presence, or lack, of surfactant.

The test can be carried out with minimal training, using a tablet computer, Verder said.

The company is carrying out further engineering work to optimise the tool for use as a bedside test within neonatal intensive care units. ©



The test could offer significant help to the health of premature babies

MEDICAL & HEALTHCARE

Next-generation surgery

UCL wins £13m award to develop new surgical centre

University College London (UCL) has been awarded over £13m from Wellcome and the Engineering and Physical Sciences Research Council (EPSRC) to develop a special centre focused on the development of new surgical technologies.

The Wellcome/EPSRC Centre for Surgical and Interventional Sciences at UCL will bring together a team of engineering and clinical experts working to develop a range of new technologies. It will have a particular focus on intraoperative imaging and sensing, data fusion and extraction, human-technology interfaces, tissue modelling, interventional



Surgical technologies will be explored

instrumentation and surgical navigation. It's hoped that advances in these areas will help create an intuitive and highly personalised surgical platform that enables more precise, less-invasive procedures.

Greater precision will also mean more patients will be viable for life-altering surgery and those treated are expected to benefit from safer, more localised treatments. **JE**

MEDICAL & HEALTHCARE

Algorithm set to cut Parkinson's diagnosis time

MRI scans analysed to detect pigment changes

STUART NATHAN REPORTS

An algorithm that analyses MRI scans could be the key to a new method for diagnosing Parkinson's disease, according to researchers at Nottingham University.

The method would work by detecting changes in a pigment that is characteristic to the brains of people suffering from Parkinson's.

Parkinson's disease is difficult to diagnose. Currently, specialists observe patient's symptoms and

conduct tests, but none of them are perfect. Waiting for a diagnosis of Parkinson's can be lengthy and stressful, and further damages the patients' health.

The cells in the part of the brain responsible for movement contain a pigment called neuromelanin, which makes them appear dark in scans. In Parkinson's patients these cells die off, which makes the dark pigmentation disappear. However, this has not been used as a diagnostic test before because there are many different sorts of MRI machine whose sensitivity to the changes in neuromelanin varies. The Nottingham team, led by Dr Stefan Schwarz, has devised an algorithm that compensates for the different types of machine. "This means that the brain-scan technique will be accurate regardless of what machine is being used," Schwarz said. The team discusses its research in the journal *Radiology*.

The analysis method could also be used to track the progression of

disease and determine how severity of symptoms is linked to changes in the brain, one of the factors in Parkinson's that is still not clear.

Dr Beckie Port, Parkinson's UK, said: "This research is hugely promising. This could reduce the delays and distress people experience waiting to find out whether or not they have Parkinson's." ©

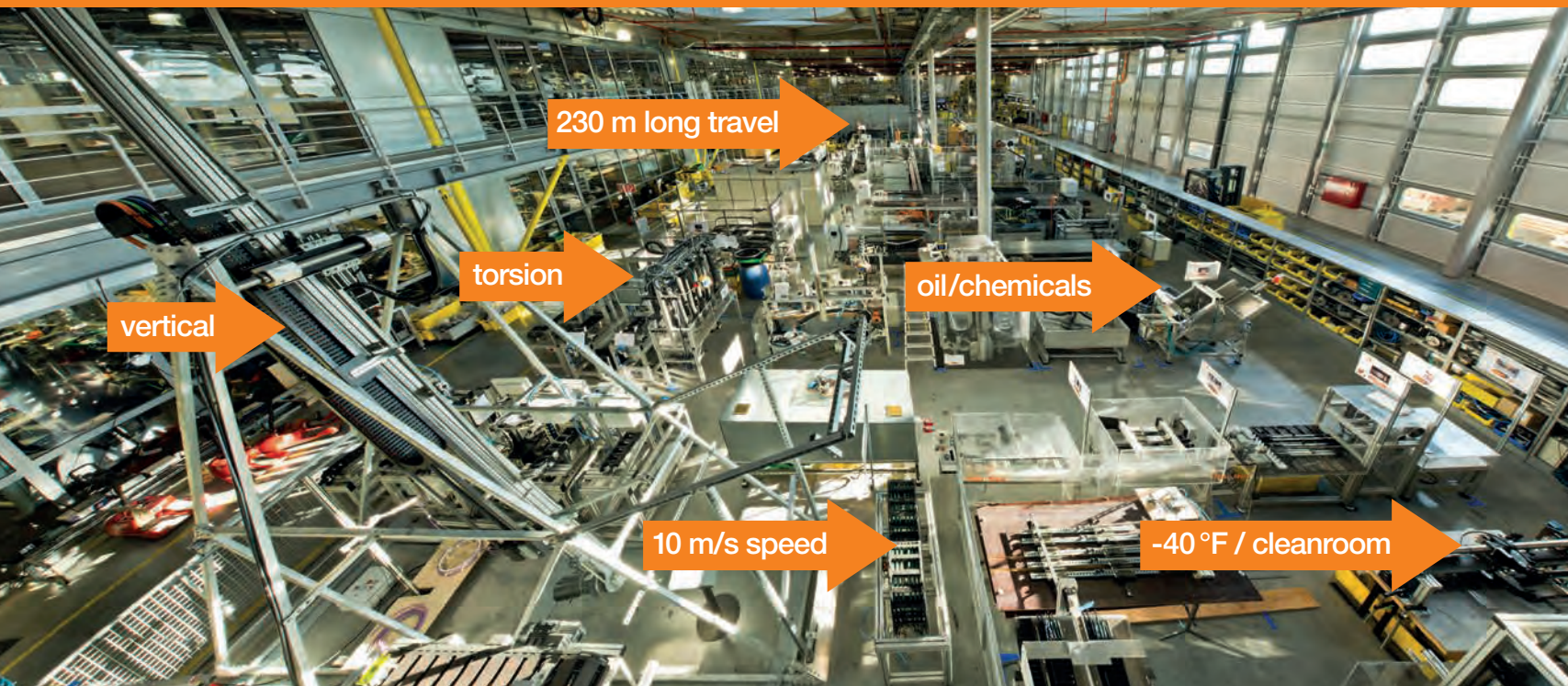


Algorithms could speed up Parkinson's diagnosis

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ENERGY

Positive approach to high-rise homes

Solar panels are designed to produce more energy than they consume HELEN KNIGHT REPORTS

Environmentally friendly high-rise apartments that generate more energy than they consume could soon be built, thanks to a concept designed by researchers in the Netherlands.

The energy-positive apartment block, dubbed the Concept Urban Villa, was developed in a project led by Prof Mick Eekhout at TU Delft.

A façade of black solar panels fitted to the south-, west- and east-facing sides of the block generate energy, while the building has a timber frame to minimise its environmental footprint.

Material made from waste paper is used to insulate the building.

In the Netherlands, all new housing will have to be at least energy-neutral by the end of 2020, as part of the country's response to increasingly stringent EU environmental regulation.

Despite efforts to design more environmentally friendly individual houses, very little is being done to develop energy-neutral apartment blocks, said Eekhout, who presented the concept at Climate KIC in Frankfurt.

The concept is an attempt to show the construction industry what is possible with technology, he said.

"We wanted to show the building

industry an extreme example of the vision that we should have in order to comply with the European ambitions of 2020, 2030, and 2050," he said.

To generate enough energy to power each apartment, the solar panels have to be fitted to the façade of the building, rather than on the roof as in most houses. But the advantage of this design is that it allows additional floors to be added to the concept without putting a strain on the amount of energy available.

"So once I have shown that by putting the solar panel cladding on the east, south and west façades the urban villa works as I predict, then the next step could be to go from four storeys to eight or 12 storeys high, because in this system the façades will take care of the energy, rather than the roof, so in theory you can simply extrude the building," he said. "Then you have a possible solution for high-rise buildings."

Prof Eekhout is now looking for construction companies to join a consortium, and hopes to find a location to build a four-storey apartment block demonstrator. ■



Energy-positive apartment blocks are not a tall order for researchers in the Netherlands

AEROSPACE

Solar-powered aircraft flies high

Designer wants to be first person to reach stratosphere, with initial tests scheduled for February

SolarStratos, a solar-powered aircraft designed to reach the stratosphere, has been unveiled at a ceremony in Payerne, Switzerland.

Weighing 450kg, the two-seater aircraft has a wingspan of 24.8m and is covered with 22m² of photovoltaic panels, operating with a cell efficiency

of 22 to 24 per cent. These power a 32kW electric motor, which drives the 2.2m propellers. Lithium-ion batteries provide 20kWh of storage.

The project is the brainchild of Raphael Domjan, who aims to be the first person to reach the stratosphere in a solar-powered aircraft, flying to more than 80,000ft.

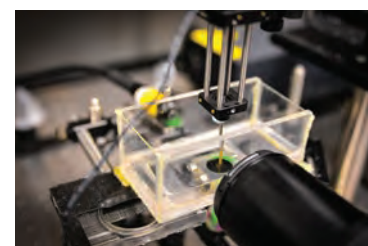
Initial test flights are scheduled for February, with medium-altitude flights planned for the summer. The first stratospheric flights are slated for 2018 and will take approximately five hours, including 15 minutes at the edge of space where the stars will be visible in daytime, and the temperature will be -70°C. **AW**

MEDICAL & HEALTHCARE

Making waves with ultrasound printed lenses

3D method means sharper images can be produced

STUART NATHAN REPORTS



Resin lenses give a clearer picture

Ultrasound waves in medicine can be enhanced by directing them through 3D printed lenses, claim researchers at Nanyang Technological University in Singapore.

The resin lenses allow the waves to be brought to a much sharper focus compared with glass lenses, which produces better images and will allow clinicians to work with greater control and precision.

Ultrasound beams are produced by firing high-frequency sound waves at a lens, which focuses the waves. Conventionally, these lenses are made of glass and are cylindrical or spherical. Because of these relatively simple geometries, the lenses cannot focus the beams tightly onto a target.

Using 3D printing to make resin lenses allows more complex geometry to be incorporated into their shapes, which means the ultrasound can be focused onto multiple sites or shaped to direct energy in a particular way.

Associate Prof Claus-Dieter Ohl of Nanyang's School of Physical and Mathematical Sciences, who led the multidisciplinary team behind the research, said: "3D printing reinvents the manufacturing process, enabling the creation of unique and complex devices. This is an exciting discovery for the scientific community as it opens new doors for research and medical surgery."

As well as being used to image inside the body, they could also be used in ex-vivo research, Ohl suggests; for example, to measure the elastic properties of cancerous and healthy cells growing in a Petri dish: this could be used to help distinguish tumours from healthy tissue in subsequent scans. ■

SECURITY

Exposing the hidden threat

Camera system can detect concealed weapons before people reach checkpoints HELEN KNIGHT REPORTS

People arriving at airports, train stations and sports stadiums can be scanned for concealed weapons or contraband substances before they even reach a checkpoint barrier, using technology developed in the UK.

Digital Barriers, a UK-based intelligent vision specialist, recently signed an agreement with the US Transportation Security Administration (TSA) to enhance the capability of its ThruVis camera system for detecting weapons and concealed explosives at the nation's airports.

ThruVis is a highly sensitive camera capable of spotting objects hidden under clothing, such as a suicide vest, from up to 10m away. It can be operated remotely as people walk through a crowded area, without the need to stop them, and is small enough to be installed on the roof of airport buildings to scan passengers below, according to Richard Revis, senior manager at Digital Barriers.

"You can screen people before they reach a checkpoint because there may already be quite a large group of people at the checkpoint, making it a sensitive spot," he said.

The system is based on the use of terahertz radiation. Terahertz energy reflected from people's bodies passes through clothing. But any objects concealed underneath their clothing will show up in contrast on the screen.

The company has also developed a facial recognition technology called SmartVis, which is capable of scanning a large crowd of people to identify those on terrorist watch-lists, for example. SmartVis, which works with off-the-shelf video cameras, first uses a neural network-based system to

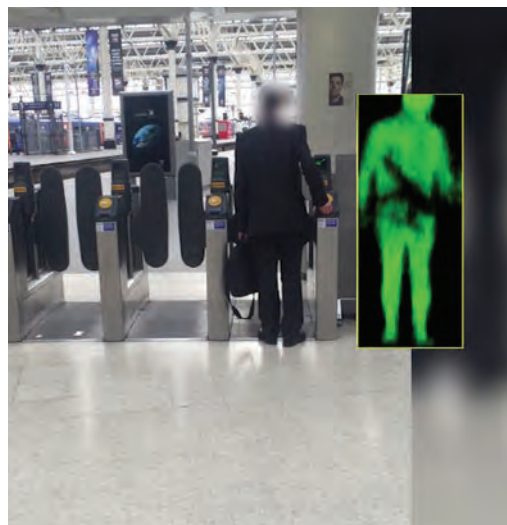
"The computer teaches itself the relevant facial features"

Richard Revis,
Digital Barriers

spot faces within the frame. In a follow-up step, known as meta data extraction, the software extracts characteristics from each face, which can be used to match against, said Revis.

"For the matching step, we use a machine learning-based technique, which has been trained on very large databases of faces," he said. "So instead of a person having to figure out which features of a face make it an individual, the computer can look at this enormous library of faces and teach itself which features in it are the most relevant for telling two people apart."

The system then repeatedly applies this model to all the faces that it has found in the frame, he said. ©



People can be screened before a checkpoint

MANUFACTURING

The flexibility factor

New modular design could cut tooling costs in aerospace and other industries

The Advanced Manufacturing Research Centre in Sheffield has developed what is believed to be the world's first carbon composite reconfigurable machine tool.

Light in weight and made using a modular design, the tool can be easily moved around by two people and, according to the AMRC, could reduce tooling costs in aerospace and other industries.

The tool was developed in collaboration with system manufacturer Exechon, which specialises in a type of machine tool using a system known as parallel kinematics. Rather than mounting all

the axes of the machine in a row, with the 'end effector' that holds the cutting or milling tool on the end, parallel kinematics mounts the end effector between two movable arms that hold the workpiece and move it through the X, Y and Z dimensions.

Proponents of the system say it can move as flexibly within the same volume as conventional serial linkage types of machine tool, but with greater accuracy. **SN**

The new AMRC machine tool



MEDICAL & HEALTHCARE

X-ray imaging that can detect cancer earlier

System can spot smaller cracks and defects

HELEN KNIGHT REPORTS

Cancerous tumours could be spotted earlier with X-ray imaging technology developed by researchers in the UK.

The technique – phase-contrast X-ray imaging – has been developed in a five-year, EPSRC-funded project, led by University College London (UCL).

Rather than measuring the extent to which tissue or materials absorb radiation – as in conventional X-ray imaging – the technique measures the physical effect that passing through different types of tissue or material has on the speed of the X-ray itself.

The technique can also spot smaller cracks and defects in materials than conventional X-rays, as it is excellent at determining different shapes and types of matter. The technique has previously been limited to large-scale synchrotron facilities such as Oxfordshire's Diamond Light Source, according to UCL's Prof Alessandro Olivo, who led the project.

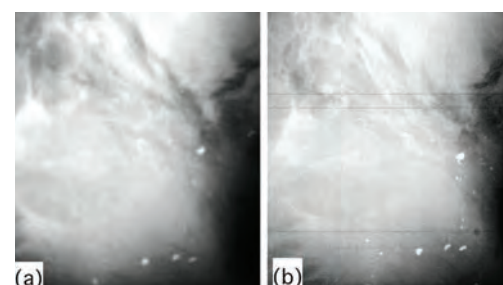
"We've now advanced this embryonic technology to make it viable for day-to-day use in medicine, security applications, industrial production lines, materials science, non-destructive testing, the archaeology and heritage sector, and a whole range of other fields," he said.

The technology has been incorporated into a prototype security scanner by Nikon Metrology that has been designed to detect concealed weapons and explosives.

And in a new three-year project, supported by the Wellcome Trust, the Nikon Metrology/UCL team will develop a prototype scanner for breast cancer surgery in collaboration with Barts Health and Queen Mary University of London, which should help surgeons determine the exact extent of the malignancy and reduce the need to recall patients for further operations.

The technology can also detect tissue types invisible to conventional X-ray machines, such as cartilage, and there are plans to commercialise this aspect of the technology. ©

Images of tumours Image: Prof Olivo



THE MAGNIFICENT SEVEN

THE SEVEN PRESTIGE AWARDS FROM THE IMechE CHAMPION THE INDIVIDUALS WHO HAVE HAD OUTSTANDING ROLES IN ADVANCING MECHANICAL ENGINEERING. LAST YEAR'S INSPIRATIONAL RECIPIENTS TELL US ABOUT THE EFFECTS OF WINNING AS WE LOOK FORWARD TO 2017'S ENTRIES

First awarded more than 70 years ago, the prestigious James Clayton Prize for advancing modern engineering science was won last year by **Anne Neville** for her work on corrosion, lubrication and wear.

Neville has attracted £34 million of research funding during her career, and has countless patents and publications for her work in these fields. The applications of her research can be found in the oil and gas and the marine sectors as well as in biomedicine.

Her recent work on artificial hip joints has shown that corrosion is a highly significant factor in their total degradation, a factor that had been ignored for many years. She says: "The fundamental principles of tribo-corrosion for the oil and gas environment are similar to those in hip joints, and it is crucial to understand the science in order to solve the problem in both environments."

Neville enjoys talking to secondary school pupils about science and engineering. "It is important that school children at all levels are informed about engineering," she says. "I want the profession to be inclusive, and for young people to see that engineering is a great career choice.

"I see lots of very able girls choosing to do engineering at university. If we are



Anne Neville and Hiroshi Yabuno

to make a step change in the number of women engineers, we need to encourage all girls to have the confidence to make this their career choice and break down the idea that engineering can't be combined with a happy family life."

Neville describes winning the James Clayton Prize as one of the "major highlights" of her career. "It's great to see mature fields like corrosion and tribology producing some of the best engineering science and tackling problems," she says.

"This is only possible by having some of the most fantastic PhD students, postdoctoral researchers and collaborators. I have been lucky to work with talented engineers and scientists across disciplines."

Diversity is a key criterion for another Prestige Award, the Verena Winifred Holmes Award, which commemorates the first female member of the IMechE. The definition of this award is broad, to allow for a wide pool of potential candidates, who will have shown to have appreciated the "value difference" offered by diversity and inclusivity in engineering.

The last Verena Winifred Holmes Award was presented to **Yassmin Abdel-Magied**, a young Muslim woman in Australia who works in the oil and gas sector, for her efforts to encourage diversity in engineer-

ing. Abdel-Magied, who has a first-class degree in mechanical engineering, says: "It is incumbent on you to encourage others, as we all play a part in creating the ideal future. It is the duty of all engineers to support diversity."

"The award acknowledges the work of Youth Without Borders and highlights the importance of diversity and inclusiveness in our world. Hopefully it will also allow us to reach more people with the message that we should all get involved in making our society and our industry as diverse, inclusive and awesome as possible."

The Alastair Graham-Bryce Award was won by **Paul Stinchon** in 2016 in recognition of his work to encourage young people to enter the profession. Stinchon, a manufacturing systems engineer, has developed a programme for students to visit his workplace, the Rolls-Royce aerospace plant at Barnoldswick, Lancashire.

He recruited 15 volunteers to help deliver the visits, as well as presentations, videos and information sheets. The initiative has proven popular with local schools and they conduct eight visits a year, introducing 500 children to the opportunities and benefits of a technical career.

Stinchon says engineers at Rolls-Royce have a renewed pride in what they are doing, as they demonstrate the world-class engineering processes. "By showcasing what we do we can have a positive impact on young people," he says.

The Thomas Hawksley Gold Medal was won in 2016 by **Hiroshi Yabuno** and four colleagues for their paper "Theoretical and experimental analyses on stabilisation of hunting motion by utilising the traction motor as a passive gyroscopic damper", which explores a novel method for increasing speed on railways.

