theENGINEER

First for technology & innovation | www.theengineer.co.uk

JANUARY 2015 | £3.70

Deep freeze

The technology that will probe Jupiter's icy moons »18

Energy options

The head of Imperial's Energy Futures Lab on the UK's energy mix »26

What's in store?

Experts answer your questions on carbon capture and storage technologies »28

Careers feature

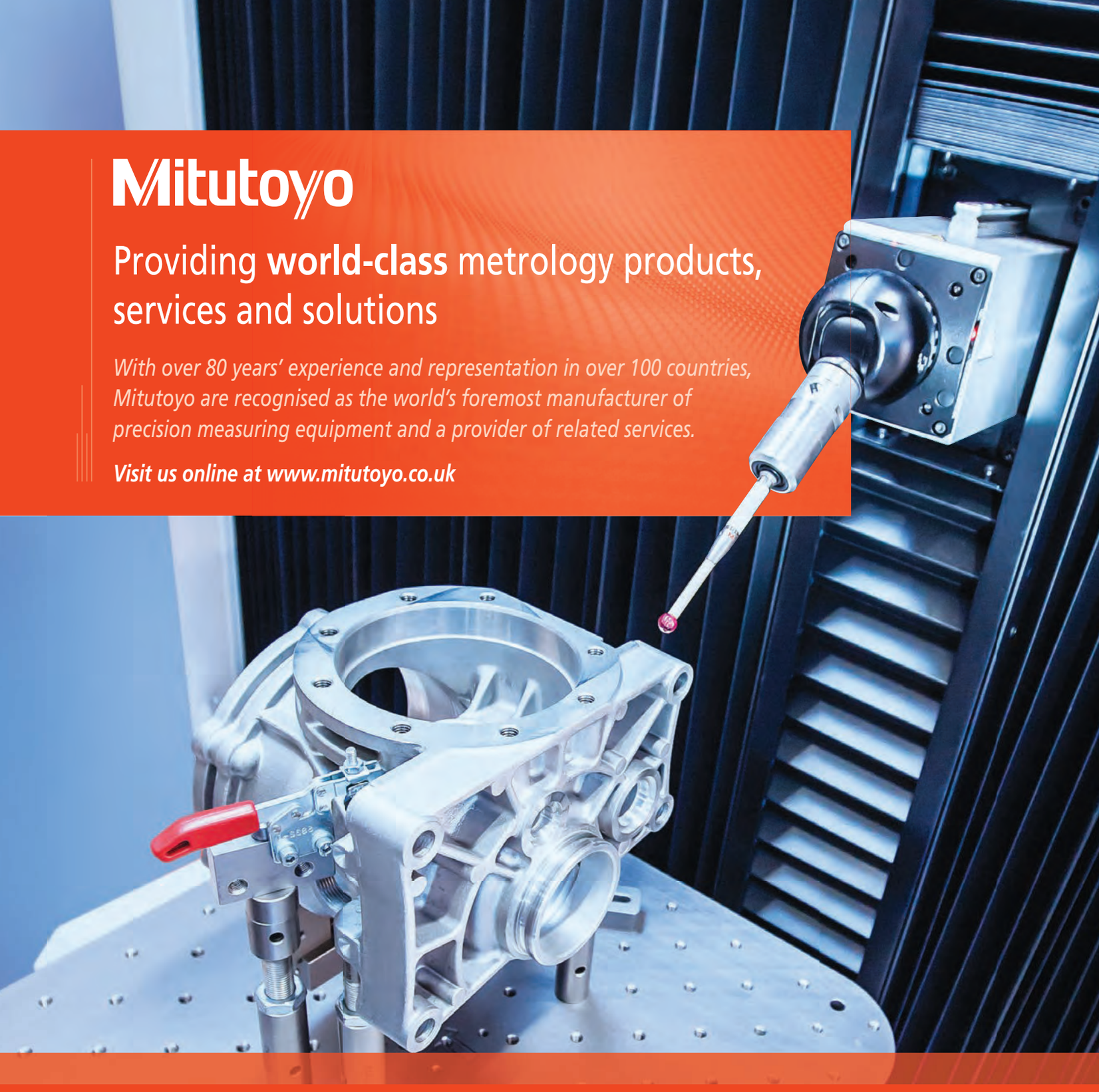
Why opportunities at consultancies aren't just about civil engineering »44

Mitutoyo

Providing **world-class** metrology products, services and solutions

With over 80 years' experience and representation in over 100 countries, Mitutoyo are recognised as the world's foremost manufacturer of precision measuring equipment and a provider of related services.

Visit us online at www.mitutoyo.co.uk



City & Guilds
Approved Centre

EXCLUSIVE DIMENSIONAL METROLOGY QUALIFICATION

Mitutoyo alongside City & Guilds exclusively offer the first National Qualification in Dimensional Metrology
Find out more, or book your place at *www.mitutoyo.co.uk/education*

inthisissue

Volume 296 Issue No.7859 | Established 1856

News

05 **Technology** Device could diagnose Ebola within an hour

06 **Technology** Nuclear detection system set to thwart development of bombs

10 **Design** Washing machine utilises polymer beads to cut down on water use

32 **Digest** This issue's crossword, plus a look through the archives

Opinion

12 **Viewpoint** The opportunities offered by commercial unmanned aircraft

14 **Mailbox** Your letters to the editor and views from www.theengineer.co.uk

26 **Interview** the head of the Energy Futures Lab is optimistic about the UK's prospects

Features

18 **Cover story** UK engineers are turning their attention to Jupiter's icy moons

23 **Feature** A former cigarette factory is now home to a bulk producer of batteries

28 **Q&A** Our experts answer questions on the future of carbon capture and storage

35 **Feature** UK researchers are developing graphene measurement techniques

39 **Feature** How successful is the UK's research into plastic electronics?

inouropinion

Space to explore

When, towards the end of last year, the Rosetta mission's robotic Philae probe touched down on the surface of comet 67P, it was rightly hailed as one of humankind's more staggering technological achievements.