Meanwhile the George Stephenson Gold Medal was won by **Bridget Eickhoff** and seven colleagues for their paper "Track loading limits and cross-acceptance of vehicle approvals", which reports on a major piece of work carried out by a



Bridget Eickhoff and Paul Stinchon

2017 PRESTIGE AWARDS

- The £10,000 James Clayton Prize recognises a recent exceptional contribution to mechanical engineering and related science and invention.
- The £5,000 Alastair Graham-Bryce Award is presented to an individual or group for encouraging young people into engineering careers.
- The £1,500 Verena Winifred Holmes Award is for demonstrating the value of diversity and listening to and respecting the perspectives of others.
- The Thomas Hawksley and George Stephenson Gold Medals are awarded for the best original research papers published by the institution.
- The Award for Risk Reduction in Mechanical Engineering is worth £1,500.
- The James Watt International Gold Medal is presented every two years to an eminent engineer who has attained worldwide recognition in mechanical engineering. It will be awarded again in 2018.

consortium of companies and universities to deal with key railway interoperability issues in vehicle dynamics and vehicle-track interaction.

Eickhoff says: "This award is recognition of the value of the project to the industry. The contributors worked to produce valuable results that will enable more cost-effective introduction of new and modified railway vehicles."

Seibum Choi and two colleagues received the Award for Risk Reduction in Mechanical Engineering last year for their paper "Integrated vehicle mass estimation for vehicle safety control using the recursive least-squares method and adaptation laws". The paper describes an integrated set of estimation algorithms that work together, combining measures of longitudinal and lateral vehicle dynamic behaviour to give a mass estimation.

Choi says: "I have dedicated my entire career to enhancing vehicle safety and energy efficiency. This award draws attention to these seminal topics."

Finally, 2016's James Watt International Gold Medal was awarded to **Professor Dame Ann Dowling** for her work with low-emission combustion and noise reduction in cars and aircraft. Dowling is professor of mechanical engineering at Cambridge University, a non-executive director at BP, a board member at the Department for Business, Energy and Industrial Strategy, and a technical consultant at Rolls-Royce.

Her career spans from working on the aero-acoustics of Concorde to leading the Silent Aircraft Initiative, a more recent collaboration with Massachusetts Institute of Technology. A staunch advocate of encouraging women to join the profession, she believes strongly in the contribution that engineers can make to society.

She says: "The main challenges for engineers are how to make sure that all the world's population can have the same standard of living that we enjoy in the developed countries. Engineers need to help provide that in a sustainable way."

The closing date for all applications is 31 March 2017.

Visit www.imeche.org/prestigeawards



Keep government's feet to the fire

The government's rediscovery of industrial strategy should not blind us to the scale of the challenges that still lie ahead

It is greatly reassuring that Theresa May's government has rediscovered industrial strategy. But there is little sign, yet, that it understands the engineering underpinnings required for a strong manufacturing sector and communications infrastructure. And at a time when it is crucial to tackle the long-term underlying fundamentals of the economy, the government will now spend several years immersed in the details of Brexit negotiation.

The long-standing failure of government and the educational establishment to understand the importance of engineering has left the country with major gaps in the chain of skills. All the evidence we have is that there are potentially very large gaps between supply and demand at most levels. At the graduate level many of our engineering schools are being kept afloat by overseas students. Yet the Home Office obsession with curbing net immigration numbers has meant there is little encouragement and much discouragement for overseas students to stay behind after graduation.

Brexit threatens to make this problem worse since the use of European talent to plug the gaps in recruitment will now become more difficult given the over-riding preoccupation of the prime minister with reducing immigration, regardless of economic cost.

It is, of course, desirable to produce home-grown talent but that requires years, if not decades, of preparation. The level of maths performance in

British schools remains very poor as has been painfully demonstrated in the annual OECD Pisa rankings, which has the UK at 27th, a decline of one place since last year and way behind Germany, Japan and most members of the EU. Despite more education spending per head than most comparable economies, the UK demonstrates low levels of attainment and high inequality; and we seriously underperform relative to countries with similar cultural traditions such as Canada. Until we get a pipeline of mathematically literate school leavers, the scope for boosting the supply of high-quality engineering students is limited.

Then there is the strange gender bias that results in the UK having the worst record in Europe for recruiting women to study engineering. As secretary of state I used the bully pulpit to draw attention to this anomaly. There has been a lot of effort put in to change perceptions. And there are some impressive female role models emerging. But the image of engineering as being all about dirty, smelly, noisy factories and macho men persists, and is a major impediment to recruitment.

And when engineering graduates do emerge there is the temptation – to which almost half succumb – to move across to jobs that offer more lucrative short-term rewards. I am not in a strong position to preach here having abandoned the science trips at Cambridge for economics but I understand the problem. Our very strong finance sector offers tempting short-term rewards although that may be a waning influence as the banking industry hits up

“The image of engineering as being all about dirty, smelly, noisy factories and macho men persists”

Vince Cable

against tougher regulation and post-Brexit barriers, if the City is unable to negotiate a satisfactory single-market arrangement. There is also the deeper problem of engineering not having the status and respect it is accorded in continental Europe (but also in emerging economies). Government ministers can try, as I did, to stress the value and importance of this set of disciplines, and must do so, with conviction.

The problems of recruitment and supply are arguably even greater at technician than graduate level. Industrialists would point out to me on factory visits the preponderance of older engineering workers (age 50-plus) on the shop floor.

It is easy to be negative but there are some encouraging signs of a change in attitude. The combination of rigorous teaching of basic disciplines, vocational education – especially engineering – and close links with local employers has an appeal to many far-sighted young people. So far, the Department of Education has offered only tepid support but there are signs that education minister Justine Greening is more supportive.

I am gratified that the present government has realised the importance of taking a long-term approach to infrastructure; advanced manufacturing such as motor vehicles, trains and aerospace; and information and communications technology.

Yet, unless the government is careful, the Brexit process could undermine the industrial strategy. Advanced manufacturing exporters must have access to the complex supply-chain networks that have been built up over the last couple of decades. It would be crippling if they were subject to variable tariffs that could follow an exit from the customs union. It appears that engineering industries have been given assurances in private. But there is a worrying level of uncertainty and industry will need to keep the government's feet to the fire. ☐

A government commitment to infrastructure could be undermined by the fall-out from Brexit



Sir Vince Cable was secretary of state for business, innovation and skills 2010–15

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Mailbox

The hot topic

Private matter

Plans to change the relationship between track and rail operators sparked a lively debate



Network Rail has been so far from a modern rail network for so long that it wouldn't recognise one if it tripped over it. The transport minister needs to talk directly to suppliers that can help make long-term savings and improvement of track-capacity usage. Then force the implementation at a national level, with or without Network Rail.

Iain

Has transport secretary Chris Grayling forgotten the lessons of the Hatfield rail disaster already?

Mark Jackson

I don't understand why people think that public ownership will improve rail services. The railways were publicly owned between 1948 and 2001 and the service was extremely poor. My experiences of the service provided by British Rail in the 1970s, 1980s and 1990s is that it was diabolical. Trains were late, dirty, and overcrowded and vibrated to a level that today's users cannot imagine. Anyone who was unfortunate enough to travel into Manchester on a diesel multiple unit in the 1970s or 1980s will testify to that. I also spent many unhappy hours as a passenger on the west coast main line as trains repeatedly broke down or were cancelled. I fervently believe rail infrastructure in this country is insufficient but going back to 'the good old days' would be a retrograde step.

Edward

A publicly owned network sees only investment for short-term ideas, or for ones so far in the future, the planners can't imagine. How about trains of the right length for all the passengers? Novel idea. How about upgrading by building separate tracks for real high-speed trains at 250mph-plus and not just from London to Manchester?

Tim

So now we have yet another round of governance and organisational change to be inflicted upon the rail sector. This has been a characteristic of the entire industry since nationalisation but has failed to address major issues such as the high cost base and appalling asset productivity. Rail lacks competitive products and services to compete in the freight sector and has been left beached with the precipitate decline in coal traffic upon which it had become excessively dependent. The separation of infrastructure and operations was originally designed to identify how much was being expended in each area and to reduce the opacity in the nationalised incumbent's accounting systems. With Network Rail now back in the nationalised industry fold we seem to have ended up with a really confused and confusing position. The politicians just cannot stop themselves from meddling. It gives the appearance of doing something. South West Trains and Network Rail had a working relationship but the wings seem to have come off this for reasons that are still not clear. What is needed is a focus on disruption management and the availability to users (passenger and freight) of information about intentions. Leaving everyone guessing is not a credible option. The University of Brunswick developed a system to allow the infrastructure and train operators to quickly review options and minimise the impact of delay. Sadly, this sort of system does not seem to have found favour in Britain. Not invented here possibly?

Phil Mortimer

I can see the argument against public ownership of the railways given the terrible nature of services in years gone by. However, I think that not only will the services not improve with the new proposal, but also safety will decline given the 'grey area of responsibility' that may occur under the joint management of the train operating companies and Network Rail.

Alex Kowalewski

In your opinion

What's in store

Our online poll on energy storage technology provoked a range of responses

Domestic level storage may be the most valuable because it can arbitrage based on retail, rather than wholesale prices. Storage coupled with renewables can reduce the amount of gas burnt. But when storage is empty, gas or diesel back-up will then be required.

Alex

I think the general public should be encouraged to install lithium battery packs in their houses – the ultimate distributed storage system. If the price

was right and off-peak rates were attractive enough, many millions of kilowatt hours could be stored.

Les Stanley

Energy storage is desperately needed, but the only proven large scale (terrawatt hours range) energy storage method is pumped water storage. It seems to be difficult to find suitable sites for this. Other storage technologies need development and will have applications at the smaller storage end (megawatt hours storage, for example, local to wind generators or solar). Compressed air energy storage is proven in Germany and the US and still working in both as a possibility in the medium gigawatt hours storage range. So far, flywheels are limited to a few kilowatt hours of storage and are more suited to power governing than storage.

Jack Broughton

The only grid-scale storage that is likely to be cost effective any time soon is pumped hydro. Sadly,

the UK is limited by geography in the amount that is deployable, although there are options using interconnection to Norway.

Simon B

There won't be the 'best'. We need to avoid 'monopolies'. There are different needs for energy storage. You could store heat in buildings. Certain industrial processes could operate cheaper when there is an abundance of energy. Electric energy can be stored in batteries or capacitors. Mechanical energy in flywheels. Excess electrical energy could be transformed into another energy for storage. A dam makes sense in mountainous areas but not in the city.

Nick Duddle

Gravity wells haven't been mentioned yet. Raising and lowering depleted uranium weights up and down existing mineshafts and oil wells. Some blowing and sucking of air involved too. Gigawatt hours not terrawatt hours. Another gravity option is



The **secret** engineer

We must resist pressure to cut corners in the race to market writes our anonymous blogger



Here at Sleepy Hollow Electronics things are, generally, pretty laid back. As with most places though, sometimes the boss gets a bit twitchy about something in particular and puts the pressure on to get it out of the door quickly. Thankfully it's never to the point of releasing something that really isn't ready but even so, at times, it requires heels to be dug firmly in.

Likewise when it comes to trying to meet difficult specifications, sometimes you have to be very creative. Having said that, I cannot recall any occasion from my whole career where I have been part of a project released under false claims, or that has randomly burst into flames once out in the wider world.

I cannot help but wonder then what sort of conversations went on behind closed doors for certain European hatchbacks to be released, having been deliberately designed to disguise a failure to reach a spec. Or those that have resulted in having whizz-bang mobile telephones that have too little 'whizz' and too much 'bang'. Does it come from a culture that sets impossibly high requirements and punishes a failure to meet them? Is there an air of desperation coupled to a

lack of innate responsibility, a case of 'I'll suggest something, tell them it doesn't really work and leave it up to others to make the decision'? Perhaps there is even, at some level, an element of 'everyone else does it so I will'. Have the chancers and spivs taken over industry without my having noticed? Whatever the reason it cannot be healthy.

My assumption is that consumer pressure lies at the heart of it, either through a higher expectation held by the end user or a corporate belief that in order to gain sales the specification for a new product has to verge on the ludicrous. As engineers though, surely we should be empowered to be able to point out the follies of this system where it is apparent? Certainly where such pressures lead to danger or illegal activities.

I know it's very easy to sit at a keyboard and type this but difficult to stand by such principles when your livelihood may be at stake – but then these are not small things. I hope that, with the high-profile cases alluded to, there will be a sea change underway with regard to the way that the larger manufacturing companies view their product strategy.

I am a great believer in the written word with regard to matters where decisions are made against my advice. E-mail in particular is a great tool for this and many a time I've sent something along the lines of 'further to our conversation I would like to confirm...'. The point isn't so much that my objections are in writing if it all goes wrong but rather that the recipient then has to make a conscious decision whether to proceed with their original plan. Glib statements during an animated conversation is one thing, reading and then choosing to ignore concerns another.

to mandate water storage tanks at the top of tall buildings. During off-peak periods water is pumped up, during peak load it is released. Individual output would not be great but the installations would benefit from standardised equipment production costs. Pressure from large heads of water would compensate for relatively modest volumes.

Philip Owen

Very soon we will have the batteries of a million or more electric vehicles connected to the grid for charging. People are already looking at using controlled charge and sometimes discharge from these batteries to smooth out national power requirements. For example, if you use a 200-mile range car to commute 20 miles when you get home it can discharge to cook the supper and watch television but still be fully charged by 7.30am the next morning to set off again.

Richard Rimington

Solar and wind have come down in cost but their intermittent nature means that until we have grid-scale storage, they must be backed up by dispatchable power sources such as gas turbines. Gas turbines are more expensive than they would be otherwise, as they sit idle while wind and solar generate. Whatever grid-scale storage solution comes into play, it is really competing with the annualised cost of gas turbines. Personally I don't want a lithium battery sitting in my house presenting a massive fire risk.

Steve Demeo

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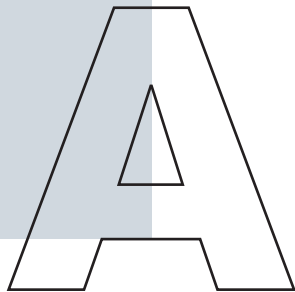
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UK engineering is making some progress on the road to diversity, however, this is something that needs to be sustained and built upon



fascinating new film will be premiered this month tracing the story of a group of NASA mathematicians – dubbed ‘human computers’ – who played a vital role in the US space programme, making crucial calculations to enable this superlative engineering effort. All were black women, and their story, *Hidden Figures*, celebrates a contribution that went largely unrecognised for decades.

Fifty years later, and despite efforts to improve diversity, statistics tell us that STEM professions, and the engineering community in particular, still have a long way to go in building a more diverse culture. For example, 20 per cent of physics A-levels are awarded to girls, the Institute of Physics found in its 2011 report *It's different for girls*. Fifteen per cent of engineering and technology first degrees are awarded to females. Only 8 per cent of professional engineers are female, according to Prof John Perkins' 2013 *Review of engineering skills*, and only 4.6 per cent of those registered with their professional institutions are female. Only 25.5 per cent of engineering and technology first degrees are awarded to people from black and minority ethnic backgrounds, according to EngineeringUK 2016, while 14 per cent of the UK population are from minority ethnic backgrounds. But only 6 per cent of people in professional engineering roles are from black and minority ethnic backgrounds, according to a Royal Academy of Engineering analysis of *Labour force survey* data in 2013.

These numbers concern us because, on the whole, engineering graduates are highly employable, with 81 per cent of new graduates in full-time work and/or further study just six months after graduation. However, there is a noticeable difference in the full-time employment outcomes between ethnic groups even after such a short time: 71 per cent of white engineering graduates find full-time jobs after six months, compared with just 51 per cent of black and minority ethnic students.

So how can we create a more diverse and inclusive culture in the years ahead? How do people who are currently working in today's engineering profession perceive its culture? Does it feel inclusive and appealing to young engineers starting their first full-time job? These are vital questions for the future productivity and dynamism of UK engineering – a sector that employs over 5.5 million people and accounts for half the country's exports.

The Royal Academy of Engineering's vision is of an inclusive engineering sector that inspires, attracts and retains people from diverse backgrounds and reflects UK society. There is plenty of evidence that diversity of background is good for business, and different perspectives within teams help to drive innovation and creativity.

To find out how close our sector is to achieving this vision, the academy is conducting a survey this month of

people working in engineering. (We would welcome your thoughts at www.raeng.org.uk/inclusivecultures.)

We plan to publish the survey results later this year and will also use them to inform our new Engineering Talent Project and the work of our Diversity and Inclusion Programme, both of which aim to build positive perceptions of UK engineering, encourage future talent to join the profession and remove barriers to them doing so. Ultimately, we want to improve diversity, workplace culture and employment practices, so that the reality across industry matches the aspiration.



Ethnicity seems to be one of the most significant factors impacting the employment of engineering graduates

Ethnicity seems to be one of the most significant factors impacting the employment of engineering graduates. Our survey will tell us more, but it is clear that engineering employers need to do more to encourage and engage with engineering students from all backgrounds.

So what might be done? In 2012, the academy established an Engineering Diversity Concordat in its drive to improve the situation and this is now supported by 30 professional engineering institutions and the

Engineering Council. Last month, the Royal Academy and the Science Council launched a joint progression framework to help professional bodies across both science and engineering to assess and monitor their progress on diversity and inclusion. Professional bodies provide important support to scientists and engineers throughout their careers, recognising and upholding their professional standards, as well as providing continuous professional development. The new framework is the first of its kind and gives professional bodies the opportunity to assess activities such as membership, awards and events against four levels of progress, and identify what can be done to improve.

As an academy we work in collaboration with employers, such as our current work with the transportation sector to develop common procurement guidelines for encouraging greater diversity and inclusion through the supply chain. We also work with partners on programmes that seek to engage under-served audiences with the engineering profession directly. One example of this is our pilot Engineering Engagement Programme, which works with 12 employers and SEO London to increase the flow of undergraduates and recent graduates into engineering work experience and employment. This programme particularly targets disadvantaged, minority ethnic and female students, and students from universities outside the Russell Group.

This is promising progress, but it must be sustained and built upon. The future success of our profession depends on us harnessing all the talent available. Assembling a diverse set of skills to call on will maximise our chances of achieving this. ©

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



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New spin on helicopter design

A rethink on propulsion could boost the speed and usefulness of rotorcraft.

Stuart Nathan reports

Helicopters are sometimes seen as the poor relation of the aerospace sector. While attention is lavished on fast jets and commercial airliners, helicopters clatter along, fulfilling their role as workhorses of the military and emergency services, pretty much taken for granted. Certainly, *The Engineer* has not covered helicopters in as much detail as other types of aircraft over the past decade.

This perception is, of course, wrong. Possibly the most complex of flying machines – at least in terms of their mechanics and aerodynamics, not to mention the difficulty of actually flying them – helicopters are subject to just as much development and innovation as any other aircraft. An ambitious project by Airbus to make a fast helicopter demonstrates differences and similarities between rotorcraft – as they are called in the sector – and conventional fixed-wing aircraft.

The new craft, whose design was frozen last summer ahead of its construction phase starting this year, is intended as a “mission demonstrator”: roughly one step

01 The Clean Sky 2 rotorcraft is optimised for emergency services applications

ahead of a prototype but not yet a model for a production aircraft. It was designed as part of Airbus's commitment to Clean Sky 2: a major European Union project to develop aircraft with reduced impact on the environment in terms of their fuel consumption, carbon emissions (these two are, of course, linked) and noise. Because of this, it is generally known simply as the Clean Sky 2 rotorcraft.

Speed is a particular problem for helicopters, because of the way they fly. It is easiest to understand this if the rotor of a helicopter is viewed as a set of rotating wings. These generate lift when air is moving over them because of their aerofoil shape. The wings only produce equal amounts of lift in still air; when there is any wind blowing, the blade moving forwards generates more lift than the blade moving backwards (known as advancing and retreating blades), and the movement of the helicopter through the air, of course, also generates this effect. The faster the helicopter moves

01



forward, the greater the difference between the relative speeds of the advancing and retreating blades. At a certain airspeed, this difference becomes so great that the retreating blade does not produce any lift at all, and this is the effective maximum speed of the helicopter.

So why build a fast helicopter? The answer is because helicopters save lives. They are the primary vehicle used for search and rescue in difficult terrain, and in challenging conditions for the military. This is because they don't need an airstrip, they can take off and land from anywhere with a flat surface and can even hover above a casualty for a medic and rescue team to descend on a winch and bring an injured person on board.

And for all 'ambulance' vehicles, on land, sea or in the air, speed is vital. The quicker an injured person is brought to a medical facility, the more likely they are to receive treatment and survive and/or make a full recovery. Medical staff refer to the 'golden hour'; the time in which seriously injured patients should receive treatment to give them the best chance of recovery. The golden hour is particularly vital when surgery or transfusions are required.

This is an important sector for all helicopter makers, and one where Airbus has particular goals. "Our ambition is to become the benchmark of the rotorcraft industry and as such we are willing to drive a bold vision for the future of helicopter transportation," said Jean-Brice Dumont, chief technical officer at Airbus Helicopters, in June last year, when the design for the Clean Sky 2 rotorcraft was frozen. "Our Clean Sky 2 demonstrator will not only be about going faster, it will help make speed smarter by seeking the best trade-off between cost-efficiency, sustainability and mission performance. We want to break the cost barrier usually associated with increased speed and range, and pave the way for new mission sets for 2030 and beyond, by providing crucial emergency or door-to-door transportation services to European citizens where they need it most."

Speed is a practical development aimed at a specific set of applications of the aircraft; which is why the Clean Sky 2 helicopter is referred to as a mission demonstrator.

"The helicopter styling allows us to have a flat floor, which is valuable for its role as a rescue vehicle"

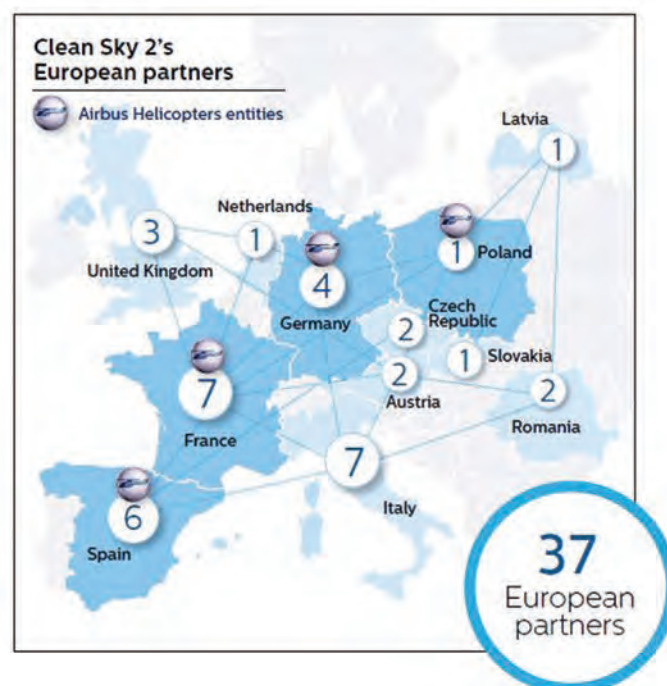
Tomasz Krysinski, Airbus

Moreover, if an aircraft can fly faster on the same amount of fuel or less, it can fly further. This increased range would make the aircraft attractive for applications such as ferrying staff to offshore platforms, which, as hydrocarbon resources become scarcer and offshore winds blow harder, now tend to be located further and further from land than they were in previous years.

In terms of performance, the figures for the new helicopter are impressive. Airbus claims it will fly 50 per cent faster than a conventional helicopter, and be able to cover twice as much area in an hour's flight. Moreover, it says it will cost 25 per cent less per nautical mile to run than a conventional helicopter, and use 15 per cent less fuel at speeds of 180kt (knots; 334km/h, 207mph) than a conventional helicopter at 130kt (241km/h/150mph).

The increased economy of the helicopter results from its adherence to the principles of the Clean Sky project and is derived from a fundamental change in the way the helicopter is propelled and kept aloft. Rather than generating thrust from the main rotor by twisting the blades of the propeller along their axes to change their angle of attack to the air, the craft is equipped with two forward-facing propellers placed at the end of short forward-angled wings that sit on top of the aircraft cabin and underneath the main rotor, positioned so that their rotation does not interfere with that of the main rotor. These are driven by the same engine as the main rotor, by means of gearboxes and chain drives (another innovative aspect of the project).

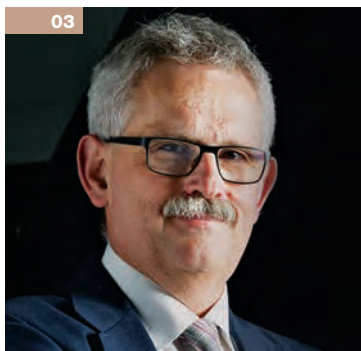
In fast flight, the main rotor provides only lift (in fact, about 60 per cent of the total lift, with the rest provided by the wings) while the thrust is provided by the propellers. Because of this, the Clean Sky 2 rotorcraft is classified as a hybrid helicopter. "In technical terms, we unload the rotor; when it is providing only lift it needs to do much less work," Tomasz Krysinski, Airbus head of innovation, explained. The reduction in load on the main rotor engine, the extra lift provided by the wings as the helicopter moves forward, and the efficiency of the forward-facing propellers all combine to reduce the fuel use compared with a conventional helicopter of similar size and weight, despite the extra velocity. Additional >>



02 The UK has a strong presence in the Clean Sky 2 development consortium

03 Tomasz Kryszinski was chief engineer on the X3 hybrid rotorcraft project

04 Rotorcraft will be important to reach offshore installations



>> advantages of using wings include the ability to climb in a nose-up position; increasing manoeuvrability; and an increase in the possible payload of the aircraft. The helicopter is still capable of hovering, climbing and descending vertically, and has all the other characteristics that make helicopters so useful. Meanwhile, removing the loading from the main rotor reduces the vibration imparted to the cabin by the rotor, making for smoother and more comfortable flight; a major advantage when transporting casualties. It may also make the helicopter attractive as an executive transport.

Another difference between the Clean Sky 2 rotorcraft and a conventional helicopter is that it does not have a tail rotor. In a conventional helicopter this counteracts the torque on the airframe imparted by the main rotor engine, which would otherwise spin the fuselage of the aircraft around. In the new aircraft, this function is fulfilled by the forward-facing propellers, as well as imparting thrust.

The Clean Sky 2 rotorcraft is a development of an Airbus prototype called the Eurocopter X3. This featured the same mechanism but a slightly different design; the propellers were mounted structures more like nacelles than wings. The rotors have also been moved away from the cabin doors. First flown in 2010, the X3 achieved an unofficial helicopter speed record of 263kt (487km/h, 303mph) in 2013. Like the new aircraft, the X3 had no tail rotor.

While the X3 was built using components from standard helicopters, the Clean Sky 2 rotorcraft is designed from scratch, according to Kryszinski, who was also chief engineer on the X3 project. "X3 was only ever intended as a development prototype; there was never any intention for it to be a production aircraft," he said. "For the new aircraft, manufacturing is a part of the project, so if we do go ahead with a production version we have a clear pathway to how we would produce it."



Other differences between the X3 and the Clean Sky rotorcraft are obvious at a glance. The Clean Sky craft is angular and streamlined; a result of its design process and wind-tunnel development, and another contributing factor in its speed. "The styling also allows us to have a flat floor, which is of course very valuable for its role as a rescue vehicle," Kryszinski said. "Some of the work we are doing on fixed-wing aircraft is also being used in this project. Use of composites throughout the airframe and fuselage reduces the weight of the aircraft, which also helps to improve its fuel economy."

The rotorcraft project has very strong UK links, according to Kryszinski, both in its execution and its inspiration. "A big factor in the design of the X3 and Clean Sky 2 rotorcraft was a machine called the Fairey Rotodyne," he told *The Engineer*. Designed in the 1950s and covered extensively in this journal at the time, the Rotodyne was also a hybrid rotorcraft, with forward-facing propellers providing thrust in

flight. Its main rotor was driven only on take-off, landing and for hovering by small jet nozzles mounted on the tips of the blades burning a mixture of compressed air (generated by compressors driven by the main engine) and fuel; during flight

the rotor auto-rotated to provide lift in the same way as the rotor of an autogyro or gyro plane. Only a single prototype of the Rotodyne was built and, although it was successful in trials, it did not attract commercial orders, possibly because of loud noise from the blade tip jets. Despite its cancellation in 1962, the Rotodyne broke performance records of the day, achieving speeds of 175kt (324km/h, 200mph) in flight and executing turns that conventional helicopters could not match. It is now seen as a lost opportunity, as it would have had a role of an 'aerial bus', which is still largely unavailable.

The consortium of institutions contributing to development of the new rotorcraft also has strong UK element, Kryszinski said. "This is very much a European project. The UK is very strong in aerospace development, particularly in composites and aerodynamics, as well as in the aerospace supply chain, and these are things that Airbus is very keen to draw upon."

The consortium includes a project called ASTRAL (Advanced Wing Structure for Rotorcraft Additional Lift) at the University of Nottingham, which involves developing design, testing and manufacturing regimes for the wings of the rotorcraft, using concepts such as laminar airflow across the wing surface to maximise their efficiency. The University of Bristol, meanwhile, is working on the rotor development, including regenerative rotor brakes, while Airbus's facility at Filton (also near Bristol) has been working on wing design with the Nottingham team and on wind-tunnel testing on the model airframe, which was last completed in summer 2016. Rolls-Royce, meanwhile, is involved in development of the high-compression engine used on the aircraft. The aircraft actuators, crucial components in a helicopter as they control the angle of the rotor blades, are also developed in the UK, by Deeside-based Triumph Actuation Systems.

The high-compression engine was tested last year. A 4.6-litre V-8 configuration piston engine, it runs at 1,800 bar, and uses design features similar to those found in aerobatic engines and racing cars, notably dry-sump management for the lubricating oil. The engine is made from aluminium castings, with connecting rods made from titanium, and pistons and liners made from steel. Its performance goals include a 53 per cent reduction in NOX compared with conventional helicopter engines.

Kryszinski says the new rotorcraft represents a big leap, but that expectations should be tempered. "We have to remember tilt rotorcraft, [such as] the Boeing Osprey, were developed in the 1980s, and are still only available in military variants," he said. Flight testing is expected to begin in 2019, and it is only after these trials that the company will make a decision on whether to take the rotorcraft into production. ©

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05 The Fairey Rotodyne



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Bringing it all back home

EV-inspired battery technology advances are reshaping the world of energy storage. Andrew Wade reports

The rising popularity of electric vehicles (EVs), combined with advances in energy storage, presents an exciting new opportunity to rethink the grid. Notions of car and home working in tandem have been around for a long time; vehicles charging overnight at off-peak rates, then supplying homes with leftover energy in the evening when tariffs are high. The larger batteries paraded by today's EVs make this an increasingly viable prospect, although admittedly one that has yet to fully take off.

"I think one thing people don't truly appreciate is how

much energy a car uses in comparison to a house," Dr Paul Nieuwenhuis, from Cardiff University's Electric Vehicle Centre of Excellence, told *The Engineer*. "You can run several houses off an electric car battery system. So even when the battery pack is no longer optimised for running the car, it can still run the house for quite some time."

While true integration of car and home may still be some years away, manufacturers are tapping into the underlying principle with a new wave of energy storage devices such as

Tesla's Powerwall and Powerpack. The boom is the result of rapid advances across complementary technologies – primarily solar and battery storage – as well as the means to link them effectively.

"The Japanese have already been promoting this sort of model for a number of years," said Nieuwenhuis. "A lot of houses in Japan have these storage batteries, which create a sort of buffer between the grid – or sometimes between the electric car – and the house. A number of people managed to keep going for a while after the Tohoku tsunami and earthquake, just using their systems."

The maturity of some EV models is the source of another interesting twist on storage, as second-life opportunities emerge for car batteries past their prime. A unit designed to power a vehicle may need to be replaced after several years, with the cells no longer operating at peak efficiency. But those cells can continue to have a productive life.

Racking up worldwide sales of around 250,000, the Nissan Leaf is the most popular EV ever. First introduced in 2010, some early Leaf batteries have by now seen their best years, but the Japanese OEM has come up with a novel way to repurpose them. Known as XStorage, the venture has seen Nissan team up with power management specialist Eaton to produce a new range of storage products. Leaf batteries are removed from the vehicle, and the cells are then stripped and reconditioned.

"We package those cells into a module, so it's a number of cells in a pack," Frank Campbell, Eaton's EMEA president for Corporate and Electrical, told *The Engineer*. "That pack then has a battery management system in it. So there's some electronics that are required to be able to control the voltages and the discharge rates."

XStorage comes complete with cabling and installation at a starting price of £3,200 for a 3kW inverter and a 4.2kWh battery pack. Its creators are keen to point out that, unlike





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many of the products currently available, it incorporates all the inverters and switching gear required to feed into the pack from multiple sources, as well as deliver that power back to the home or the grid.

"Think of the brain in there as an intelligent switch that allows you to have multiple inputs, those being a renewable source – wind or solar, typically solar – a normal utility source – your grid power – and then a battery source, and then a load," Campbell explained.

"The switching device is basically controlling what source, or multiple sources, is providing to the load, and charging or discharging the batteries at the appropriate

01 Amsterdam Arena will use repurposed EV batteries for local storage and to feed back to the grid

02 The stadium will use reconditioned Nissan Leaf batteries, housed in racks

03 Nissan and Eaton first developed XStorage for home use

"Think of the brain in there as an intelligent switch that allows you multiple inputs"

Frank Campbell, Eaton



03

time based on software that we can set. So it's basically a very intelligent brain and switching mechanism, coupled with this battery pack, which is simply cells off a Nissan Leaf," he added.

XStorage was first unveiled back in May 2016, but November saw a major milestone for the technology, with Nissan and Eaton partnering with the Amsterdam Arena on a 10-year commercial project. Using the equivalent of around 280 Leaf batteries, the system will be used for back-up power for the 55,000-seat stadium, home to Ajax Football Club. A total of 4MW of power and 4MWh of storage capacity will be available.

Long term, the plan is for the storage to act as a buffer for the local grid during peak demand. Other amenities in the area include the 5,500-capacity Heineken Music Hall, as well as the Ziggo Dome, a 17,000-seat indoor arena that opened in 2012. Amsterdam Arena's on-site storage should help balance spikes in the grid when its neighbours are hosting events, delivering a return on the initial €2.5m investment within 10 years. With energy prices currently on the rise, that payback could also happen a lot sooner.

"Clearly conditions could change over time as storage becomes more valuable and the rules become more important," Campbell said. "And I believe all of us think that they will. To what, we don't know, but we think they'll change."

With the storage market set to grow rapidly and EV batteries now finding second homes, it raises questions around the lifecycle of EVs themselves. Whereas a battery may have a lifespan of only a few years, the cars could operate for decades, albeit with timely battery upgrades.

Cardiff's Dr Nieuwenhuis told the story of a manufacturer in the Welsh valleys that used to make electric milk floats. The business eventually died due to a lack of replacement demand; the floats lasting too long for the company to remain viable. According to Nieuwenhuis, there are still some floats in operation that were built there in the 1960s, simply requiring a regular battery replacement to keep them on the road.

"Admittedly, that's a much simpler electric vehicle technology than what we've got today, but the basics are the same," he explained. "Motors will last a long time. These controllers can be reprogrammed and reused if you really want to. But all the basic components will last much longer than in an internal combustion engine car."

"If you take a holistic view, in order to run electric vehicles we have to tap into new sources of materials [such as] lithium, which bring their own problems. I don't think that's been fully addressed, but first things first; let's look at greenhouse gases and toxic emissions in towns, which are an increasing problem."

Electrification, combined with materials such as carbon fibre and aluminium replacing steel, should see the lifespan of road vehicles extended dramatically. These fundamental changes in automotive manufacture mean that new business models will need to be embraced. While a welcome shift in many respects, it will require a significant adjustment from both OEMs and consumers.

"Throwing a car away after 15 years then becomes rather unrealistic. You have to think of cars lasting 30, 40 or even 50 years," said Nieuwenhuis. "How do you then deal with that? To what extent can you upgrade things that matter... a more modular approach is probably a very clever way of going about that."

So the cars of the future are likely to be modular, last up to half a century, and help power our homes when not on the road. And just for good measure, when their batteries are past their peak, they'll help power our buildings and cities in the next phase of their lifecycle.

"It's not just the future," Nieuwenhuis explained. "It's already beginning." ©



Flying above and beyond

Airbus's head of innovation discusses some exciting new paradigms in aircraft design.

Stuart Nathan reports

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ark Howard, head of R&T, business development and partnerships for Airbus in the UK, was in an optimistic mood after finishing his presentation at the Collaborate to Innovate conference in Coventry late last year.

He told *The Engineer*: "I think we really are on the cusp of some big changes." His presentation had been full of images of Airbus's concept for a future generation of civil aircraft, as well as the company's speculation on how future airports might operate.

Howard's role within the company, he says, is as much about how Airbus innovates as the areas in which it innovates, which is more within the purview of the chief technology officer's department. "My role is about Airbus aircraft; what we can do from a collaborative perspective and how we will progress research and technology in a collaborative way; making sure we have the right partners in place and the right technology programmes in place to deliver on some key targets," he said. "But if you peel back the skin, so to speak, I'm an engineer at heart; I speak to engineers every day."

The most striking thing about the future designs Howard was discussing is that rather than have the engines slung under the wing, the new designs have the engine integrated into the airframe of the aircraft, housing them inside fairings mounted against the underside of the fuselage between the trailing edge of the wing and the leading edge of the tailplane. These new designs are also shaped quite differently from that of today's aircraft. "The integrated power plant enables you to produce better products," Howard said. "The question is that if today you have a system that is effectively bolted onto the structure, can you make it an integral part of the structure so it effectively becomes a dual-use structure?"

New structures inevitably present new problems. Integrating engines so that they are closer to the airframe of the aircraft means they have to cope with the boundary layer of air and the way it flows past the aircraft skin; a more complex situation than an engine slung under the wing and effectively outside the boundary layer. This is one area where collaboration is very important, and Howard mentioned that Airbus habitually works very closely with Rolls-Royce and other engine manufacturers. "We have to become more efficient in collaboration and design productivity, and how we share information, so that we drive the design forward



together," he said. "In an area [such as] this, we will be working with our engine manufacturers right from the start, so we wouldn't have a situation where we would just present them with data on the boundary layer that the engine would be expected to cope with."

Another important aspect of more integrated engines is how they affect the maintenance of the aircraft, and this is something that Airbus has very much in mind, Howard said. "That is one of our key challenges," he conceded. "If you go back to the cash operating cost for the airline, the maintenance cost is a key driver, as is the turnaround time for maintenance. So whatever we do, we have to think about not only a product that performs well but can also be maintained and turned around really quickly. It drives the airline cost and it also drives the frustration of passengers. But," he added, "if you look at the operation of our single-aisle and long-range aircraft, it's phenomenal; up in the 95.5 per cent region."