And yet the success of this mind-bogglingly complex exercise also highlights one of the curious conundrums of space technology development: that while space missions are frequently invoked as yardsticks of human endeavour — measures of how far we've come in technology terms — they're frequently underpinned by technology that, in some cases, can be decades old.

Philae is a good example. The mission was approved by the European Space Agency (ESA) way back in 1993 and the spacecraft carrying the probe launched more than a decade ago. And although the team involved has stressed that the data coming back from the probe is beyond their wildest dreams, it's tempting — given the huge progress in many areas of technology over the last 10 years — to wonder what might have been achieved with today's technology.

In this issue's cover story (Deep freeze, p18), we take a look at 'today's technology' and examine some of the issues that engineers face as they set about developing the spacecraft that will explore the icy moons of Jupiter, which, of all our solar system's bodies, potentially come closest to harbouring some form of life. Hopefully one day, today's advanced technologies will help some of the ambitious projects outlined over the following pages join little Philae on the roll call of incredible engineering achievements.

"Space missions are often invoked as yardsticks of human endeavour

Elsewhere in this issue, there's a distinct focus on the more earthbound issue of future energy supply: from the emotive topic of carbon capture and storage (the subject of our Q&A feature, p28) to an interview with Prof Timothy Green, the head of Imperial College's influential Energy Futures Lab.

The debate around the UK's energy future is so frequently a gloomy one — particularly in the more hysterical corners of the national media — so it's great to hear a more upbeat analysis from one of the industry's experts.

Finally, I'd like to take this opportunity to wish all of our readers a very happy and prosperous 2015.

Jon Excell Editor
jon.excell@centaur.co.uk

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

ISSN 0013-7758.
Printed by Headley Brothers Ltd, Ashford TN24 8HH

Visit **www.theengineer.co.uk** for constantly updated news, products and jobs and to sign up for our FREE weekly email newsletter and tailored job alerts

CENTAUR MEDIA The Engineer isprinted on 100% recycled paper

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

Direct dial 020 7970 followed by extension listed **Advertising fax** 020 7970 4190 **Editor** Jon Excell (4437) jon.excell@centaur.co.uk **Special projects editor** Stuart Nathan (4125) stuart.nathan@centaur.co.uk **News editor** Jason Ford (4442) jason.ford@centaur.co.uk **Senior reporter** Stephen Harris (4893) stephen.harris@centaur.co.uk **Senior art editor** Phil Gibson (4135) philip.gibson@centaur.co.uk **Recruitment advertisement manager** Mauro Marenghi (4187) mauro.marenghi@centaur.co.uk **Senior sales executive** Dean Wylie (4160) dean.wylie@centaur.co.uk **Senior sales executive** Ricky Rana (4426) **Sales executive** Jason Padam (4677) **Sales executive** Harry Clark (4811) **Commercial director** Sonal Dalgliesh (4487) sonal.dalgliesh@centaur.co.uk **Business development manager** Peter York (4942) **Production** Emma Griffin (4434) emma.griffin@centaur.co.uk **Publisher** Simon Lodge (4849) simon.lodge@centaur.co.uk **Subscriptions & Customer Services** tecirc@centaur.co.uk

The Engineer is available for International licensing and syndication. For more information please email simon.lodge@centaur.co.uk

NEWS 020 7970 4442 DISPLAY 020 7970 4487 RECRUITMENT 020 7970 4110 SUBSCRIPTIONS/CUSTOMER SERVICES HOTLINE 020 7292 3705

The Trusted Leader

for Any Measurement

NI data acquisition products are the most trusted computer-based measurement devices available, offering superior accuracy and maximum performance. CompactDAQ systems feature more than 50 measurement-specific modules and complete breadth and depth of I/O. Coupled with the analysis and signal processing capabilities of LabVIEW software, this platform puts the power of graphical system design at your command so you can build any measurement system faster.

LabVIEW offers powerful analysis functions for sensor and signal data, simplifies GUI development and helps you program the way you think–graphically.

>> Accelerate your productivity at ni.com/measurements-platform

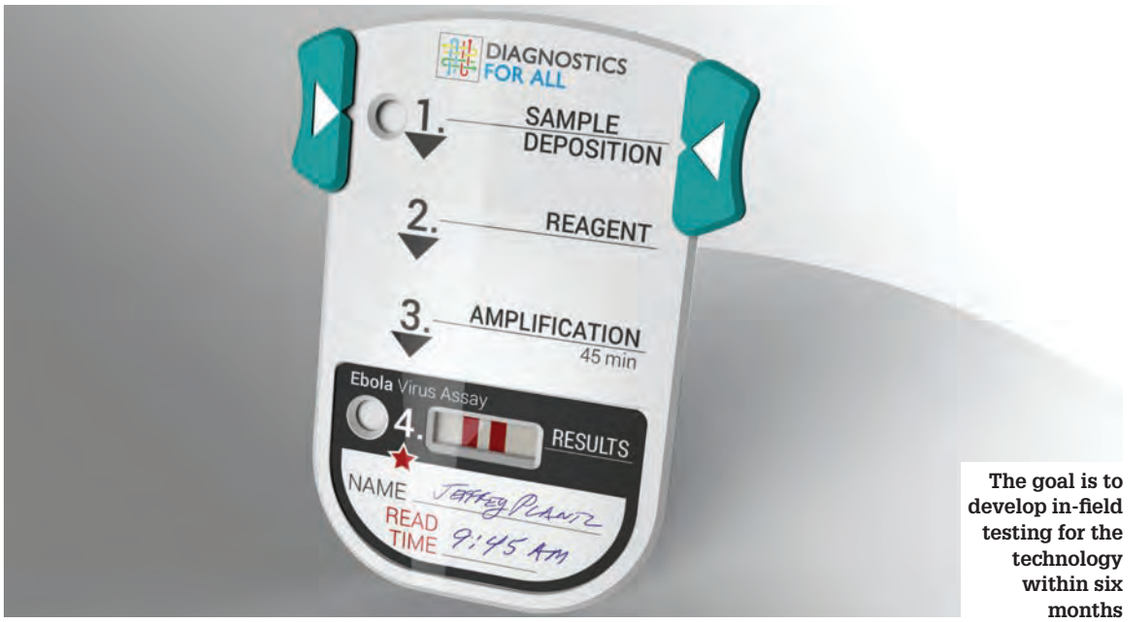
01635 517300 | **uk.ni.com** *Follow us on* *Search* **niukie**