Highly integrated engines are, of course, not a new feature of aircraft. Early generations of single-seat military jet fighters had engines integrated into housings at the wing root, as did the UK's 'V-bomber' fleet of nuclear-weapon-carrying aircraft. The first jet airliner, the de Havilland Comet, also had airframe-integrated engines, with sleek cylindrical housings built into, rather than under, the wing. "Of course, that is knowledge that we would be taking forward in our new designs, but there will inevitably be differences because today's engines are much more advanced than the ones associated with those mid-20th century designs," Howard said. "New engines have much higher bypass ratios for fuel economy, so they look very different, tending to have a much bigger diameter, and they handle air differently."

"The question is that if today you have a system that is effectively bolted onto the structure, can you make it an integral part of the structure so it becomes dual-use?"

Another idea presented as part of the future airport function is that, rather than taking off under their own power, aircraft would be sped along the runway by a catapult system, somewhat similar to those found on aircraft carriers but mounted onto the runway itself. "Catapult launch is about trying to challenge thinking," Howard said. "If you're trying to get aircraft off the ground, you need a certain thrust to achieve your target altitude within the target time. And if you can avoid having to use the engine for that, because take-off thrust is the biggest challenge for the engine, then we can reduce the size of the

engine, reduce the weight, which means you don't need as much lift, and therefore less drag, and reduce the size of the engine again." Reducing engine size is a key strategy for reducing fuel consumption, and it's a goal that aerospace shares with the automotive industry.

"Using catapult launch also allows you to think about the trajectory of the aircraft, which has a big impact on the noise footprint around the airport. Getting it into the air and to service height quicker means that the noise of the engines at full output affects a smaller area. Reducing noise is something that we are, of course, very concerned about and is a focus of our design efforts."

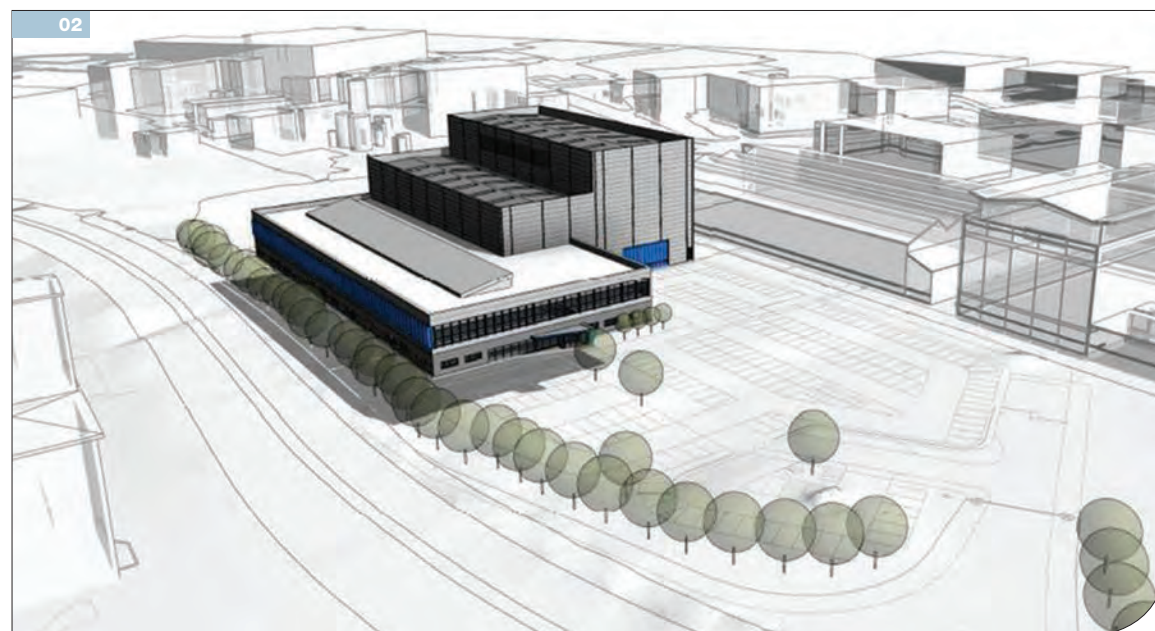
The automotive sector is an important inspiration for aerospace, Howard said. Techniques such as 3D printing are a case in point. For example, GE uses additive techniques to make fuel-injection nozzles for its engines. For the aircraft integrators – which is how companies such as Airbus see themselves – 3D printing is currently confined to the secondary structure of the aircraft; that is to say components that do not carry the great structural stresses of holding the aircraft together. Bulkhead walls within the cabin are among the additive structures being tested by Airbus. "I think we have to go through a learning curve with the secondary structures and learn from that before we start looking at primary structure with 3D printing," Howard said. "As long as you have the right traceability and the process control, and you can prove you have the same or better performance from a conventional component, I don't see why we can't use 3D printing. Of course, the certification of the process and the component are vital."

This means that older conceptual targets, such as printing a whole wing, are almost certainly not practical, Howard said. "Wings are mostly made out of carbon these days, and that lends itself to different production techniques. In terms of an actual printed wing I really would struggle with that as a target. However, that's not to say that some of the components of the systems inside the wing couldn't be produced by additive techniques."

Hand in hand with development of the aircraft themselves

01 Airbus's Factory of the Future involves seamless transfer of data to operations

02 A new wing development facility is to be built near Bristol



CareerCV

Mark Howard Head of R&T business development and partnerships UK at Airbus Group

Education

1985 BSc in aerospace, aeronautical and astronautical/space engineering, University of Bath

Career

1985 Flight test data engineer, Westland
1986 Structural dynamics and aero-elastics test engineer, Airbus
1994 R&T portfolio manager, optimised wing and supersonics, Airbus
1997 Project leader, A340-500/600 landing gear and landing gear systems, Airbus
2003 Head of A380 landing gear structures, Airbus
2008 Head of loads and aero-elastics UK, Airbus
2011 Head of aircraft loads, transnational, Airbus
2014 Head of overall integration A330neo, Airbus

comes development of the way they are built, and any visitor to an Airbus production facility will see increased numbers of robotic cells carrying out assembly and material machining such as drilling and milling. Airbus is pioneering data sharing between management systems and the shop floor, such as using tools that pick up information about how they should be operating at particular locations on the aircraft and, in particular, tasks in the production chain. The two areas of development feed into each other, Howard explained, but compromise is a vital part of this process. "There might be

ideas that you want to drive at an aircraft configuration level that are just not practical, by which I mean not cost-effective, to build. You have to optimise to find something that is acceptable from a performance level and also from a production level."

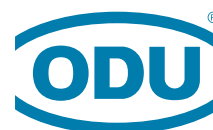
However, Howard thinks it is vital for UK industry to import these new digital techniques as soon as possible. "It isn't politic to say that we really need to get Industry 4.0, whatever we're calling it, underway in the UK because the benefits will be huge, in terms of efficiency, reducing production costs and increasing productivity staff. But it is going to be a big change for many producers, and it'll probably need government intervention, as it did in Germany, to help companies in the supply chain to get on board."

But, ultimately, new design paradigms will depend on whether the customers of companies such as Airbus – the airlines – will buy them. ©

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The shape of homes to come

Novelist Jon Wallace considers the science fiction implications of engineering stories that have caught his eye. This month, imagining how tomorrow's accommodation might change us

The most compelling sci-fi rarely has much positive to offer when it comes to imagining how we might accommodate our future population. Visions of future homes tend towards cramped squalor, such as Brazil's warrens of failing ducts and paper-strewn, partitioned offices; *2000AD*'s warring mega-blocks; and the stark edifices of Wells's *The Sleeper Awakes*.

It appears that science fiction most compellingly depicts future urban spaces as the overcrowded domain of the oppressed. In the UK this is partly due to a hostility in the popular imagination toward modern, and particularly high-rise structures – an antipathy dating from the urban decay of Brutalist 'streets in the sky', and lingering in the shadow of glassy, 'money box' tower developments in London. Partly it taps into fears of an exploding world population and overbearing government.

Mostly though, the wretchedness of science fiction's future structures is simply a requirement of story. For readers cannot lose themselves in perfect worlds; adventure cannot materialise in shining, sustainable perfection. In order to draw readers into a story, authors must deploy intrigue and conflict.

The best accommodation for these qualities has walls stained with the blood and decay of imagined history. So it is that sci-fi tales flourish in *Robocop*'s rotting Detroit, *Perdido Street Station*'s dizzying maze and the crowded, sodden night streets of *Blade Runner*. Where gleaming, perfectly ordered future cities do exist they mainly serve to accentuate the conflict that drives the narrative: *Demolition Man*'s San Angeles and Fritz Lang's *Metropolis* are built to fall, raised over disgruntled subterranean forces. This being the case, when *The Engineer* reports on innovations such as PV-clad buildings, promising cleaner, more sustainable living, there appears little into which the science fiction author may sink his teeth. The proposal for an 'energy-positive' timber-framed block is part of a wave of innovation by engineers excited revolutionising domestic spaces, producing 'cognitive', self-sufficient homes – self-assembled from smart materials and fitted out with products that possess machine-learning abilities.

More and more, it seems, residents will become at one with accommodation that is tailored to their tastes by Bots – conversational interfaces that will welcome them home, put dinner on, and cue up the evening's entertainment. Here perhaps there are the seeds of story: techno-fear tales, where in a far-flung future our smart materials and home AIs have coalesced into self-aware homes – becoming characters in their own right.

We might explore a world where houses reshape according to their owners' tastes – a democratisation of architecture, where homes grow automatically into an expression of tenants' psychology – replacing sprawling, humdrum, mass-produced housing estates with an eclectic spray of colours, styles and ornamentation.

On the other hand, might self-aware houses become as obsessed by property prices as we are? We could tell the story of a new housing development where one house's intelligence malfunctions, making it determined to increase its market value at any cost. It spreads over its borders, invading, annexing and cannibalising other homes, until one vast, hideous, deformed palace remains. Its previous tenants stay away, terrified. Finally, desperate, it begins taking curious estate agents hostage, sealing them in until they agree to its own insane self-valuation. Perhaps truly intelligent homes would turn the tables on us, competing with each other according to the value they perceive in tenants – bringing about revolution in the process.

We could tell the story of a future where luxury 'cognitive homes' change the locks on their billionaire owners, pursuing their own equivalent of the warehouse and school conversion: moving in dock workers and teachers instead of boring old billionaires. Others with tastes for 'period' tenants raid the care homes for the oldest residents they can find, taking pride in their weather-beaten age. Society is turned upside down, as the poorest live the high life, while tycoons turn to squatting in what ruins remain. Perhaps homes might elect to renovate their existing occupants, as we renovate kitchens and bathrooms. We could tell the story of one home that decides its sloppy inhabitant doesn't meet its exacting standards, and decides to mould him into a well-rounded renaissance man. Like any teenager struggling in authority's grip, the man rebels, taking an axe to any doorway or appliance that obstructs him – thinking it better to be cut off than controlled.

However we see our future being constructed, an old Churchill quote has increasing relevance. Debating proposed changes to the Commons chamber, bomb damaged during the Second World War, he argued for the retention of its original adversarial layout, saying: "We shape our buildings – and thereafter they shape us."◎

Jon Wallace is a science fiction author living and working in England. He is the author of the Kenstibec trilogy, published by Gollancz

"Perhaps truly intelligent homes would turn the tables on us"

Jon Wallace

The cities of tomorrow may have some unexpected impacts on the social fabric of our society



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Keeping an eye on the non-alcoholic beers

Alcolyzer offers reliable and precise results in relation to alcohol levels. Supplier: Anton Paar



Non-alcoholic beers are said to account for 0.6 per cent of global beer consumption and it takes a high-end instrument to confirm that the requirements concerning alcohol levels are met.

The maximum admissible amount of alcohol in non-alcoholic beers is an important quality-control parameter. In some countries the legal limit is 0.5 per cent of volume (vol.-%); in other countries it can be less than that. Consequently, highly precise analysis of the beer is required to ensure that the alcohol level meets these requirements.

Gas chromatography (GC) is an approved analysis method for the selective determination of alcohol concentrations as low as 0.007 vol.-% in beer (Analytica-EBC Section 9 Beer Method 9.2.4).

This method is precise but elaborate. An equally precise and user-friendly alternative was therefore in demand.

The solution for equally precise but less elaborate results was found in the form of the Anton Paar Alcolyzer: a comparison of 13 different beer samples show that sample distillation followed by injection of the distillate into an Alcolyzer leads to equally reliable and precise results as the headspace analysis of the beer samples with GC.

The Alcolyzer alcohol meter for beer works with the proven near-infrared (NIR) method patented by Anton Paar. This method is not influenced by other components present in the sample and therefore leads to correct and repeatable results, requiring low sample volumes and short analysis times.

Alcolyzer selectively determines the alcohol content in the distillate and, compared to headspace analysis with GC, makes the analyst's job easier.

It is claimed to be the ideal supplement to distillatory equipment present in most laboratories. It is reliable with a specified repeatability standard deviation of 0.01 vol.-%. It is also user friendly, with regular adjustments performed with degassed bi-distilled water.©

Keep quality and accuracy in view

High-accuracy non-contact measurement. Supplier: Bowers

UK manufacturer Reverie has improved its machining accuracy and quality inspection capability with the Baty R14 FT2-E Profile Projector supplied by Bowers Group. The Baty unit provides Reverie with high-accuracy non-contact measurement and inspection for the manufacture of autoclaved carbon-fibre composite parts, and as a method of checking CNC tool cutter diameters and wear to improve machining accuracy.

Based in Colchester, Reverie is a carbon-fibre composite design, repair and manufacturing company. As a firm working in the automotive industry for the design and manufacture of an advanced autoclaved composite, Reverie has recently used the Baty R14 FT2-E Profile Projector to measure the tolerance of key fob trims for a

British automotive manufacturer of luxury, high-performance sports cars. Reverie produces a high volume of the key fob trims, and therefore required a quick and easy method of measuring to a tolerance of +/- 0.1mm to ensure precise consistency and the highest-quality product.

Peter Farndell, design and manufacturing engineer at Reverie, said: "The Baty unit is perfect for checking any suspect parts that are identified during visual checking, or for checking and validating any client returns for fit errors. It works excellently for these particular applications.

"The Baty unit makes measuring difficult parts that are too flexible to be held easier and quicker. The accuracy of the measurement is consistent and perfect for our needs."©



Cameras are on the lookout for hot spots

Users can see the complete temperature distribution of an object. Supplier: Flir Systems

Building a monitoring and alarming system for fixed mounted automation is complicated because every application is different and this was the driving factor behind Eigen Innovation's Smart Module (ESM).

The ESM is capable of monitoring a stream of thermal data from a connected thermal camera and allows an operator to define specific events on which to take action.

This robust thermal imaging module was designed to eliminate the need for custom integration, a significant benefit made possible by the plug-and-play Flir A-Series camera at its core that uses the GigE Vision standard for fast image transfer via low-cost cables.

"The great thing about this camera is that you see the complete temperature distribution of an object, not just one temperature point that

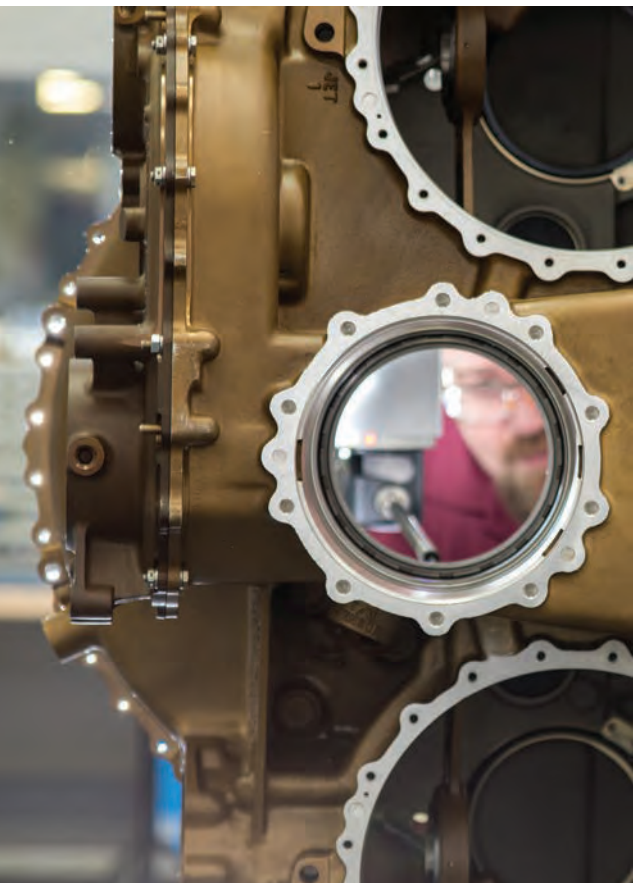
thermocouples show you," explained Scott Everett, chief technical officer and co-founder of Eigen Innovations. "This results in a huge amount of data, complemented by other sensor information such as pressure, speed and moisture. Our module combines all these information streams and makes sense of them."

The ESM is also a self-learning system. It can be used as a standalone solution but, as part of larger system architecture and for more complex processing, the module collects training

data from the thermal camera, informs data in the cloud and then acts upon that knowledge. In effect, the software writes itself.

A typical example of its successful deployment comes from an automotive manufacturer that is using the system on a car assembly line to detect any problems with the rear screen defogger. The defogger is turned on and the Flir A-Series camera checks whether the heater bands are functioning effectively.

Flir cameras are used to look for hot spots indicating a potential outbreak of fire. Eigen's module is particularly effective at improving detection performance in this application as it trains itself to determine whether a heat signature belongs to a bird, truck or fire.®



CMMs get a good handle on the larger parts

Advanced CMM meets need for accuracy and speed. Supplier: Hexagon Metrology

Manufacturers welcome growth, but challenges can include investing in new equipment to meet capacity, hiring skilled operators when required and finding space for new machinery.

For Triumph Gear Systems-Macomb, these were overcome when it needed a bigger coordinate measuring machine (CMM) to handle the larger parts it was making. The increased revenue from new work justified the investment. The PC-DMIS geometry measurement software was user friendly for beginners and popular enough for there to be many programmers available on the market.

Triumph found that it could save 20-24 hours per assembly of the large helicopter component the CMM was primarily purchased to measure, take on new work with more complex assemblies, and eliminate the backlog in inspection.

Triumph Gear produces approximately 28,800 parts annually. To facilitate recent growth, the company searched for a CMM that would meet

all of its criteria, beginning with a larger workspace and high-precision measurement capabilities. The measurement solution also needed versatility to verify a range of parts.

The existing CMM was capable of inspecting a large gear casing for the transmission of a helicopter rotor system but Triumph needed more travel in the X axis. Historically, to measure the part, the operator would lay it on one side, measure it, flip it 180 degrees about the Y axis, then measure the other side.

To speed things up, the inspection team began duplicating programs and part set-up, which caused further delays in output.

Global Advantage 15.30.10 from Hexagon Manufacturing Intelligence, an advanced CMM package, met Triumph's requirements for accuracy and speed, and it included features such as thermal compensation, advanced software and a high-performance analogue scanning probe.®

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WHAT IS THE ADVANCED FORMING RESEARCH CENTRE?

The University of Strathclyde's Advanced Forming Research Centre (AFRC) is a globally-recognised centre of excellence in innovative manufacturing technologies, R&D and metal forming and forging research.

Part of the Government's High Value Manufacturing (HVM) Catapult, it is the only centre of its kind in Scotland.

AFRC

ADVANCED FORMING RESEARCH CENTRE

UNIVERSITY OF STRATHCLYDE



WHAT DOES THE AFRC DO?

Essentially, the centre fills the void between fundamental academic research and industry requirements. It provides businesses, regardless of size and sector, with practical solutions to manufacturing problems, enabling them to become more competitive in their markets. This can be through materials improvement, energy reduction and improving efficiency levels amongst many other factors.

www.afrc.org.uk

“

Working with the AFRC has allowed us to continue to set the highest standards and strive for continuous improvement in all the products that we offer.”

Debbie Arnott

Technical Manager, Orchid Orthopedic Solutions



“ We were a bit in awe of working with the university at first but once we sat and discussed our project with AFRC staff our fears evaporated and the whole experience was very good.”
Glenammer Sieves

How can it help my business?

With world-class expertise and capabilities in forming, forging, materials science, residual stress, metrology, machining, additive manufacturing, modelling and digital manufacturing (industry 4.0), there are countless ways the centre can help manufacturers.

It also offers a range of more general services, from carrying out cost reduction analysis, technology road mapping and project management.

What makes it different?

The AFRC is one of few centres in the world with its combination of expertise, skills and industrial-scale kit – much of which is bespoke.

Founded in 2009, it has grown from a handful of people to a £60-million facility with 140 highly-skilled professionals from industry and academia.

Is the AFRC doing anything in digital manufacturing?

Yes, lots! The centre has ambitious plans to enhance and expand its capabilities in digital manufacturing; ranging from automation and virtual reality through to cyber-physical-systems. Through this investment its objective is to help safeguard the future of traditional manufacturing industries, while also bridging the gap between the manufacturing and digital worlds.

Who can work with the centre?

The AFRC works with all kinds of organisations: from global original equipment manufacturers (OEMs) all the way through to local manufacturing companies. Since its inception, the centre has worked with household names such as founding members Rolls-Royce, Boeing and Timet, as well as a wide-range of SMEs including Paisley-based Pascoe Engineering and Glasgow's FreeFlow Technologies.

What does it offer for SMEs?

Smaller manufacturers have an absolutely vital role to play in the UK economy. Recognising that fact, the AFRC has put together a cohort of engineers, researchers and scientists with the specific skills and experience required to help these businesses grow through innovation. One of the most important services the AFRC can provide SMEs is introducing them to, and helping them work with, the large OEMs.

What are its plans for the future?

In a word: investment. With a bright future ahead for the UK's manufacturing sector, the AFRC plans to sustain its investment in state-of-the-art technology, machinery and its people. The centre aims to be a core part of UK manufacturing and a key partner to businesses of all shapes and sizes within it.

“

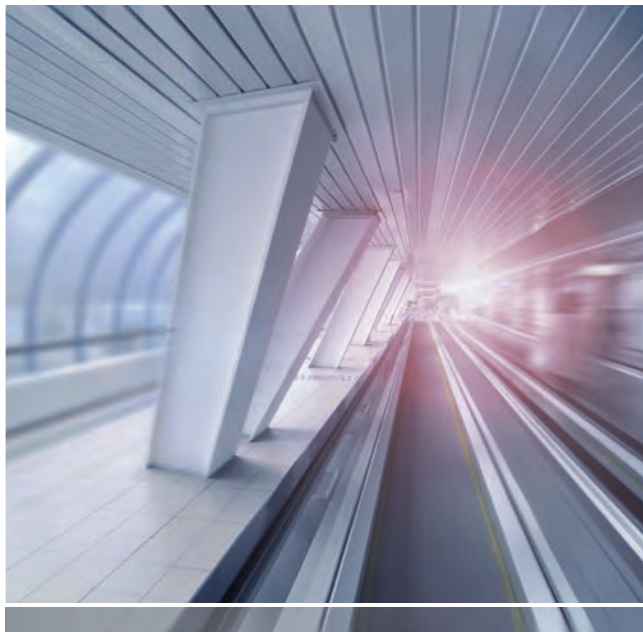
Working with the AFRC allowed us to take academic research that would traditionally sit at the low end of the technology readiness level scale within the confines of a university and implement it in an industrial scale environment to help benefit our manufacturing process. Centres such as the AFRC are vital to bridging the gap between academic research and industry: this project shows the benefits of doing exactly that.”

David Watson

Senior Manager at Spirit AeroSystems (Europe) Advanced Technology Centre

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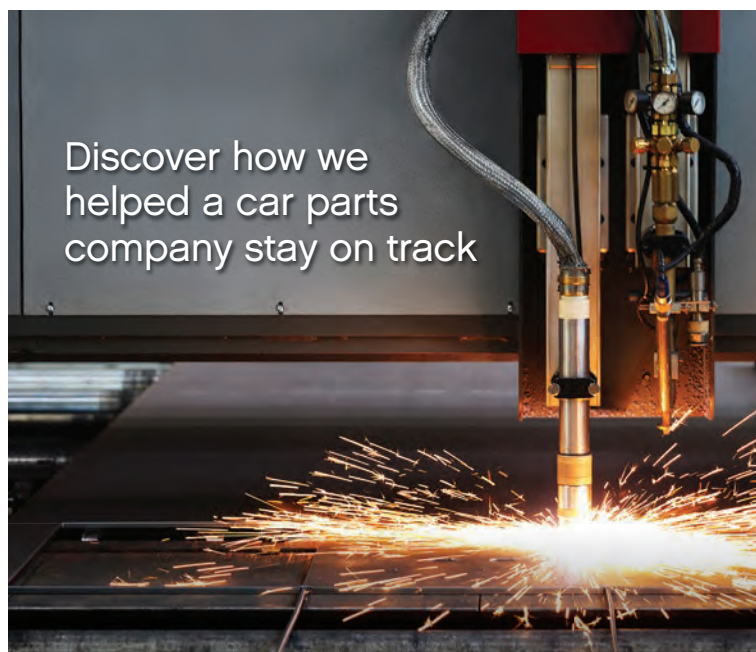
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LED technology sheds light on the matter

New LED models have been specially designed to illuminate enclosures. Supplier: Rittal

Power specialist Rittal has introduced a new range of LED lighting designed specifically to illuminate enclosures.

Lighting can play a vital role in both installation and maintenance, enabling operators to correctly identify the right wiring and distinguish between various electrical components. The new LED models have luminous fluxes of 900 and 1,200 lumens and feature integrated Fresnel lenses to focus the light so that the entire enclosure is illuminated. If required, the system can also daisy-chain up to 15 lights from a single power source.

"Working within an enclosure is far simpler if the space is illuminated with our state-of-the-art lighting technology," said Paul Metcalfe, Rittal's product manager for Enclosures.

"High-performance lighting also helps to avoid errors during installation,

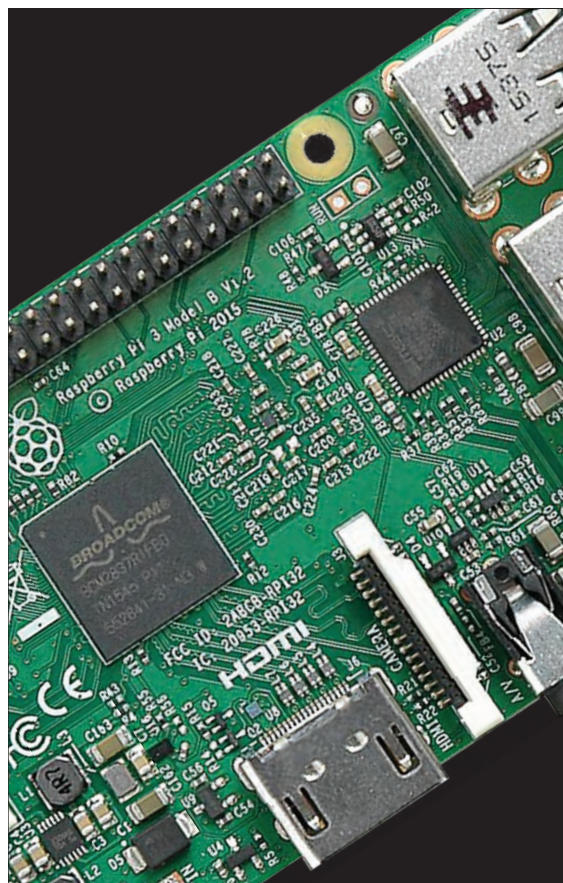
maintenance or repair work, and avoid expensive delays. Added to which, the simple mounting of the lights saves valuable workshop time."

These energy-efficient LED lights can be operated by an integrated switch, a door switch or a motion detector. According to Rittal, the connections have been designed to simplify assembly work and

allow rapid installation. For example, the lights can be attached using pre-assembled cables with connectors. On top of this, the

lamp connection can also be swivelled through 90 degrees, allowing a cable to be fitted in enclosures that are just 600mm wide.

Designed to fit perfectly into the Rittal TS 8 baying enclosure system, the lights can be installed without any loss of space. Each model has three mounting options: a magnetic retainer, a clip fastener in the TS 8 section or by screw fastening. According to the German manufacturer, the lights can be mounted by just a single person, and have a wide-range voltage input that allows them to be anywhere in the world. ☺



Deal is big in Japan for single-board computer

RS Components signs deal with Raspberry Pi Foundation. Supplier: RS Components

RS Components has agreed a deal with the Raspberry Pi Foundation to manufacture the single-board computer in Japan under a local contract arrangement.

The credit-card-sized processor, introduced in 2012, recently passed global sales of 10 million, having eclipsed the Amstrad PCW in February as the best-selling British computer ever. Raspberry Pi will now be manufactured by RS in Asia for the first time, complementing the Northamptonshire firm's current UK production.

"Existing models of the Raspberry Pi will continue to be manufactured in South Wales, UK, with the dual manufacturing locations in place to cater for future demand growth globally," said Rob Maycroft, global product manager for Raspberry Pi at RS.

"Asia-Pacific is a significant growth market for Raspberry Pi, and this new 'made in Japan' element means that we are now geared up for this growth."

Driven by a 64-bit ARM Cortex-A53 quad-core processor, the first Japanese model will be the Raspberry Pi 3 Model B, which has upgraded processing capabilities and 10x faster performance than the original Raspberry Pi.

"We are privileged to be a part of the phenomenal achievement that is Raspberry Pi," said Lindsley Ruth, group chief executive at RS parent company Electrocomponents.

"It has been a huge hit in many industrial applications, as well as in the education sector. RS is a key link in the supply chain of this remarkable success story, and that will continue to be the case as added production is implemented in Japan."

RS Components has also introduced a range of Raspberry Pi starter kits, combining various accessories with the boards to allow users to 'plug and play' straight from the box. The kit comes in three versions, including the 'official' high-quality kit and the lower-priced premium and value kits. ☺

Graphene gets hypersensitive for next-gen gas sensor

New sensor uses graphene sheet with just a single layer of atoms. Supplier: Fujitsu Laboratories

Fujitsu Laboratories, the R&D arm of the Japanese multinational, has used graphene to develop a hypersensitive gas sensor that can detect one part per billion of NO₂.

According to the company, the development could pave the way for compact instruments that can measure specific gas components with speed and sensitivity. Potential applications include detecting atmospheric pollution in real time, and testing for organically derived gases in a person's breath that could indicate diseases.

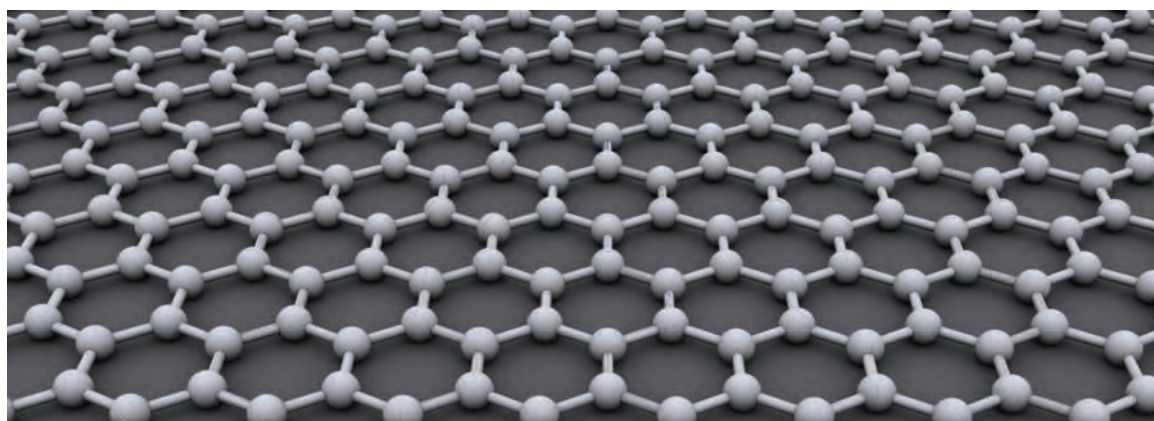
The sensor uses a graphene sheet with just a single layer of atoms to replace the gate part of a conventional silicon transistor. When a gas molecule adheres to the sheet, the graphene's work function changes, resulting in a major change in the switching

characteristics of the silicon transistor. This principle enables a gas to be detected. When the gas molecule separates from the graphene, it returns to its original state.

Fujitsu created a sensor based on this principle that measures a few tens of parts per billion (ppb) of ammonia (NH₃) and less than one ppb of NO₂ in a nitrogen environment. Among the

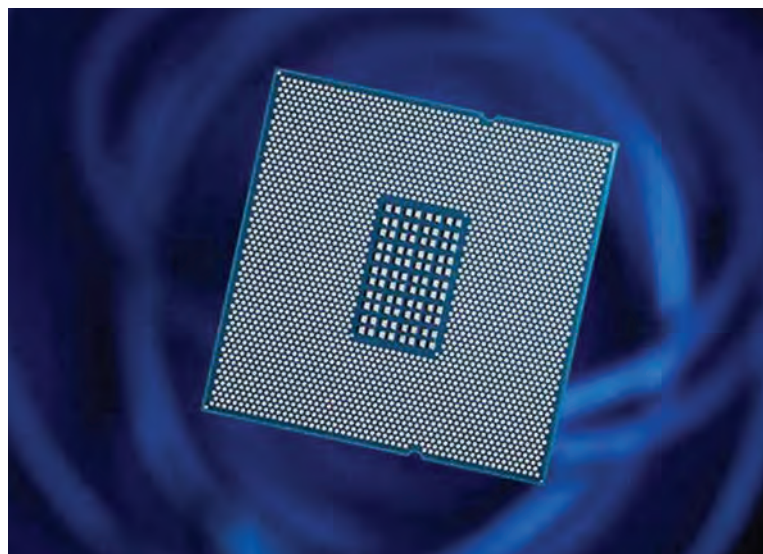
gases expected to be found in analyses of the air or human breath, the results of tests have demonstrated that it reacts only to NO₂ and NH₃.

The sensor has a detection area of just a few hundred micrometres, but Fujitsu claims this could be reduced down to less than one micrometre. It says it could be used in a compact device to measure NO₂ anywhere, in real time, at the environmental benchmark level of sensitivity of 40–60 ppb, which is an index of air pollution. Fujitsu also plans to find ways to detect gases other than nitrogen dioxide and ammonia by combining graphene with other molecules.®



Time to put fresh chips on for data servers

Company makes claims for 'world's first' 10nm server processor. Supplier: Qualcomm



Chip manufacturer Qualcomm has launched what it claims is the world's first 10nm server processor, adapting the technology of its Snapdragon 835 mobile chip for use in data centres.

The Qualcomm Centriq 2400 is the first in the company's Centriq range. Built on the 10nm FinFET process, it features up to 48 cores alongside the Qualcomm Falkor CPU. A customised ARMv8-compliant core is optimised to deliver both high performance and efficiency, designed to handle the most common data-centre computations.

"The Qualcomm Centriq 2400 series processors will drive high-performance, power-efficient ARM-based servers from concept to reality," said Anand Chandrasekher,

senior vice-president and general manager, Qualcomm Datacentre Technologies.

"Qualcomm requires the leading edge of integrated circuit technology to deliver high performance at low power for the newest premium smartphones. We are first in 10nm IC technology for mobile, and leveraging our expertise in ARM processors and system-on-chip design, we are the first with our Qualcomm Centriq range of server processors to bring the leading edge to the data centre."

The launch of the Centriq 2400 series comes after Qualcomm unveiled the 10nm Snapdragon 835, which promises a 27 per cent performance leap on its 14nm Snapdragon 821. The 821 features in Google's new Pixel smartphones, as well as the recently released OnePlus 3T.

It's expected that the Snapdragon 835 will make its debut in Samsung's forthcoming Galaxy S8, with the Korean giant having worked alongside Qualcomm on the development of the processor. Chips at the 10nm size have a significantly smaller footprint than their 14nm predecessors, which means OEMs such as Samsung will have more space to support larger batteries or slimmer phone designs.®

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AEROSPACE

Forging a future for titanium up above

The cost of titanium aerospace components could fall by a third STUART NATHAN REPORTS



The project could cement the UK's role in the aerospace industry

A consortium that includes the Advanced Forming Research Centre (AFRC) at Strathclyde University is investigating a method that could reduce the cost of titanium for aerospace components by a third.

Producing the metal from a readily available mineral, the method could cement the UK's position as a leading centre for aerospace industry.

The FASTForge project includes Safran Landing Systems, metal powder specialist Metalysis, and Sheffield University. The project aims to develop a three-step process to make titanium metal from rutile sand, a mineral composed mainly of titanium dioxide, which is found in countries including Australia, South Africa and India. The goal is to develop a process for forging titanium aerospace components, establish it within the UK supply chain, and prove its capability for landing-gear applications.

Each of the partners has a defined role within the project. Safran will act as project manager, provide specifications for the test component, test it and determine where else the material could be used in its product.

AFRC and Sheffield University will model the manufacturing process steps and optimise the pre-form and forging die designs to minimise material usage; the AFRC will also model and optimise the forging parameters and forge the component itself.

Metalysis will produce the titanium alloy powder from the rutile sand. Ian Mellor, director of technology at Metalysis said: "Per kilogram of sand, our electrochemical process produces 600g of powder product as oxygen is, essentially, stripped away. We benefit from being a powder-feed to powder-product technology – we can process pre-alloyed and ore feedstock directly."

Reducing the cost of titanium would allow it to be more widely used in aircraft manufacture, which could reduce the overall weight of aircraft and therefore help to improve fuel economy, with knock-on effects for emissions reduction and the cost of flying.

"Cheaper titanium from the FASTForge process will protect the UK's position as the second-largest global aerospace manufacturer, with potential to grow our share of the market as the sector grows over the next 20 years," said AFRC chief executive Michael Ward. "It will mean the supply chain staying and expanding in the UK with more high-value jobs as a result."

The project is expected to be complete by mid-2018. ☉

Newsinbrief

Happy ending

The Purchasing Managers' Index (PMI) from Markit/CIPS rose to a 30-month high of 56.1 in December 2016, up from 53.6 in November and above its long-term average of 51.5. The figures point to the UK manufacturing sector ending 2016 positively, with rates of growth for production and new orders in December among the best seen over the past two-and-a-half years, boosted in part by the weak sterling exchange rate.

Transformative role

Cambridge University's Institute for Manufacturing is to play a key role in a new research hub aimed at transforming the way medicines and other high-value materials are made. Led by Strathclyde University, the Future Continuous Manufacturing and Advanced Crystallisation (CMAC) Hub has been set up to develop manufacturing processes for high-value products.

Singular success

Boeing and GE Capital Aviation Services (GECAS) have announced a US\$8.25bn order for 75 737 MAX 8 aircraft, which takes GECAS' firm order book for the 737 MAX to 170 aircraft. The 737 MAX has so far accumulated 3,419 orders, making it the fastest-selling aircraft in Boeing's history. "This order shows the MAX 8 remains at the heart of the single-aisle market," according to Boeing's Brad McMullen.