NATIONAL INSTRUMENTS

MEDICAL

Device could diagnose Ebola within an hour

UK engineers help to develop low-cost test method



The goal is to develop in-field testing for the technology within six months

BY JULIA PIERCE

Cambridge Consultants is taking part in a $1m (£657m) project to develop a device that uses a relatively new DNA amplification technique to provide a cheap and fast method of testing for Ebola in the field.

The product design and development company is working with US non-profit enterprise and molecular diagnostics specialist Diagnostics For All to develop the low-cost point-of-care device, using a grant from Massachusetts Life Sciences Center.

The goal of the project is to develop, produce and complete in-field testing for the resulting technology within six months, producing a device that is simple to use and can deliver results in an hour in areas where there may be little or no access to medical facilities or trained doctors, nurses and lab technicians.

To test for the presence of Ebola in blood, DNA from the virus needs to be extracted and replicated to amplify it, as there may not be that much of the virus in a single blood sample.

'The test will extract the nucleic acid from the virus in a sample, replicate this and deposit the replicated nucleic acid onto a testing strip, where it can react with other ingredients to create a red positive line — if the person has Ebola — and a control line to show the device is working. It is similar to the process in a pregnancy test kit,' explained David Chastain, programme manager at Cambridge Consultants.

At present, diagnosing Ebola is extremely challenging. It can be hard for patients in remote areas to get to a clinic to have their blood drawn — and the sample must then be transferred to a lab and tested by trained technicians. Once there, the current gold-standard test for Ebola is the PCR (polymerase chain reaction) test. Invented in the 1980s, this involves cycles of heating and cooling a sample to create more copies of a piece of DNA, and the process takes several hours. By the time the results are produced and returned to a clinic — often hours or days later — the patient may have left or infected others.

However, the test under development uses loop mediated isothermal amplification (LAMP) technology, which depends on a simple electric heater within the unit to heat the sample to a single constant level, and does not require cycling of the temperature to produce results.

It can be used outside of clinics by minimally trained workers on those who are showing symptoms such as fever, vomiting and diahorrea — symptoms that are also typical of other diseases common to Ebola-infected areas, such as malaria.

'We think that the Ebola virus sequesters in the spleen and liver and then comes out in force into the rest of the body later in the infection,' said Chastain. 'This makes it hard to detect earlier in the infection process. However, this test would let us separate the malaria and other patients from the Ebola patients, minimising the risk [of] infecting the first group with Ebola when they come to clinics.'

The test will cost less than $10, and will consist of a handheld, single-use disposable device that is smaller than a deck of cards. It will only require a health worker to prick a patient's finger and directly apply a droplet of blood onto the device. Everything else needed to test the blood will be fully integrated inside the device and the entire process will be completed in 45 minutes.

To comment visit **theengineer.co.uk**

readmore online
theengineer.co.uk

Aerospace
Wing research aims for energy efficiency in space

Automotive
New design improves methanol fuel-cell efficiency

Energy
Natural networks have promise for cheap, flexible optoelectronics

Medical
Protective suit keeps aid workers cool in the fight against Ebola

Defence
Laser weapon destroys targets with 'near-instantaneous lethality'

Electronics
New dimensions added to robotic arm controlled by thoughts

Automotive
Smoothing steering to prevent accidents

Medical
Graphene used to deliver anti-cancer drugs

Rail
Driven by diversity: Bechtel's global rail boss Ailie MacAdam

Manufacturing
Manufacturers must refocus to realise £60bn in new nuclear contracts

For news and jobs visit us at **theengineer.co.uk**

inbrief

More news daily at **theengineer.co.uk**

Advanced stage

EPSRC is providing £20m for university-led research projects aimed at advancing the UK's manufacturing capability and developing functional materials through to application. The 10 projects will include the development of thin-film materials and manufacturing methods for wearable technology, as well as the advanced manufacturing of nanoparticles for healthcare applications.

Failed proposals

Plans to return foreign students to their country of origin following graduation have reportedly been blocked by the Conservative Party. Under the proposals from home secretary Theresa May, foreign students would be required to leave the UK and apply for a work visa to re-enter. Welcoming the news, Campaign for Science and Engineering (CaSE) said Britain should match the conditions offered to foreign graduates in countries such as Canada and the US.

Show stopper

The countdown has begun for The Engineer Design & Innovation Show 2015, which debuts at the NEC in Birmingham on 2–4 June. Running alongside The Engineer Conference and the Advanced Manufacturing and Subcon events, the new show will focus on everything an engineering designer needs to do their job: from high-end products and services to the components, materials and technologies used to create next-generation technologies and processes. Exhibitors include Tharsus, ML Electronics, Proto Labs, Infolytica Europe and Panasonic Electric Works, which will be showing its MIPTEC 3D injection-moulded circuit technology. For stand space and sponsorship enquiries contact Daniel Gray at daniel.gray@centaur.co.uk.

DEFENCE AND SECURITY

Dirty work

Nuclear detection system set to thwart development of bombs

PHIL ROOD

New nuclear detection technology is set to provide authorities with a cheaper, more efficient method of countering terrorists attempting to smuggle radiological components for 'dirty bombs'.

The Modular Detection System for Special Nuclear Material (MODES_SNM) has been developed under a European Commission FP7 programme spanning the continent and has already been trialled by customs authorities in the ports of Rotterdam and Dublin.