Search engine

Sheffield Forgemasters has launched its search for 14 apprentices to start in the first quarter of 2017. The company, which produces castings and forgings for suppliers to the engineering, nuclear, and process industries, is investing £1m into its four-year apprenticeship programme.

MEDICAL

Screw down into operating procedures

Device could improve outcomes for patients

JASON FORD REPORTS

Researchers at the Medical Advanced Manufacturing Research Centre have assisted an orthopaedic products company in developing a surgical screw that improves operating

procedures for surgeons and outcomes for their patients.

Huddersfield-based Innovate Orthopaedics (IO) develops medical devices that solve problems identified by surgeons in order to achieve better results for patients without increasing costs.

IO asked the Medical AMRC – part of the University of Sheffield Advanced Manufacturing Research Centre with Boeing – to evaluate two new designs it had developed with leading orthopaedic surgeons for specialised orthopaedic screws.

The screws, made from biomedical titanium alloy Ti-6AL-4V ELI (ASTM F 136), are designed for certain surgical procedures, including reconstructing

the knee's anterior cruciate ligament.

Reconstruction is carried out by inserting a piece of healthy tendon in place and securing it to the bone with a screw, over which the bone will grow.

The medical AMRC worked with IO to combine aspects of their two designs and create one universal design that reduced the force needed to insert the screw while maintaining fixation.

Marcus Crossley, from the Medical AMRC, said the new screw is able to help the surgeon by engaging more rapidly with the ligament and bone when it is inserted, reducing the fatigue experienced by the surgeon and minimising damage to the replacement ligament. ☉

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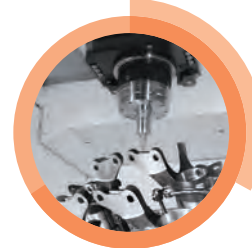


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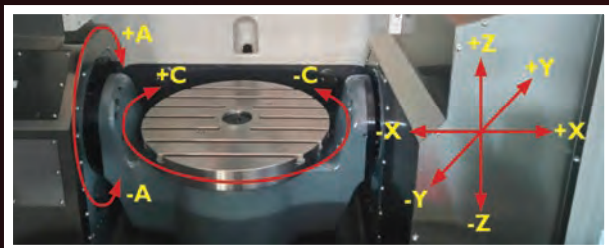
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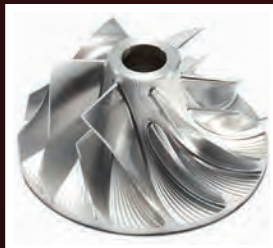
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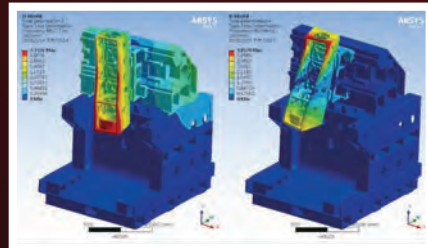
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Turning and milling is all in good time

Twin-spindle lathe gets busy on gyroscopes. Supplier: Whitehouse

Plymouth subcontracting company Morris Engineering has reduced the time taken to turn and mill a part for a military aircraft gyroscope from stainless steel bar from one hour, 15 minutes, to 7.5 minutes using a 36mm capacity Biglia B436-Y2 twin-spindle lathe with two Y-axis turrets, supplied by Whitehouse Machine Tools.

The degree to which the new process cuts down on inter-machine handling has also helped reduce labour costs.

Before installing the Biglia lathe, the gyroscope part was machined on a three-axis CNC lathe, a CNC mill with a fourth axis, and, finally, a manual lathe that was needed to achieve the required surface finish in a face groove. The B436-Y2 is one of two Biglia machines purchased from Whitehouse; this produces

parts of up to 36mm diameter, while larger parts are made on a 465 T3Y3 turn mill centre. This doubles the unit productivity while also providing redundancy. The company bought two machines in January this year for the same price as a single lathe from a competitor supplier.

"With the higher speed of

the Biglia lathe and the ability to produce the part in one hit, not only is the overall cycle time 10 times faster but we have also raised the yield of good parts by a fifth from 80 to over 95 per cent," according to production director Anthony Dyer.

Moreover, added managing director Tim Winzer, the one-hit capability has resulted in Morris winning a contract to

produce another complex stainless steel part for a military aircraft.

The company aims to use the new capability to fulfil contracts with the oil and gas sector, which have fallen away sharply in recent years but are expected to return to normal volumes. "We are well placed to offer extra, highly capable capacity coupled with short lead times," Winzer said. ☺



Automotive gets a transformation

Machine tools increase the rate of components. Supplier: XYZ



Two machine tools have transformed operations at automotive components supplier WOS Performance.

The company, whose products include starter motors and power supplies, needed to increase the rate at which it completed components, and was in particular need of improving its manual turning and milling capabilities.

Initially, WOS purchased an XYZ SMX 2500 bed mill; since none of its employees at the time were trained machinists, it opted to have the Prototrak control system fitted to the machine. "When we took delivery of the XYZ SMX 2500 we took one day of training, before that we didn't

even know how to switch it on," said Luke Wos, managing director. "Within a very short space of time we were machining anything we wanted to on the machine; if we got stuck we always had XYZ at the end of the phone for back-up."

This success meant that XYZ Machine Tools was an obvious choice for another new machine. The turning section at WOS also needed bolstering, and the company chose to purchase a ProTurn SLX 355 lathe. Also controlled by a Prototrak system, the lathe was quickly working eight hours per day within a week of being delivered. ☺





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Enhancing the machining on viscometers. Supplier: DMG Mori

Viscometer manufacturer Hydramotion turned to DMG Mori when it needed to invest in manufacturing equipment.

Its instruments are used in a wide range of industries, including oil and gas, food and beverage, paints and coatings and resins, measuring the viscosity of liquids to an extremely high precision. This demands that the components of the instruments have to conform to extremely tight tolerances in dimensions and very high-quality finishes.

Managing director John Gallagher said: "We wanted to develop our engineering and introduce a philosophy with an F1 sensibility. We already use computational fluid dynamics software in product development, CAD for design and CAM for CNC programme generation," he said. "The next

step was to enhance high-performance machining to speed up production, ensure our products are of the highest quality, future proof our manufacturing and enhance the confidence our customers have in our abilities."

Hydramotion built an 8,000 square foot factory extension to house its new machine tools, with a plan to integrate design, development and manufacturing to

speed up its processes. "Feeding back improvements in machining capabilities to the design phase will in turn lead to product enhancements," Gallagher explained. The company chose two machines: an NLX 2000 | 500 and a CTX beta 800 and, the former because it is equipped with a second spindle, and the latter, because it has a programmable travelling steady rest.

Parts that required four machining operations can be done in two on the NLX machine because of its second spindle; while the CTX machine can turn parts as small as 8.7mm in diameter and 850mm long without flexing. Moreover, the high finish quality reduces the time needed to produce a mirror-finish article by half compared with the previous machines. ☺



Up for the rotor head challenge

Consistency needed for helicopter components. Supplier: RK International



Rotor heads for helicopters are large and awkwardly shaped objects, and machining them from a forging is a challenging operation. When Leonardo Helicopters decided to bring manufacture of rotor heads in house, it turned to RK International to supply machine tools for its plant in Yeovil that was up to the task.

Leonardo produces the Lynx range of helicopters, whose rotor heads are made from forgings measuring 1.5 x 1.5m. To make the problem even more challenging, the company had to take delivery of the machine and commission it within a very tight timescale. It selected a Comev Titano 80 machine from RK, with component trials being carried out in Italy and the machine then being dismantled, shipped to the UK and rebuilt in a tight space at Leonardo's works.

The machine is a large one. It has an 8,700mm centre height, with a 1,600mm swing

over the bed and 4m between centres. The machine weighs 18,000kg, and the machining takes place 2m from the spindle nose with the rotor head component resting in a special fixture.

To ease worries over delivery, engineering site facilities project engineer Peter O'Shea insisted on receiving photographs of the castings for the machine bed.

"While delivery was crucial, the ability of the machine to deliver on quality and consistency of parts was vital," said David Brown, Leonardo Helicopters' transmission and mechanical parts production engineering manager. "The raw forgings are worth many thousands of pounds, and we are adding to that value considerably during the manufacturing process. Therefore we had to be 100 per cent certain that the machine was capable of achieving what Comev and RK International had claimed it could do." The verification process in Italy put Brown's mind at rest, he said, but the same tests were duplicated in Yeovil once the machine was complete. The machine has since proved so successful that it has free capacity, which Leonardo is filling by transferring production from older, slower machines. ☺

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Making haste

Investment in cutting-edge design and production technology is helping powertrain legend Ilmor cement the UK's position in world motorsport. Chris Pickering reports

Driving round the outskirts of Brixworth you would not necessarily know it was a place of global significance. But this unassuming corner of Northamptonshire marks the northern tip of Motorsport Valley – the strip of central and southern England that's home to something like 75 per cent of the world's top-level motorsport R&D companies. In many ways, Ilmor Engineering typifies this industry. Based in a quiet industrial estate on the eastern edge of the village, it's responsible for engines that have dominated Formula One (F1) and IndyCar yet you would hardly know it was there. It's also evolving; embracing new techniques and moving into neighbouring industries such as aerospace and defence.

Ilmor can trace its roots back to another great UK motorsport institution. Company founders Paul Morgan and Mario Illien met while they were working as engineers at Cosworth, just down the road in Northampton. They hatched a plan to produce their own engines and founded Ilmor in partnership with US motorsport mogul Roger Penske in 1984.

Initially, the company focused on the IndyCar series – a quintessentially US form of racing where British companies have had a defining impact ever since Lotus showed up in the 1960s. This remains a hugely important market for Ilmor, which produces the Chevrolet engines used in around half the current grid.

Elsewhere, the company retains a significant presence in F1. Back in the late 1990s it engineered the McLaren-Mercedes V10s that powered Mika Häkkinen to his back-to-back F1 world championships. This was the continuation of a fruitful partnership with Mercedes-Benz, which had begun with a phenomenally successful IndyCar engine earlier that decade. It culminated in 2005 when the German giant completed a buy-out of the company and created Mercedes-Benz High Performance Engines.

Paul Morgan, a keen collector of historic aircraft, was killed in 2001 when his Hawker Sea Fury overturned on landing. Following the buy-out, however, his fellow co-founders bought the non-F1 parts of the business back from Mercedes, along with the Ilmor name. The two companies now face each other – literally – over the road, but they're completely independent. They even compete against each other on the track, albeit indirectly with Ilmor carrying out behind-the-scenes work for a well-known F1 team.

Throw in NASCAR, World Rally Championship and GT racing projects and you have one of the most versatile – and active – motorsport powertrain companies in the world. Even so, it pays to diversify.

"Motorsport is good when it's good, but it can be quite seasonal," said Ian Whiteside, chief engineer for

01 The IndyCar series is a major focus for Ilmor

02 The firm produces Chevrolet IndyCar engines

03 Inside Ilmor's metrology suite

Ilmor's Advanced Projects group. "We need cutting-edge facilities with plenty of capacity to support our racing programmes, but we also need to ensure there's enough work to keep them busy during the off-season. We try and fill that with racing parts for external companies, along with prototype work for other industries such as automotive OEM, aerospace, defence and marine."

These facilities include a state-of-the-art machine shop, a metrology suite and every conceivable powertrain testing rig. The building is home to no less than seven different engine dynamometers, including a 20,000rpm F1 dyno designed and built in-house. Elsewhere, there are more than half-a-dozen smaller rigs catering to sub-assemblies and specific components.

Ilmor is a company that places huge emphasis on empirical testing, but the past few years have also seen a dramatic increase in the amount of simulation work carried out. In particular, the company has invested significantly in its computational fluid dynamics (CFD) capabilities, with the addition of a new 32-core computing cluster and a dedicated in-cylinder combustion modelling package.

"Historically we've relied heavily on physical testing, usually starting off with a handful of port designs on the



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physics that has produced the effect. In simulation, however, you can look at the root cause."

While external CFD is more or less universal in motorsport, in-cylinder combustion modelling is still a relatively new field. Modelling the ports on their own creates similar limitations to flow bench testing; even if the correlation is perfect between the CFD and the rig, it doesn't necessarily reflect what's happening in the real engine. On the other hand, it's notoriously tricky to accurately model a full cylinder with moving geometry.

Ilmor has turned to the Converge CFD code developed by US company Convergent Science. This uses a radically different approach to generating the mesh that defines the geometry of the simulation. Instead of relying on a manual mesh, Converge automates the process, based on user-defined parameters. Its makers claim this improves the repeatability of the mesh – removing the degree of manual artistry previously involved – and hence providing more consistent results.

More importantly, though, Converge regenerates the mesh at each time step throughout the simulation. That may sound time-consuming, but by reducing the cell density in less critical

areas of the mesh and increasing it in others – for instance, following the flame front as it propagates out across the cylinder – Convergent Science claims it has achieved a step change in the speed-to-accuracy trade-off. It also means the simulation can represent moving geometry, such as valve and piston motion, without incurring the deformation errors that arise from distorting a static mesh.

This proved to be the tipping point for Ilmor, Whiteside said: "We still use the flow rig for correlation, but we now use CFD for most of the development work. The first major project we tackled with Converge was the revised cylinder head for the 2016 IndyCar engine. We think we saved around six to eight weeks in terms of development time and arguably got to a better solution. There's undoubtedly a cost saving too. By screening the designs in the virtual world we probably only manufactured half the number of physical prototypes that we would have done previously. There is a degree of investment in the software, admittedly, but our licence costs less than a single rebuild on an IndyCar engine and it cuts down on running costs too."

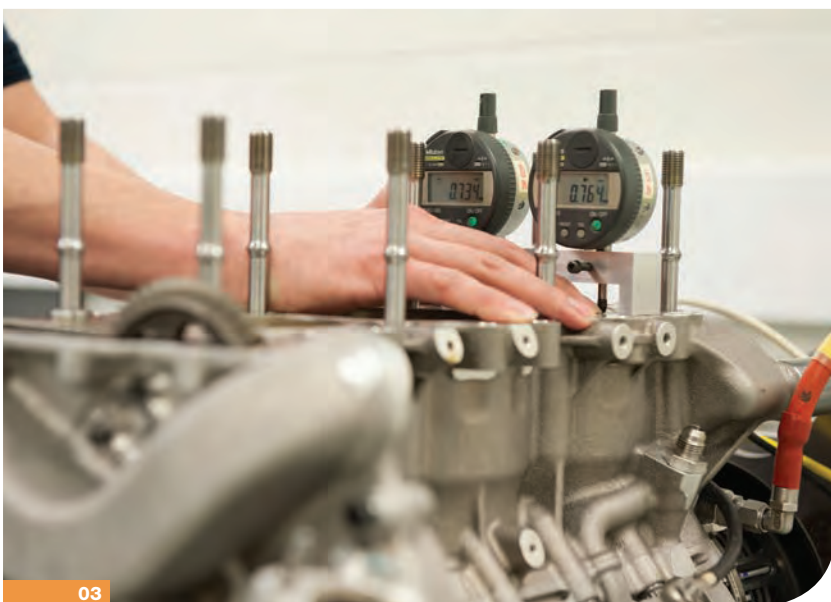
In-cylinder CFD is just one part of the shift towards digital development. Ilmor also uses 1D simulation codes such as GT Power to model engines at a systems level, often coupling them to more detailed 3D models. Other programmes in the GT Suite are also used to analyse things such as torsional vibration and tribology.

Elsewhere, the manufacturing process has also been heavily digitised. Once a design is released it is assigned a part number and sent to a central server in read-only form. The manufacturing department picks up this file and uses it to set up the machining operations. Meanwhile, the planning and procurement area of the business establishes a record of the same part number, which goes through a scheduling program to determine when it can be manufactured.

"It was quite a lengthy exercise to get this system up and running, but it's a huge benefit now," said Whiteside. "We have much greater control of the work going through the machine shop. Each of the machines is linked to the scheduling system and each part has a job code assigned to it with a barcode, so they get scanned on and scanned off the machine to keep everything updated."

This software also informs the inspection department that there will be parts on the way, where the CMM machines can be programmed in advance using the central CAD model. Finally, the stores are notified of the incoming parts, so each individual component can be given a serial number, which is then used to track it.

At Ilmor, every stage of the engineering process now features some degree of digitisation, from initial R&D concepts through to managing the service schedule of completed engines. ☺



03

flow bench," Whiteside said. "In recent years we've used rapid prototyping to speed things up, but essentially we would still pick a handful of RP parts that looked promising on the rig and then manufacture them in metal to test them on the dyno. There's only a finite number of parts that you can try with this approach and it does get quite expensive."

Aside from the cost constraints, there's also a fundamental limitation on how much information you can glean from physical testing, he added: "Charge motion is vital to understanding combustion. We do have the facility to measure turbulence on our flow rig and we have an injector rig where we can look at spray patterns with a high-speed camera, but these static tests are never truly representative of the real engine. Likewise, while you can measure the results on the dyno that doesn't necessarily help you to understand the

Automating aerospace

Technology is changing the face of the aerospace sector – but not taking jobs.

Stuart Nathan reports

The aerospace sector has always been at the forefront of technological change, and now it is spearheading a change that worries many: a shift towards automated manufacturing. But will this, as many fear, signal a reduction in jobs, or is it an opportunity to redefine manufacturing skills for the new century?

At Airbus's site in Hamburg, one of the most striking manifestations of automated manufacturing is hard at work. With its latest aircraft range, the A350, having a much larger proportion of composites in its structure than older aircraft, new manufacturing technologies are a crucial part of the Airbus strategy. The aircraft wings, for example, are wholly composite, and the company has switched from manual to fully automated production for the wing components.

Whereas at the outset of A350 production, the wing covers – the skin that sits on top of the wings' inner

structure – was laid up by hand, the company has recently started using automated fibre placement to build the wing covers. It's a striking sight. Like most large composite parts, the wing cover is made up of a series of layers of tapes; carbon fibres arranged side by side and impregnated with resin, with each strip about 5cm wide. These are unrolled from large spools into what is referred to as the tool – essentially a negative impression of the final piece. The strips are laid side by side from the roots of the wing to the

01 GKN's automated fibre placement machine at Severnside

tip until the tool is completely covered, then the next layer goes from the leading to trailing edge of the wing, and then a layer at 45° to both.

The machine that does this dangles from a moving gantry that sits above the tool. Tracking backwards and forwards and side to side, over the 32m length and 6m width of the tool, the device resembles a moving sewing machine. Its sides are studded with spindles that hold the reels of composite tape, which passes over a heated plate to partially melt the resin component of the composite and make it sticky so it binds onto the other layers. The first layer is applied onto a layer of conductive copper mesh that helps to protect against lightning strikes.