Consortium members include Padova and Insubria universities in Italy and Liverpool University in the UK; the National Centre for Nuclear Research in Poland; Arktis Radiation Detectors and ETH Zurich, Switzerland; CAEN Spa, Italy; and end users such as the Revenue Commissioners in Ireland.

MODES_SNM, which can be configured to operate from vehicles, is claimed to be the first system in the world to combine fast and thermal neutron detection. It is also a modular and man-portable system. The baseline unit comprises five neutron and two gamma modules, a computer and electronics module and a UPS battery.

Arktis co-founder and chief executive officer Rico Chandra

said modifications have been made to the system following the port trials, responding to requests from the end users, but these were minor. The system is now available commercially and he expects the first order to be placed by a European user before the end of the first quarter next year.

Chandra said that MODES_SNM has several advantages over current systems including ease of usability; it is battery operated with the ability to offer up to eight hours' autonomy; and it offers higher sensitivity. The system reduces false alarms through the ability to detect fission sources more accurately by distinguishing their radiation signature from natural backgrounds. In addition, MODES_SNM does not use Helium-3 (He-3), an expensive raw material typically used in most neutron detection systems.

'Arktis is under contract from the DARPA research organisation to develop the next-generation neutron detection systems without using He-3,' said Chandra. 'In the future, it will be more difficult to use He-3 in detection systems because it will not be readily available and, as a result, we have developed a different technology proprietary to Arktis.'

To comment visit **theengineer.co.uk**

MATERIALS

Shielding for spacecraft

New materials could protect astronauts from space junk

BY JULIA PIERCE

New materials are being developed to help protect ESA astronauts and spacecraft from damage by radiation, space junk and micrometeoroids.

To protect spacecraft, satellites and crews, Leicester-based engineering company Magna Parva is looking at developing fibre metal laminate (FML) materials that can provide more protection per kilogram than anything currently on the market.

Owing to the needs of the space industry, any new material developed must be lightweight and low cost. At least 15 concepts are being considered, including aluminium, titanium and polymers reinforced with a material such as glass fibre, carbon fibre or Kevlar.

Spacecraft in orbit around the Earth continually sustain damage from hyper-velocity impacts, colliding with micrometeoroids and tiny fragments of orbiting debris left over from previous launches and missions. However, although small, these objects are travelling at a velocity several times the speed of a bullet. Over time, the impacts can cause abrasions similar to an object having been sandblasted, as well as microscopic holes. There are also some larger objects in orbit, which have the potential to create catastrophic damage.

Not only must shielding for spacecraft protect against impacts, it must also shield astronauts from radiation received from energetic particles originating from our Sun and supernova explosions and other high-energy events outside the Solar System. Outside the Earth's protective magnetosphere, these can harm sensitive electronics and the astronauts themselves.

'The materials we develop in this contract will be particularly useful in deep space missions such as those planned for the Orion capsule,' said Magna Parva's director Andrew Bowyer.

To comment visit **theengineer.co.uk**

Can you afford unplanned and expensive downtime?

Bosch Rexroth is the only company that can repair and replace Hagglunds products back to the original specification. We can;

- help save you expensive downtime
- help reduce your machinery failure
- provide a broad portfolio of service agreements to suit your requirements
- provide onsite service/fault finding

Our Back to New pledge means you have peace of mind knowing your machinery and equipment is being looked after by the only authorised company to do so. Don't take the risk, call our helpline today: **0800 169 6624**

BACK TO NEW
SERVICE EXCELLENCE from Rexroth

Bosch Rexroth Limited,
Devilliers Way, Normanton, West Yorkshire WF6 1GX
www.boschrexroth.co.uk/service
service@boschrexroth.co.uk

The Drive & Control Company

Rexroth
Bosch Group

The consortium is in talks with UK train operators concerning applications of the DDflyTrain system

RAIL

Clean brake

System lowers carbon footprint of trains

BY JULIA PIERCE

A new flywheel-based regenerative braking system has shown it can reduce the carbon footprint of rail travel on Britain's diesel-powered trains, and potentially increase capacity.

The DDflyTrain project has resulted from a collaboration between Ricardo, who designed the flywheel, digital hydraulics firm Artemis Intelligent Power and rail technology company Bombardier Transportation.

The system combines Ricardo's TorqStor high-speed flywheel energy storage system and the Artemis Digital Displacement hydraulic pump-motor transmission system to store and reuse energy using flywheels spinning at 45,000rev/min.

The consortium's aim was to build a demonstration rig to show that the technology could work in a diesel environment on multiple-unit trains.

'Every train journey involves a lot of stopping and starting, and so also a lot of braking and acceleration,' said David Rollafson, vice-president of global innovation at Ricardo. 'If we can harvest some of the energy from braking and use this when the vehicle is gathering speed again, we can save a lot of diesel and so a lot of money for train operators.'

There would also be benefits in terms of reducing pollution. 'When pulling out of a station, diesel engines are noisy and pump out a lot of pollution,' said Rollafson. 'Adding stored energy to help acceleration would reduce this.'

Compared with their electric counterparts, diesel trains are also slower to accelerate. However, using energy from the flywheel would improve this, and could therefore increase capacity on existing rail lines.

The system could also be used on third-rail, live-rail electric trains to improve their efficiency. Whereas electric trains with an overhead power supply can harvest energy from braking and put this back into the network without much loss, the losses are too great with a third rail to make this efficient. Instead, the flywheel-based system would capture energy at its source and immediately put this back into the vehicle's power system, meaning that around 80 per cent of this captured energy could be reused.

The system is easy to retrofit and is modular, meaning operators could scale up their energy storage when finances allowed. The consortium is now in talks with UK train operators concerning applications of the technology within their existing rolling stock.

MANUFACTURING

Artificial intelligence system is a cut above

Technology could prevent machine failures

BY JULIA PIERCE

A new artificial intelligence system that detects problems with cutting tools on manufacturing lines with 100 per cent accuracy could prevent catastrophic failures.

The technology, which could one day monitor machines' daily wear and tear, was created by researchers at Nottingham Trent University, led by Prof Amin Al-Habaibeh, professor of intelligent engineering systems.