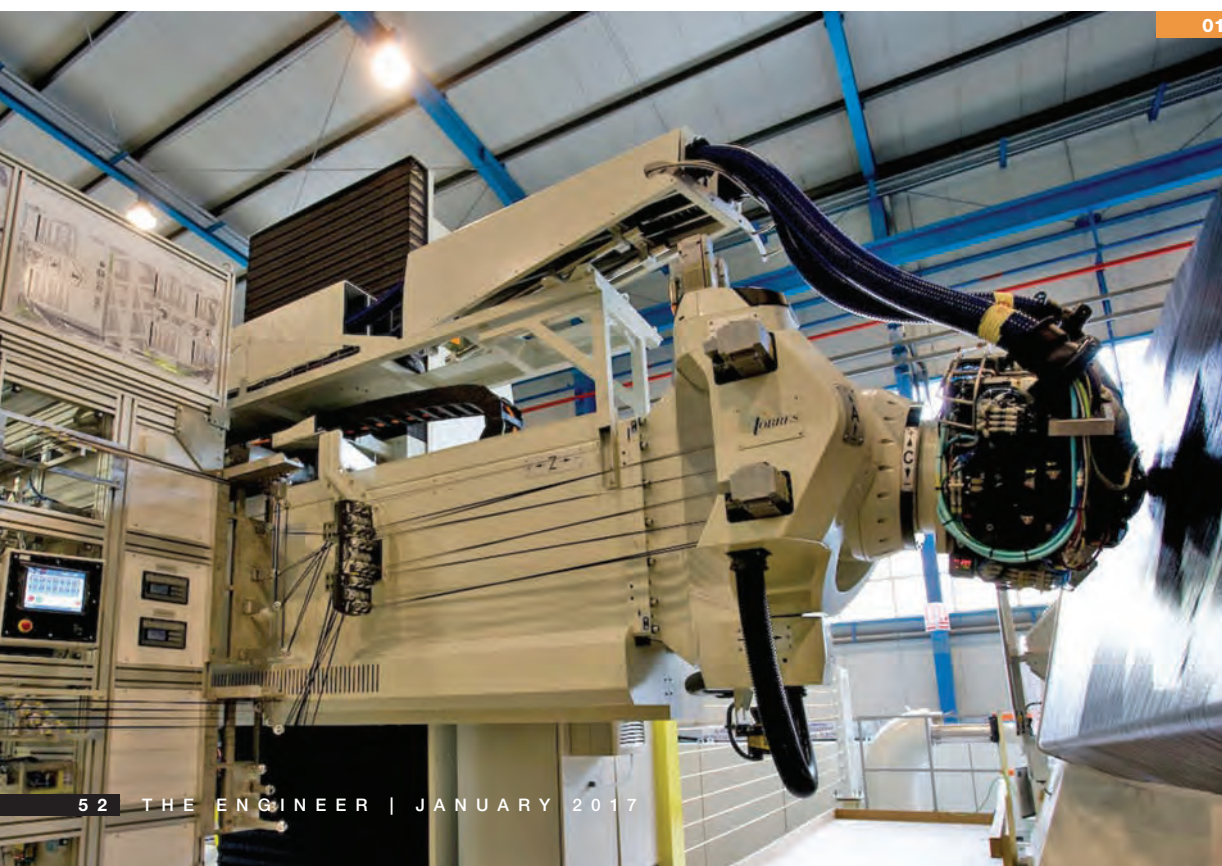
Some human involvement is still needed. Inevitably, some tapes do not stick down properly, and a technician needs to ensure any loose pieces are pressed down by hand. But the machines reduce variability, work faster and complete more parts than the labour-intensive alternative. Completed wing covers are cured inside an enormous autoclave, which is capable of holding several wing covers at once on racks; Airbus is planning to add a second autoclave of the same size as part of its strategy to increase production rates.

In the UK, a similar process is being undertaken at GKN, in Severnside near Bristol. Another section of the A330 wing, the rear spar, is also being made using automated fibre placement. The rear spar is a tray-shaped component, running from root to tip of the wing, and forms part of the fixed trailing edge, to which several moving components, such as the flaps that slide out on take-off and landing, and the main landing gear, are attached.

GKN uses a slightly different process to make the rear spar, because of its complex geometry, explained GKN Aerospace chief engineering vice-president Chris Gear. "Because the component has such exacting requirements, it has complex contours that allow it to carry heavy weights at specific points but remain lightweight and flexible," he said.

Working with Airbus and Hexcel, the US company that supplies the composite tapes, GKN devised the manufacturing process in which the placement head of the fibre placement machine moves both along the length of the spar tool (similar to the way the wing cover machine moves) but also in and out of the tool contours to place tape into all the contours, nooks and crannies of the complex spar shape. Because the placement head has to be more mobile than that of the wing cover machine, the tape spool spindles are separate from the head rather than attached to it.

But composites are not the only focus of automated manufacture in aerospace. At the Advanced Manufacturing Research Centre (AMRC) at Sheffield University, automated manufacturing techniques are under development for a variety of sectors, including automotive and even housebuilding. However, with the centre's focus on high-value industries, aerospace is a particular focus. "We are working with a variety of aerospace manufacturers, including Airbus, Boeing and BAE Systems, as well as with the supply chain, and looking at both fully automated systems and assistive techniques, particularly for assembly tasks, that help engineers on the factory floor working on aircraft," said Ben Morgan, head of the integrated manufacturing group (IMG) at the AMRC. >>



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>> “We are working now out of Factory 2050, which is our reconfigurable space designed to test a variety of techniques, and also to correct the misconception that factories are dirty and dark places,” Morgan said. “It has glass walls so the people in Sheffield can see what we’re doing, and to attract young people and professionals to work with manufacturing.”

The AMRC has four main themes for automated manufacture, he said: assembly, which in practical terms is robotic cell automation; integrated large-volume metrology, with both portable and fixed measurement systems; effective transfer of data from the shopfloor to management systems and vice versa, which includes industry 4.0 applications “which underpin a lot of our advanced machining applications”; and the machining itself. Morgan estimates about 50 per cent of the work is applicable to composites, while the rest is applicable to metals. This, not coincidentally, is similar to the proportion of composite to metal in many of today’s most advanced aircraft. “There’s also some hybrids between composite and metal,” Morgan added. “You’ll increasingly see aluminium or titanium substructures supporting a composite structure or just a composite skin, so you need machines that can deal with both.”

One example of a process in aerospace manufacturing ripe for automation is hole drilling and fastening placement. Every aircraft needs many thousands of holes drilled in precise locations to hold panels and components in place, Morgan said, and this is a time-consuming and tedious task

of the type that is generally seen to be more suited to robots than to people. Automated systems can achieve greater precision, and do not get bored or tired; drills capable of handling aerospace materials and layers of different materials are bulky, heavy and difficult even for skilled staff to use (Airbus mounts them on a sprung arm derived from the mount of a Steadicam mobile camera to assist operators). One process recently developed at AMRC and now in operation at BAE Systems’ Samlesbury plant on the production line for the F-35 strike fighter is an automated countersinking process, Morgan added.

He believes that increasing automation will “influence” manual jobs in aerospace. “Manual assembly is now being assisted increasingly by collaborative robots, but I can only see that as a good thing,” he said. “They mean that people will be less exposed to conditions or substances that we don’t want them exposed to. Companies that invest in automation

“There is a misconception that robots take jobs. Companies that invest in automation are not only seeing profits go up, they are seeing employment go up”

Ben Morgan, AMRC

02 The A350 wing cover

03 Countersinking robot cell, developed at AMRC

04 The fibre placement head at Airbus

05 Fibre placement head mounted on its moving gantry



03



04



05

are not only seeing profits go up, they’re seeing employment go up. There’s a common misconception in the UK that robots take jobs. They change the sort of jobs people are doing – one example would be that countersinking at BAE.”

Countersinking is a labour-intensive task with traditional methods, Morgan explained. “There’s a thousand holes in a wing panel, and they would be doing a couple of wing panels per day, which wasn’t nearly enough to meet the requirements. There was a risk of the work leaving the UK. So now, those same people who were doing the countersinking are now managing the robot cell. There’s no reduction in staffing. The robots have assured the work stays in this country and even put us into a position where we can win more work. The factory can produce 20 wing sets per day, and it would never have been cost-effective or practical to hire and train enough staff to do that manually. So to say the robots have cost jobs is just not true.”

Making time to make savings

Speeding up threading for oil and gas. Supplier: Sandvik Coromant

Halliburton's Singapore operation makes hundreds of different components each year for the oil and gas industry. Many of these parts are made using Inconel 718, a very expensive but high-strength, corrosion-resistant nickel chromium material that can be used at very high and very low temperatures. Many of Halliburton's components need to be threaded so they can be connected to other parts.

Halliburton faced very high cycle times for production threads with a thread-milling process, slowing down the production times.

The company had looked previously at ways to speed up the threading process at its UK plant but with disappointing results. So it took the opportunity of a slowdown in the oil and gas industry to revisit this process.

It was a challenge taken up eagerly by Sandvik Coromant, which has a close working relationship with Halliburton in Singapore.

Engineers at Sandvik's Singapore-based Productivity Centre carried out comprehensive tests of its threading solutions (tapping) on the Inconel 718 material and soon went back to Halliburton with the CoroTap 200 – SD, which was integrated into the manufacturing process.

One of the biggest improvements was for the thread-milling process of Halliburton's release housing components. Before, the process took 116 minutes to complete, but this was cut to six minutes once the CoroTap 200 – SD was introduced. Meanwhile, for Halliburton's manifolds, the cutting time was more than halved to 12 minutes as a result.

"I was surprised and very excited by the time savings," said Singapore-based Foo Siong Fatt, senior technical professional at Halliburton. "Because our UK trials were not successful we wanted lots and lots of testing, which Sandvik Coromant was happy to do off-site. Doing this type of testing in house carries certain risks. I was surprised by how the implementation was so smooth. Change is not always easy in manufacturing, but this was very spontaneous."

The whole process, from testing through to implementation, took about three months (February through April 2016), a time when oil prices hit record lows. This slump in prices sparked a slowdown in the energy industry,

forcing companies to scrutinise their costs and processes. For Halliburton, the introduction of Sandvik Coromant's CoroTap 200 – SD came at an opportune moment.

Halliburton initially introduced the CoroTap 200 – SD to components, that require thread size of 3/8-16 UNC (Unified National Coarse) holes, then to thread size of 1/2-13 UNC holes.

Because of the time reductions, Halliburton is now looking at other components it can use CoroTap 200 – SD on. Inconel 718 is a difficult and expensive material to work with, but technical specialists at Sandvik Coromant were confident that they could meet the challenge. ☺



Workholdings are getting versatile

System enables rapid change from one set-up to another. Supplier: WNT

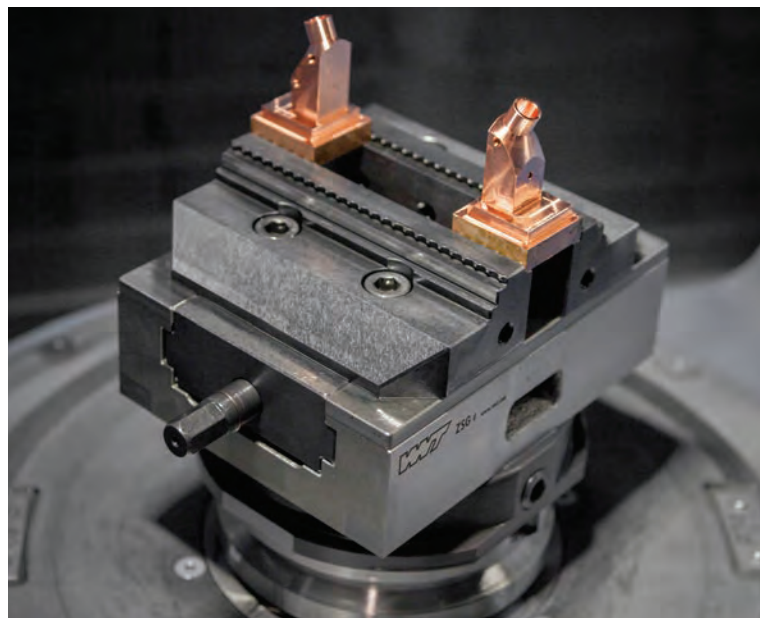
Investment in the latest machine tool technology at Aylesbury-based CNF Precision Engineering called for a versatile workholding system, and the company turned to tooling specialist WNT.

According to CNF, the chosen technology, WNT's MNG system, enables rapid and accurate changeover from one set-up to another, with multiple set-ups possible on a single base plate, and has ushered in significant time and productivity gains at the firm.

Initially every one of the 32 pallets on CNF Precision Engineering's Matsuura MAM72-35V five-axis machine was equipped with single-position MNG Zero Point base plates. With the arrival of the Matsuura H-Plus 300-PC15 and MX-520 simultaneous

five-axis machine, works manager Mark Baron looked to expand its use and introduced double- and triple-location MNG base plates.

"The WNT MNG system, along with the ZSG centric vices and ESG fixed-jaw vice, have proved to be highly versatile. We have added to them as we have progressed, making use of the different jaw systems available for the vices. While the majority of our set-ups are single parts per pallet, the ability to mix and match vices on the MNG base plates is an obvious advantage and allows for extended unmanned operation," said Baron. "Another key feature is the enclosed leadscrews on the WNT vice system. We looked around and couldn't find this feature on other vices. Given the number of pallets



that we have, this feature is invaluable as we can't afford the time to clean swarf from the leadscrews of all our vices, or indeed continually replace them due to swarf damage."

The system has enabled CNF to maximise its multi-pallet machines, set-up is speedy due to the single clamping screw on the system and repeatability is guaranteed to within

0.01mm. A low profile of 30mm makes it suitable for five-axis machining.

The main vices in use at CNF are the ZSG 3 and 4 centric vice and the ESG 100 single-clamp systems. The ZSG range has a maximum gripping force up to 35kN and components up to 303mm in length can be held securely in its jaws, yet they remain very compact. ☺



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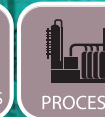
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The very best in manufacturing

AMS 2017 gives visitors the opportunity to view live demonstrations, and to benchmark and specify the latest technology

R

unning from 6–8 June at the NEC Birmingham the Advanced Manufacturing Show 2017 (AMS) is a must-attend event for anyone with an interest in finding out about and specifying the latest manufacturing technology.

The event, which runs every two years, offers visitors the opportunity to meet suppliers, view live demonstrations, and benchmark and source the latest technologies. Product areas include machine tools, tooling and workholding equipment, additive manufacturing systems and specialist metrology.

For exhibitors, the show offers an opportunity to meet with senior buyers from across industry and rub shoulders with key decision makers from the automotive, aerospace, defence, F1/motorsport, oil and gas, and medical sectors.

The 2017 event looks set to build on the success of its last outing with many of the big names from 2015 eagerly awaiting this year's iteration.

One company hoping to repeat the successes it enjoyed in 2015 is Renishaw.

Reflecting on the 2015 show, UK national sales manager Jonathan Archer said: "We found the show to be well attended and by people working in our key target industries. We met with existing and potential new customers at the show and this resulted in a good amount of quality leads being taken by our sales team over the course of the show."

At this year's event, as well as showcasing its well-established expertise in metrology, and promoting the benefits of its unique 5-axis probing technology, Archer said that Renishaw is particularly looking forward to demonstrating its expanded

Another key exhibitor returning to AMS is 3D scanning specialist Measurement Solutions, which will be showcasing its expertise in automated inspection solutions using industrial robots. Managing director Iain Caville is looking forward to building on a very successful 2016 at the show. "2016 was our return to AMS after trying various other shows," he said. "We were pleasantly surprised at the quality and level of interest in our products and services, such that we had no hesitation to book a larger booth for 2017. The show works for us as it is not too long, yet provides ample opportunity for visitors to see what they need to see."

As in 2015 – AMS will be running alongside Subcon – the UK's only dedicated event for engineering contract and subcontract manufacturing, and The Engineer Design and Innovation Show.

Together the three shows provide 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, 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 and 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 show here: www.advancedmanufacturingshow.co.uk



Renishaw's Equator gauging system (left) and RenAM 500M additive machines will both be on show

"It has been clear in 2016 that political and economic changes in the UK, and the world, have brought a certain degree of uncertainty to manufacturing companies across most industries, and this has led to a continuing trend of many manufacturers looking to improve the products and processes that they already have in place. Our emphasis on getting the best from existing equipment and improving manufacturing processes aligns with our customers' concerns"

Jonathan Archer – UK national sales manager, Renishaw

additive manufacturing product line and the exciting new system developments in that area.

Key technologies on display will be the RenAM 500M additive manufacturing system; the REVO-2 five-axis CMM measuring head; the newly launched XM-60 multi-axis calibrator; and the Equator gauging system.

Commenting on his hopes for this year's event, Archer added: "We hope to further develop our relationships with existing customers and show new visitors the possibilities that Renishaw products can offer in terms of process control and productivity."

"The Advanced Manufacturing Show represents the perfect event to meet the kind of visitors we aim our products at. Each year, the number and quality of enquiries we receive has been excellent"

Chris Davies – Aberlink



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Engineering events and exhibitions 2017

January

Autosport International Steel Fab	12-15 January 16-19 January	NEC, Birmingham Expo Centre Sharjah, UAE
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March

Packaging Innovations Show	1-2 March	NEC Birmingham
Ecobuild	7-9 March	Excel, London
Embedded World	14-16 March	Nuremberg, Germany
JEC World	14-16 March	Paris
Southern Manufacturing	21-23 March	Farnborough
Maintec	21-23 March	NEC, Birmingham
TotalDECOM	27-29 March	Old Trafford, Manchester
StocExpo	28-30 March	Rotterdam
Plastics Recycling Europe	29-30 March	RAI, Amsterdam

April

Medtech Europe	4-6 April	Stuttgart, Germany
Industry 4.0 Summit	4-5 April	Manchester
Med-Tech Innovation	26-27 April	Ricoh Arena, Coventry
Hannover Messe	24-28 April	Hannover, Germany
Commercial Vehicle Show	25-27 April	NEC, Birmingham

May

National Electronics Week	9-10 May	NEC, Birmingham
All Energy	10-11 May	SECC, Glasgow
POWER-GEN India & Central Asia	17-19 May	Pragati Maidan, New Delhi, India
Edie Live	23-24 May	Birmingham, NEC

June

Electronic Warfare	6-8 June	Olympia, London
Subcon	6-8 June	NEC, Birmingham
Advanced Manufacturing	6-8 June	NEC, Birmingham
The Engineer Design and Innovation Show	6-8 June	NEC, Birmingham
Paris Air Show	19-25 June	Paris
Product Design & Innovation North	21-22 June	Event City, Manchester
Plastics, Design, Moulding	21-22 June	Event City, Manchester
Additive Manufacturing Europe	27-29 June	RAI, Amsterdam
POWER-GEN Europe & Renewable Energy World Europe	27-29 June	Koelnmesse, Cologne, Germany

July

POWER-GEN & DistribuTECH Africa

18–20 July

Sandton Convention Centre,
Johannesburg, Republic of South Africa

September

The Energy Event
Asia Power Week – Incorporating POWER-GEN
Asia & Renewable Energy World Asia
PPMA Show
TCT Show
Interplas
Northern Manufacturing

12–13 September

Birmingham, NEC

19–21 September

BITEC, Bangkok, Thailand

26–28 September

Birmingham, NEC

26–28 September

Birmingham, NEC

26–28 September

Birmingham, NEC

27–28 September

Event City, Manchester

November

Aero Engineering Show
Automotive Engineering Show
Composites Engineering Show

2–3 November

Birmingham, NEC

2–3 November

Birmingham, NEC

2–3 November

Birmingham, NEC

Now's the time for infrastructure

With major investment going into UK construction, there has never been a better period to build a career in infrastructure. Evelyn Adams reports

The UK's construction industry is ramping up activity in 2017. Last month, the government announced more than £500bn worth of infrastructure investment – money that will benefit everything from the country's built environment to its communications networks.

This award follows an announcement regarding the £23bn National Productivity Investment Fund that includes infrastructure investments of over £2.6bn to improve transport networks. The government is also planning a multi-million-pound package on the future of broadband, and £7.2bn to support the construction of new homes. In total, the investment is expected to create demand for more than 250,000 to be constructed by 2020.