Primary applications include use within the milling and drilling processes employed in car engine manufacture, the aerospace industry and metal cutting.

The system, developed by PhD researcher Milad Elgargni under the supervision of Prof Al-Habaibeh and Prof Ahmad Lotfi, of the university's school of science and technology, uses a combination of infrared cameras and artificial neural networks to consistently detect when cutting tools are broken or missing.

The technology does not require any contact with the manufacturing machinery, and could provide live feedback via computer to alert operators in order to help prevent catastrophic tool damage.

It can detect problems in real time, which is difficult to achieve by common methods, while the artificial intelligence system can learn, making it possible to monitor various cutting tools and increasing the system's flexibility for users.

'Existing monitoring systems perhaps only look at the power of the spindle to see if a problem is occurring,' said Prof Amin Al-Habaibeh.

'However, there may be a collision if the tool is broken. Our system uses infrared to make sure the tool is working in the right place and under the right conditions at all times. We are also shortly to publish research about the use of the technology to monitor gradual wear.'

As the technology is based on using a simple infrared camera, it should be easy for manufacturers to implement without disrupting existing machinery.

To comment visit **theengineer.co.uk**

NUCLEAR

Chernobyl's giant shield takes shape

Steel arch will protect damaged reactor

BY JON EXCELL

Engineers have made huge progress on the construction of Chernobyl's New Safe Confinement, an immense shield that will replace the infamous reactor's crumbling sarcophagus.

In order to protect engineers from unsafe levels of radiation, the development of this vast steel arch called for an innovative construction approach that has seen it assembled 600m away from the reactor and then slid into place along specially built tracks.

Funded by 46 different countries and organisations through the European Bank for Reconstruction and Development (EBRD), the shelter is the key element in a €2.15bn (£1.69bn) international effort to clean up the remains of mankind's worst nuclear accident. Completion of the project is scheduled for the end of 2017.

The EBRD agreed, in December 2014, to provide an additional €350m funding for the project in order to help close an anticipated funding gap of €615m. The G7/European Commission are also organising a pledging event for other potential donors that is due to take place in spring 2015.

To comment visit **theengineer.co.uk**

Calibrate from fire to ice in a flash.

When you need high accuracy and stability across extreme temperatures and the ability to switch quickly from a blazing 650°C to a frigid -35°C, consider GE's dry block and liquid bath temperature calibrators. Simple, straightforward and accurate, these robust, easy-to-use calibrators accommodate virtually any type, shape or size sensor.

With GE's calibration solutions, your day just got easier.
Another example of how GE works—smarter.

T: 0116 231 7100
E: gb.sensing.sales@ge.com
www.ge-mcs.com

PRINTING

Painting with precision

Energy-saving inkjet lowers the cost of customising

BY JULIA PIERCE

A new digital inkjet technology from a UK-based research and development company could cut the cost of customising vehicles, white goods and architectural surfaces, while also saving energy.

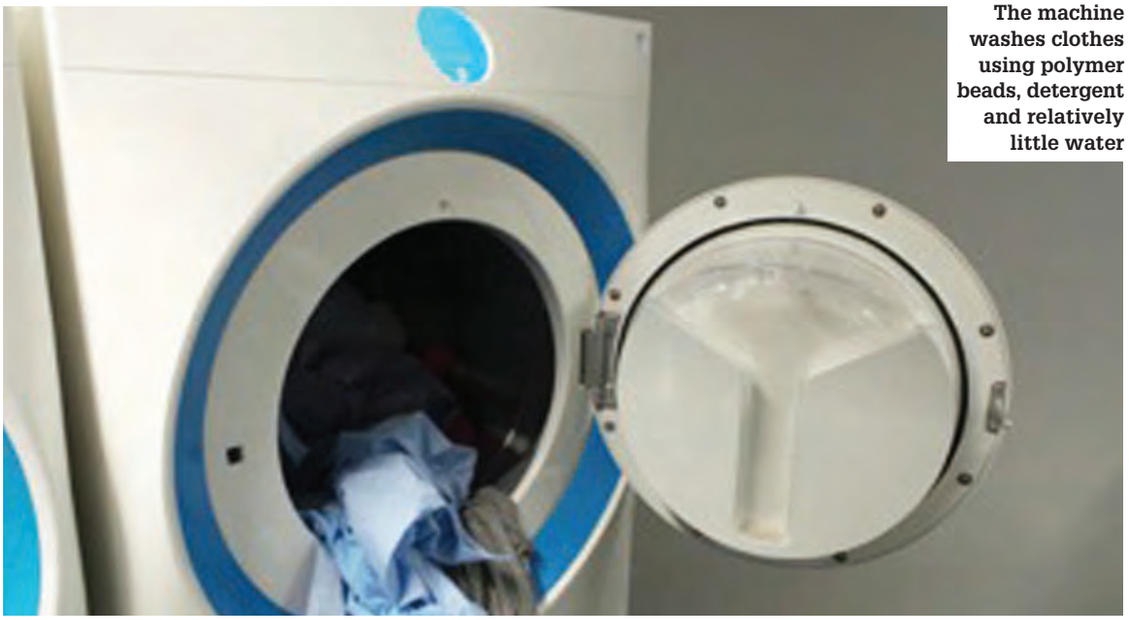
The Technology Partnership's (TTP's) Vista Inkjet system is capable of printing with standard industrial paints. Tests have already been carried out using cellulose and two-part polyurethane paints, which are used for car and aircraft body manufacturing.

'In the aircraft industry, creating a customised image involves masking-taping the area, spraying with an individual colour, then heating the hanger to cure this. The process then has to be repeated with each further shade, and that uses time and energy,' said David Smith, head of business development for Vista. 'Using Vista, the process could be completed in one go with a single curing stage.'

Other applications include coating metal coils or roof panels used in cladding and printing using thermoplastic fluoropolymer paints such as Kynar for decorative finishes on architectural metallic structures. TTP is also exploring the printing of low-cost and high-functionality materials for ceramics, textiles, security and brand protection along with high-conductivity patterns and 3D printing, and the customisation process for white goods, where a more durable paint could be used.

Existing inkjet printing is restricted by ink formulations and the use of closed chambers and narrow channels. Instead, the Vista Inkjet relies on a printhead design based on a planar construction that allows free-flowing ink circulation and accurately controls the movement of the nozzle plate to eject droplets, from 0.5 pico-litres to more than one nano-litre. The droplets created are precise, well formed and consistent.

To comment visit **theengineer.co.uk**



The machine washes clothes using polymer beads, detergent and relatively little water

ENERGY

Xeros cleans up in US

Washing machine uses polymer beads to cut down on water use

BY JASON FORD

A washing machine that uses considerably less water and energy compared with similar models is set for launch onto the US domestic market in 2016.

This is the aim of Xeros, a Leeds University spin-out that has created a front-loading washing machine that cleans clothes using a combination of patented polymer beads, a proprietary detergent and relatively little water.

In use, water and detergent help to lift dirt from clothes during the agitation stage of the wash cycle, with the beads then absorbing and trapping the removed dirt.

Water inside a bead pump is used to push the beads vertically into the wash, and the same water is then re-circulated through the system in order to repeat the process, pushing back beads that have returned to the machine's sump.

Based at the Advanced Manufacturing Park in Rotherham, the company's current 25kg machine is in use at hotels in the US where Xeros is focusing on validating the technology prior to wider roll-out.

The company plans to license its technology for an 8kg domestic model and has revealed that a number of manufacturers are interested in this proposition as the technology can be incorporated in a way that does not require radically new production processes.

Eleven million washing machines are sold in the US each year, but licensing the technology into this market is only one portion of the company's business model.

Bill Westwater, chief executive officer of Xeros, said: 'The beads, when they come to the end-of-life Xeros process, are essentially full of dirt… [but] the molecular structure hasn't been fundamentally changed at all and there're plenty of customers further down the polymer supply chain that are perfectly happy to pay us decent money for that polymer.'

To comment visit **theengineer.co.uk**

AUTOMOTIVE

Toyota invites use of patents

Car maker encourages development of fuel-cell technologies

Toyota is making hydrogen fuel-cell patents available to encourage the development and introduction of fuel-cell technologies.

The company said that it would invite royalty-free use of its fuel-cell-related patents — including technologies developed for the new Toyota Mirai. The list includes around 1,970 patents related to fuel-cell stacks, 290 associated with high-pressure hydrogen tanks, 3,350 related to fuel-cell system software control and 70 related to hydrogen production and supply.

Toyota had previously licensed patents related to hybrid vehicles, but the latest development represents the first time that it has made its patents available royalty free, reflecting what the company describes as 'aggressive support' for developing a hydrogen-based society.

Toyota said the hydrogen fuel-cell patents will be made available to automotive manufacturers who will produce fuel-cell vehicles, plus fuel-cell parts suppliers and energy companies that establish and operate fuelling stations. Companies working to develop fuel-cell buses and industrial equipment are also covered. ***JF***

To comment visit **theengineer.co.uk**

RENISHAW
apply innovation™

Design today...

See us at:
Southern Manufacturing
Hall 1, stand Q98

...build tomorrow

Unlock the potential for Additive Manufacturing

Renishaw's laser melting system is a pioneering process capable of producing fully dense metal parts direct from 3D CAD, which has the power to unlock the potential for additive manufacturing.

From tooling inserts featuring conformal cooling, to lightweight structures for aerospace and high technology applications, laser melting gives designers more freedom, resulting in structures and shapes that would otherwise be constrained by conventional processes or the tooling requirements of volume production. It is also complementary to conventional machining technologies, and directly contributes to reduced lead times, tooling costs and material waste.

- Shorten development timescales - be first to market
- Reduce waste product and cost - build only what you need
- Enjoy increased design freedom - create complex structures and hidden features

Find out more at www.renishaw.com/additive

Renishaw plc Whitebridge Way, Whitebridge Park, Stone, Staffs ST15 8LQ United Kingdom
T +44 (0)1785 285000 F +44 (0)1785 285001 E additive@renishaw.com
www.renishaw.com

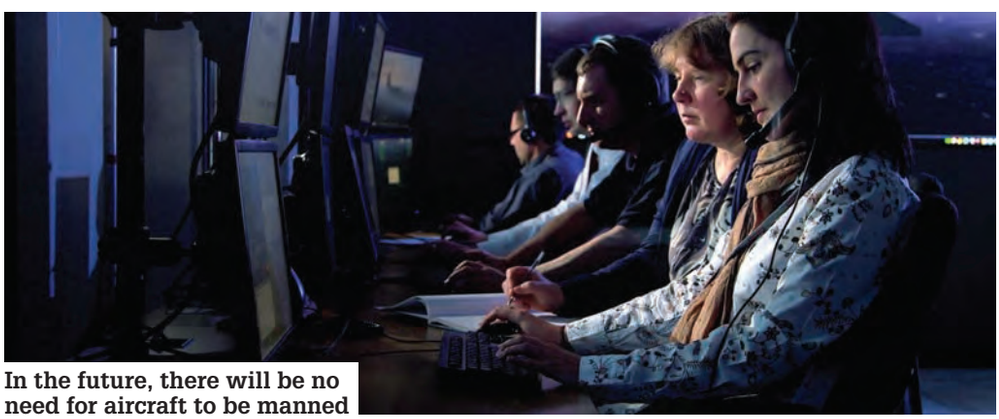
New heights

BAE Systems' Lambert Dopping-Hepenstal discusses the opportunities that could be realised by commercial unmanned aircraft

The next major step in civil aviation will be the introduction of autonomous systems to undertake roles that are beyond the capability of manned aircraft. The technologies required to achieve this breakthrough will also further enhance the safety and efficiency of today's manned aircraft. Unmanned aircraft are not constrained by size, endurance and the operating limitations imposed by the need to protect a human on board; they can fly for very long periods and in high-risk environments and can be of any shape or size. They have gained notoriety as military drones but, as common to most aviation advances (jet engine, radar, composites, fly-by-wire, GPS, etc), military developments lead to revolutions in civil aircraft performance and open up new opportunities.