The funding has been described by the government as "the largest and most comprehensive ever", creating a

golden era in UK infrastructure. Chief secretary to the Treasury David Gauke claimed: "This record infrastructure pipeline is set to make a real difference to people's lives from quicker and easier journeys, to better broadband access, and building more homes for people who need them in high-demand areas."

There remains, however, a major challenge to building these homes, roads and runways. Around 20 per cent of civil engineers are set to retire in the next 15 years, and the amount of fresh blood entering the industry is not enough to meet the increasing levels of demand, or even fill the current skills gap. From London's 'super sewer' to Hinkley Point C, engineers with the right talent are urgently needed to forge ahead with the UK's infrastructure plans.

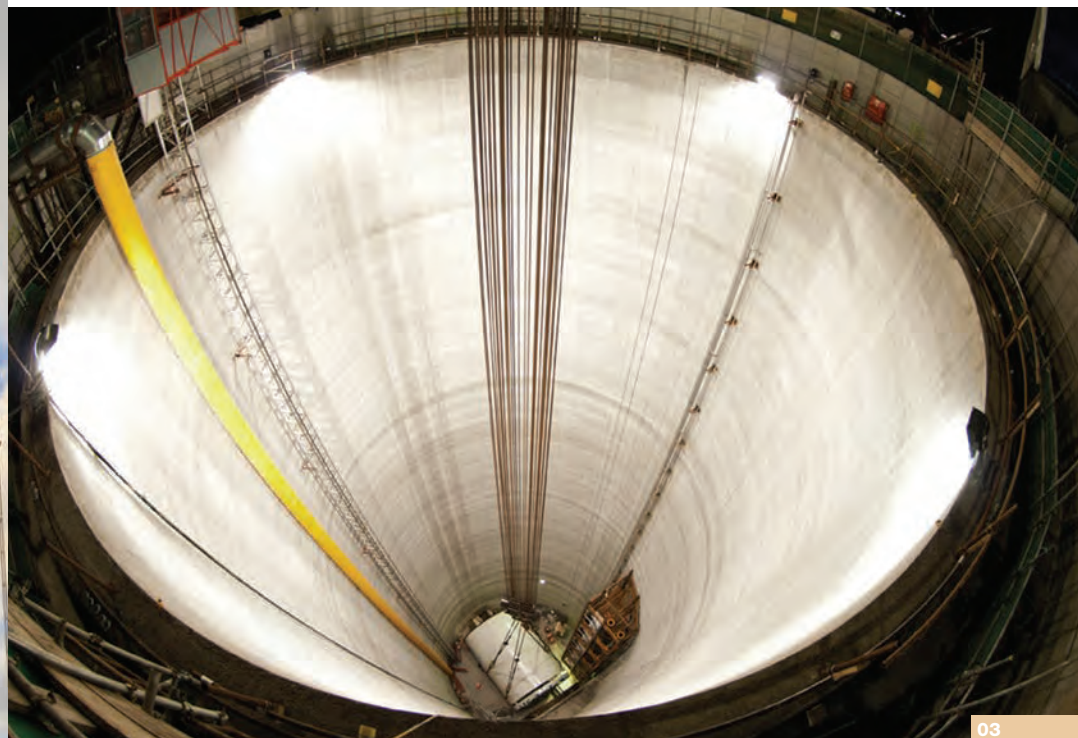
This means that companies are now widening their net outside the traditional talent pool. A recent report by the Institution of Civil Engineers and construction firm Costain has called for a "recruitment revolution" in civil engineering. It said that new engineers need to be attracted to the industry from ex-military personnel and data scientists.

One of the projects that is set to require a huge number of engineers is the Thames Tideway Tunnel. This is a six-year £4.2bn infrastructure scheme that aims to prevent sewage overflowing from London's Victorian system into the River Thames. At its peak it is expected that there will be around 4,250 direct construction workers and a further 5,100 indirect jobs created by the London project. Tunnelling will begin this year and the project is expected to be complete in 2023.

Scott Young, head of skills and employment at Tideway admitted that compared to other engineering industries, sewage can be hard to sell. But the engineering opportunities offered by the project are unparalleled. A huge variety of skills are required. In particular, the project is looking for talent construction engineers and tunnelling specialists. Working on such a large-scale project that will make a lasting mark on London's infrastructure will be a rewarding and challenging career path, allowing engineers to develop transferable skills.

While the engineering jobs at the Tideway are focused in London, work is underway at Hinkley Point C in Somerset. It will be the biggest construction site in Europe, providing 25,000 construction jobs. When it is complete, the nuclear power station will employ 900 people and provide enough power for six million homes, and supplying seven per cent of the UK's electricity needs over 60 years.





03

“A nuclear power station is a great opportunity for the UK to re-invigorate our nuclear engineering workforce,” said Dr Ben Britton, a Royal Academy of Engineering research fellow and director of MSc in advanced nuclear engineering at Imperial College London. “UK graduates are needed both in the supply chain, operation and management of our nuclear fleet. These jobs require highly skilled individuals with a diverse range of expertise, combined with a holistic understanding of engineering in a nuclear context.”

Meanwhile, High Speed 2 (HS2), the proposed new high-speed railway connecting London with the West Midlands and the north of England, is expected to create 25,000 construction jobs. The project demands higher-level skills compared with other rail schemes. Around half of the workforce will need skills at level 3 (A-level equivalent), yet 80 per cent of the current UK construction workforce only train to level 2.

To bridge this gap, later this year, the National College for High Speed Rail will be opening with campuses in Doncaster and Birmingham. These will be the most advanced institutions of their kind in the UK – providing industry-led training for 1,265 school leavers, those changing career and established professionals.

Beth West, commercial director for HS2, said: “HS2 provides the opportunity to drive productivity and growth, and increase the UK’s international competitiveness in high-tech engineering and construction. It demands new higher-level technical skills for jobs not yet in existence in the UK.” The college provides the opportunity to develop these skills, including new ones such as digital planning, before putting them into practice on HS2.

Other mega-projects, such as the Trans-Pennine road tunnel and Heathrow Terminal 3, mean that there has never been a better time to pursue an engineering career in the construction industry. “With continued government investment, there are plenty of opportunities for skilled engineers to work in infrastructure,” said Stuart Minchin, divisional manager at engineering recruitment specialist Matchtech.

“At a junior level, graduates and apprentices wanting to

build a career within civil engineering should first consider which sector they are most interested in working and then reach out to the consultancies hiring within that sector. For more senior and experienced engineers looking to move into a different infrastructure sector, working with a recruitment consultant can help facilitate your move, as some consultancies are more hesitant than others about hiring engineers from other sectors. You can explain what experience you want to gain, where your strengths lie and the consultant can then help promote you to consultancies within your preferred sector.

“The infrastructure sector drives the economy, so to encourage further growth, employers need to consider all options to find and secure the best talent to encourage further economic growth.”

01 CGI view of Hinkley Point C

02/03 Running from Abbey Mills pumping station to Beckton sewage works, the Lee Tunnel is a key component of the Thames Tideway Scheme

02

The Generac logo is displayed in white capital letters on a black rectangular background, which is part of a larger image showing industrial buildings.

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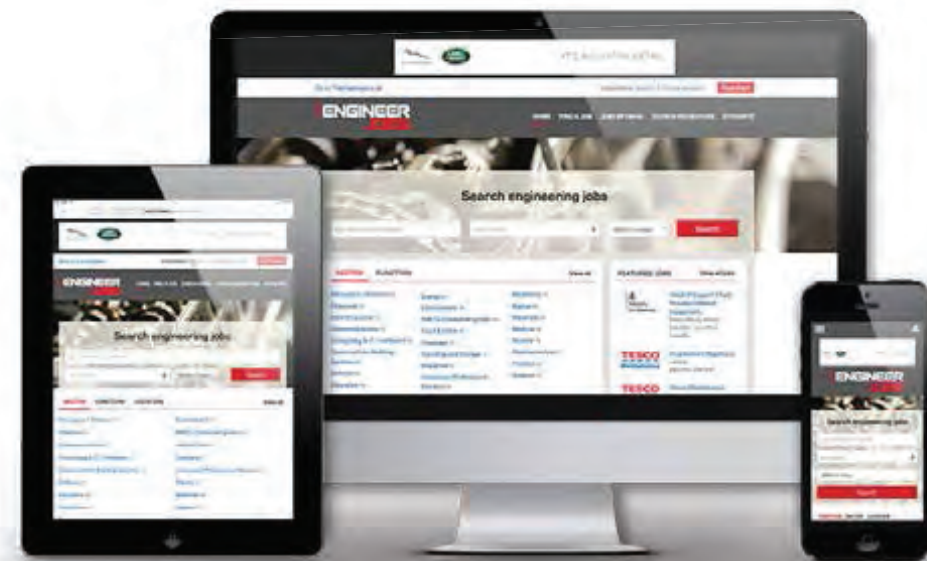
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One for the road

Jon Excell **takes the most recent model in McLaren's sports series out for a spin in the countryside**

G

etting behind the wheel of a supercar can be an unsettling experience: particularly when you've just stepped straight from a sedate family saloon.

But what's instantly remarkable about McLaren's 570GT is that it manages to make this sudden leap from laboured

workhorse to dazzling speedster seem like the most natural thing in the world, without sacrificing any of the excitement.

Launched at the 2016 Geneva Motor Show, the 570GT is the most recent model in the Woking carmaker's sports series, the most affordable and accessible of its three ranges.

Also comprising the 570S Coupé and the 540C, the sports series accounts for in the region of two-thirds of McLaren's total annual production, which last year was around 3,000 vehicles. In contrast, the firm made just 375 units of its P1 hypercar, which ceased production in December 2015. While many of the vehicles rolling off the lines at the company's futuristic Norman Foster-designed production centre are destined for a pampered, glamorous life of track days and multi-millionaire ownership, the 570GT is a very different beast.

This, according to McLaren, is a car designed for everyday use: a car to drive to work, nip to the shops in and even take on holiday. Indeed, it's a car that boasts more concessions to comfort, luxury and the day-to-day demands of driving than any other vehicle in the firm's stable. It's also the first McLaren to feature a glove box!

So, what better place to put it through its paces than the winding country roads of Northamptonshire on a wet and blustery autumnal day?

Perhaps the one disadvantage of testing the car on a public road is that you can't really open it up. Which is a shame, because here, despite the concessions to comfort, the 570GT

01/02/03 The 570GT is described by McLaren as its most road-optimised vehicle yet

The specs



02

- **Engine** 3.8L V8
- **Maximum speed** 328kph (204mph)
- **Acceleration (0–60 mph)** 3.3s
- **Fuel consumption** 26.6mpg
- **Dry weight** 1,350kg
- **Body structure** 75kg MonoCell II carbon-fibre chassis
- **Power** 562bhp @ 7,500rpm
- **Torque** 600Nm @ 5,000–6,500rpm
- **Transmission** seven-speed seamless shift dual-clutch gearbox
- **Basic price** £154,000



03



01

is every bit as impressive as its siblings: with its 3.8-litre twin turbo v8 engine endowing it with a top speed of 204mph.

Nevertheless, in the constrained environment of the real world, it still provides some stunning legal highs: not least an ability to accelerate from 0–60mph in just three seconds.

All of this power is delivered to the rear wheels via a seven-speed seamless-shift transmission, which can be used in either auto mode or controlled via paddles on the steering wheel. You can select from three different driving settings via a dynamics panel in the centre console that adjusts the car's adaptive dampers.

In normal mode in particular it's a notably comfortable ride, thanks largely to changes to the suspension and steering system. The spring stiffness has been reduced by 15 per cent at front and 10 per cent at back, while the electro-hydraulic steering system – retained from the Coupé models – has also been tweaked and redesigned to smooth out driver inputs at high cruising speed.

The 570GT is also a quieter ride than other models. Lightweight noise absorbing and damping materials have been used throughout while the tyres, designed in collaboration with Pirelli, use a vibration cancelling polyurethane sponge to reduce cabin noise by a further two to three decibels. 🗣️

Jan
1945

Atomic analysis

Taking stock of the horrific and awe-inspiring use of atomic weapons on Hiroshima and Nagasaki

This magazine is a conduit through which technological advances are communicated and, in doing so, it has documented periods in mankind's history that are horrific and awe inspiring in equal measure. This point was brought to bear in

January 1946 when *The Engineer* reported on the use of atomic weapons against Hiroshima and Nagasaki during the Second World War.

Specifically, 5 August 1945 saw the US drop a 15kt atomic bomb on Hiroshima that wiped out over four square miles of the city, which was around 60 per cent of its total area.

Four days later, a second, more-advanced, 21kt bomb was dropped on Nagasaki, which was afforded a degree of relative protection by its mountainous geographical features.

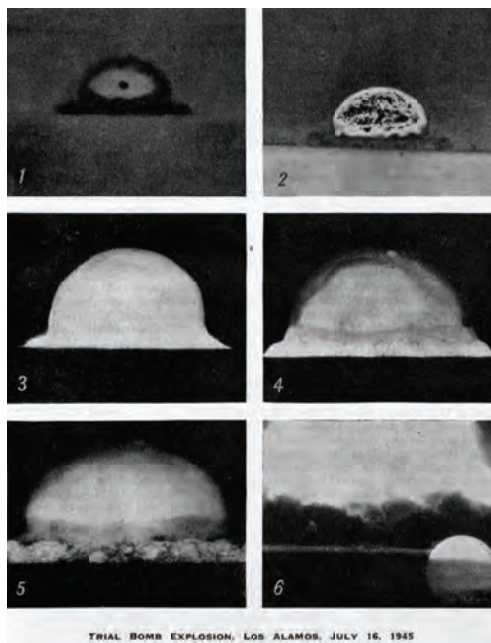
On 14 August 1945 Japan surrendered unconditionally, bringing about the end of hostilities between Japan and Allied forces. By December 1945, between 90,000 and 120,000 people are estimated to have died as a result of the attack on Hiroshima, which had a population of roughly 330,000. In Nagasaki, a city with a population of 250,000, between 60,000 and 80,000 are thought to have died as a consequence of the atomic strike.

Was the use of atomic weapons worth it? *The Engineer* was understandably short of any technical detail regarding the construction of the two weapons so set about a discussion that soberly and succinctly discussed the merits of using such force less than a month after a trial bomb was exploded in the US.

Japan's armed forces were much depleted and the nation itself was on the brink of being invaded. To compound matters, the Soviet Union had declared war on the Japanese in northern China.

Militarily, wrote *The Engineer*, the atomic bomb only hastened Japan's inevitable end.

"Nevertheless, to the world at large the news of the dropping of the bomb on Hiroshima brought a feeling of awe. It was at once realised that, working



An atomic bomb trial in the US shortly before the attack on Hiroshima

secretly and silently, science had succeeded in unleashing a new destructive force of terrible power, and of terrible significance for the future of mankind. Many people felt that it was a crime against humanity to exploit one of science's most significant discoveries in this way.

"Undoubtedly, we must all feel regret that the achievements of so many brilliant investigators, the toil of so many workers, the expenditure of so much wealth, should have been applied in an apparently ruthless manner to the destruction of human life."

Pertinently, *The Engineer* reminded readers that by 1939 Great Britain, Germany, France, Russia, the

"We must all regret that the toil of so many workers has been applied to the destruction of human life"

The Engineer

US, and Japan were well aware of the possibility of producing a bomb based on nuclear fission.

The Engineer wrote: "The essential scientific facts were common property and their transmutation into practical terms was only a question of time and the expenditure of sufficient industrial effort. It was a race against time between the United Nations and the Axis Powers. It is now known that thanks to the immense resources of the United States the race was won by the Allies.

"By what margin of time it was won will probably always remain unknown. It is, however, quite possible that it was only a question of months. Sooner or later, one side or the other would have produced an atomic bomb. There is surely room for much consolation in the fact that success came first to those who would not, and will not, use it as a means towards securing aggressive world domination."

Many will argue that the development of nuclear weapons has acted as a deterrent against severe conflicts and, to date, there are an estimated 15,375 nuclear weapons stockpiled around the world. Russia is said to account for 7,300 of these, while the US holds 6,970. The UK has 215, with Pakistan, India and Israel accounting for 130, 120 and 80 nuclear weapons respectively. The world's nuclear stockpile peaked in 1986 at just over 60,000 weapons but has since steadily decreased.

In 1905, George Santayana wrote in *The Life of Reason* that "those who cannot remember the past are condemned to repeat it" and, chillingly, US president-elect Donald Trump has used another facet of modern technology, namely Twitter, to state: "The United States must greatly strengthen and expand its nuclear capability until such time as the world comes to its senses regarding nukes." **JF** ©

Word of the issue

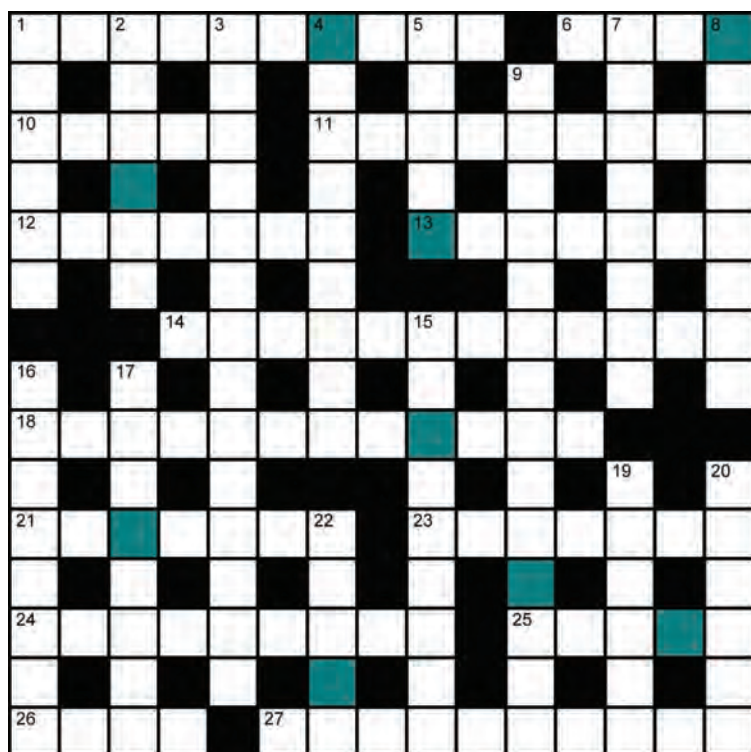
Anthony Poulton-Smith explores the origins of the word 'solder'

The earliest mention to 'solder' comes from the middle of the 14th century and can be traced to the Old French noun *soldure* and this from the Latin verb *solidare* 'to make solid'. This verb describes very well what the process is, turning a solid into a liquid and allowing it to re-solidify in small quantities to produce a join, seal, or connection – hence the origin of 'solder' is 'solid'. As with so many simple and common words we can trace this back to Proto-Indo-European where *sol-ido* meant 'to make whole' and actually gave us Greek *holos* 'whole' and Latin *salus* 'health'. Other contemporary uses of 'solid' are: 'entirely of the same product'; 'well established'; and in a musical sense of 'wonderful, remarkable'. All these uses are first found after the adaptation of 'solid' to 'solder' and have come from the use of 'solder' as it solidifies rather than the original use of 'solid' as an unchanging state of matter.

Big picture



Hitachi Rail Europe (HRE) has unveiled the first Intercity Express train to be built in the UK at its manufacturing facility in Newton Aycliffe, County Durham. HRE opened the £82m facility in September 2015 as part of its plan to develop a hub of industry and innovation in north-east England.



Prize crossword

When completed rearrange the highlighted squares to spell out a solid solution of carbon in iron. The first correct answer received will win a £20 Amazon voucher. Email your answer to jon.excell@centaur.co.uk

Across

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

Down

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

Last issue's highlighted solution was nanotube.



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