In recent years, we have seen significant developments in military unmanned aircraft but they can only operate over military test ranges and do not have the on-board systems that would allow them to operate in the general airspace of interest to commercial operations. In the UK, commercial operations are limited to small aircraft, generally weighing no more than 5kg, being flown within direct line of sight of the ground pilot, below 400ft altitude and no closer than 50m to people and property. While these limitations are manageable for small-scale agricultural and civil engineering surveying operations or inspection of local hazardous areas, they are too restrictive for many of the potential applications. Google, which recently demonstrated a 'delivery by drone' in the Australian outback, has again highlighted the potential utility of unmanned aircraft while bringing into focus the technical and regulatory challenges that yet have to be fully addressed.

Unmanned aircraft will open up new opportunities for transporting, searching, surveying, monitoring and relaying by air. Ultimately there will be no need for any aircraft to be manned. In the near term, long-distance unmanned freight transport using controlled airspace is realisable. Similarly, disaster relief, where risks are outweighed by benefit, could be realised before all the regulations and technical solutions are developed. The greatest challenge will be flight in uncontrolled, congested airspace over heavily populated areas. For this reason, the UK is investing in the ASTRAEA programme to address all the issues associated with the introduction of unmanned aircraft of any size into all categories of airspace anywhere.



In the future, there will be no need for aircraft to be manned

ASTRAEA — a collaboration with Airbus Defence and Space, AOS, BAE Systems, Cobham, Qinetiq, Rolls-Royce and Thales — has, since 2006, investigated the technical developments that will have to be addressed to meet the regulator's need for 'equivalence' and 'transparency' with manned aircraft operations. Over the last eight years, candidate technologies required to move the pilot from the aircraft to the ground have been identified, evaluated and demonstrated. These solutions include sensor systems to replicate the pilot's 'see and avoid' responsibilities, secure and reliable command and control communications systems to connect the ground pilot and the aircraft and air traffic controllers and on-board intelligence to ensure that the aircraft will follow the rules of the air in the event of a lost communication link to the pilot or other contingencies. The programme has undertaken a full survey of all the changes necessary to 'un-man' an aircraft through a virtual certification process in conjunction with the UK Civil Aviation Authority. It has also undertaken systems simulation and ground-based and airborne trials of subsystems, including: detect and avoid, the equivalent of the function the pilot of a manned aircraft undertakes to avoid other air traffic, the ground, obstacles and dangerous weather; secure communication networks — innovation is needed to ensure the integrity and security of the command, control and communications link between the human and machine is maintained; decision-making systems; power management; and air-to-air refuelling systems.

> **"The uses for small unmanned aircraft will expand rapidly and particularly when their range can be extended**

The uses for small unmanned aircraft will expand rapidly and particularly when their operating range can be extended. Although the delivery of takeaways or books in crowded urban areas will be challenging for regulators, a hub-to-hub concept may be more realistic in the near term, such as the delivery of transplant organs or blood supplies between hospitals.

Unmanned craft will become ubiquitous. This year will see further rapid growth in the applications for small aircraft and a maturing of the technologies and inevitable legislation. ASTRAEA will be a significant contributor to the next major step in aviation.

Lambert Dopping-Hepenstal is ASTRAEA programme director and engineering director of systems and strategy at BAE Systems Military Air & Information

Join the debate at **theengineer.co.uk**

POWER
FROM ABOVE

Wire-rope hoists in all capacities up to 200t.
Chain hoists in all capacities up to 5t.

Street superior lifting technology incorporates a whole series of operating and safety features that will give you a competitive advantage. We also specialise in "plug-and-play" crane kits which incorporate the latest innovations in crane technology. What's more, if you become a Street partner, we will not compete with you for end user crane or parts business.

Buy your hoists from Street and give your cranes "Power from Above"

Street Crane are actively seeking independent crane manufacturers and distributors worldwide. Please contact us for further details.

Street

www.streetcrane.co.uk

T +44 (0) 1298 812456 / **F** +44 (0) 1298 814945
E sales@streetcrane.co.uk

Street Crane Company Limited / Chapel-en-le-Frith / High Peak / SK23 0PH / United Kingdom

thehottopic

Image problem rears its ugly head once again

Our briefing on Engineering UK's annual report gathered many familiar opinions on why engineering might have an image problem.

All attempts seem to have failed to overcome the misconception that an engineer is a man under a car engine covered in grease. Do we need to coin a new word? In French, 'ingenieur' links with ingenious: in English just engine.
Chris Cordingley

This is an unfortunate result of the power struggle between Thatcher's government and trade unions. The resulting negative effect on how engineering and manufacturing has been perceived, both through the media and government rhetoric for the past three to four decades, in favour of the 'service sector', i.e banking, has demotivated an entire generation from pursuing a career in manufacturing and engineering. Skills and trades have been destroyed in the name of ideology. Compare the high regard in which countries such as Germany and Japan hold engineers — they are paid extremely well, trained continuously and highly regarded in society — to the way engineers are looked on and treated in the modern post-Thatcher UK — as a 'necessary expense' to be used and abused, hired and fired, rather than the golden asset that holds the country together (which is what they — we — are).
Anonymous

There are several factors that affect the availability of engineering recruits: the number of youths in the location that have an interest in engineering, and the youth of today are often not encouraged to enter technical fields by their parents; and the number of employers who are willing to employ green employees (in Canada, everyone wants tradesmen, i.e. mechanics, electricians etc; however they all are looking for journeyman-level experience). Only about one in 10 are willing to hire a young person who has no experience in the field. Everyone chooses to forget that every top-notch engineer/tradesman started out as a green kid with a lifetime's worth of mistakes to make.
David Koslowski

Until we in the profession are able to communicate the difference between Engineering (using ingenuity) and engineering (drilling holes), we are doomed to fail in our attempts to raise the profile of what we do. True Engineering is an exciting career. We need to illustrate how much better it is than arithmetic (sorry, accountancy). The first step unfortunately will be to pay more, which seems to be very much in the control of the bean counters. At least the IET is beginning to help, but it has a long way to go.
Peter Langridge

Having just read your article, I feel the need to share my story. I'm a product designer and three years ago I failed to impress my son with the products I had helped to design. I showed him CAD images, protos and finished products: mobile phones for Nokia, vacuum cleaners for Dyson and medical devices. 'It's okay dad, but can't you design a toy?' I took up the challenge and designed a toy, prototyped it, tooled it and received a batch of 20,000 in June. Last October, I visited the local school and we spent an afternoon discussing the design process. We finished with a tournament using the toy. The children were engaged with something they could relate to and it might have influenced their future career path. Please get in touch if you would like to know more about the Bomtanka story... I think it's important and will help to explain why we're failing to engage young people and show society just how vital and fun design and engineering is.
John Cattermole

Have your say at **theengineer.co.uk**

inyouropinion

Fallingshort?

A news article saying that falling oil prices were unlikely to affect renewables investment was greeted with some differing opinions.

■ What they are saying is that they will survive economically because the subsidies are locked in for a long time. Falling oil prices will mean that alternative generation gets cheaper and cheaper, so the unfortunate consumer will be contributing more and more to the subsidies.

They also claim that the wind is free but fail to mention the high cost of operation and maintenance. For example, one wind farm in New Zealand that sells into the electricity market does not make enough money to cover its operation and maintenance costs.

The whole renewable energy industry is a massive rip-off of the ordinary consumer who received his electricity prices climbing higher and higher to subsidise those rich enough to build wind and solar farms.
Bryan Leyland

■ 'So the unfortunate consumer will be contributing more and more to the subsidies.' The only downside being a planet that lasts a little bit longer, as far as human habitation goes.

'One wind farm in New Zealand that sells into the electricity market does not make enough money to cover its operation and maintenance costs.' Which one?

'The whole renewable energy industry is a massive rip-off.'

Whosay? You little old oil drinker, you.
Stuart

■ 'The only downside being a planet that lasts a little bit longer, as far as human habitation goes.'

No, it doesn't.

If you want to save resources, nuclear is the answer. Safer, cheaper and more reliable than renewables.

'One wind farm in New Zealand that sells into the electricity market does not make enough money to cover its operation and maintenance costs. Which one?' NZ Windfarms.

'The whole renewable energy industry is a massive rip-off. Whosay?' Anyone who looks at the subsidies per kWh. Huge. And then add in the costs of providing back-up generation and transmission — all paid for by the consumer.

'You little old oil drinker, you.' I am a hydropower engineer, I own a hydro scheme and I advocate nuclear. Beat that.
Bryan Leyland

->

thesecretengineer

The patent system as we know it is no longer relevant or fit for purpose

I was recently talking to a friend of mine, a Mr T M, and (being one of the few in our profession to know my true identity) he said: 'I know what you can write a piece about!' He then suggested that the patent system as we know it is no longer fit for purpose, laying out how he agreed with Tesla's views on such matters. As we discussed it, I have to say that I could not help but lean towards his point of view. Please note that for the sake of this short informal piece, I am going to include all forms of IP protection within the catch-all title of 'patent'.

"Can something set up so long ago in such a dynamic area of human endeavour remain relevant?

Diving into the 'I think it's correct but can't guarantee it' world of online research, I can tell you that the patenting system was set up in 1450 in Venice with a major evolution taking place in the 1790s. This continued through the industrial revolution and then essentially stabilised into what we have today. Although I am enamoured of the 'if it ain't broke don't fix it' school of philosophy, I do wonder if something set up so long ago in such a dynamic area of human endeavour can ever remain relevant?

China leads the way to shining a light on the failings. First, there is the core intent of protection. One need only look to the Chinese-manufactured Land Wind to see that a level playing field across the globe is still nowhere near being established and, without this, the protection provided by patents is incomplete to say the least. For those who don't know, the Land Wind is a car whose design is inspired by the Range Rover Evoque — as in 'inspired to the point where one wonders if the body panels are interchangeable'. Second, Chinese companies are speculatively creating new ideas and patenting them. To patent an idea to deny your competition the chance of using it is nothing new, but as far as I'm aware this is the first time it is being done as a focused, standalone activity. You have to admire the foresight to pursue such a strategy; who knows, it could even be used as a secondary revenue stream.

Given the number of patents that have been issued, the question must be: 'Is the patent system fit for purpose, relevant and sustainable?' If the answer to any of these is 'no', then should the system be adapted or even dissolved? To keep clinging on for the sake of it under such conditions would surely only hamper those who abide by it to the advantage of those who don't.

inyouropinion

Electiontime

Readers didn't know whether to be optimistic or depressed by the forthcoming general election.

■ How about a bit more optimism?! As an aerospace engineer for 17 years, subsequently radio producer and technology writer, I think that the engineering sector bears at least some of the blame for its poor public profile and image. We now have four months in which the public (and much of the media) is going to get bored stiff with repetitive arguments about the economy, immigration etc, so here's our chance to raise the profile of engineering as a new topic. Tell people how important it is to the UK — yes we do still make things. Publicise our great engineers past and present. Challenge politicians to support engineering. Can't be done? I'm back in Scotland, where I was born, and recently lived through the extraordinary referendum campaign. Whatever you think of the results, it was amazing; it brought out 85 per cent of the electorate. Approach this election positively, call phone-ins, engage on social media, write to the papers and your local candidates and start petitions.
Mike Hally

Commonground

Our news story on a UCL report recommending fossil fuels should be left in the ground received some unfavourable feedback.

■ I disagree with this UCL study. Resources should be developed in response to the free market, not arbitrary and uncertain environmental targets.

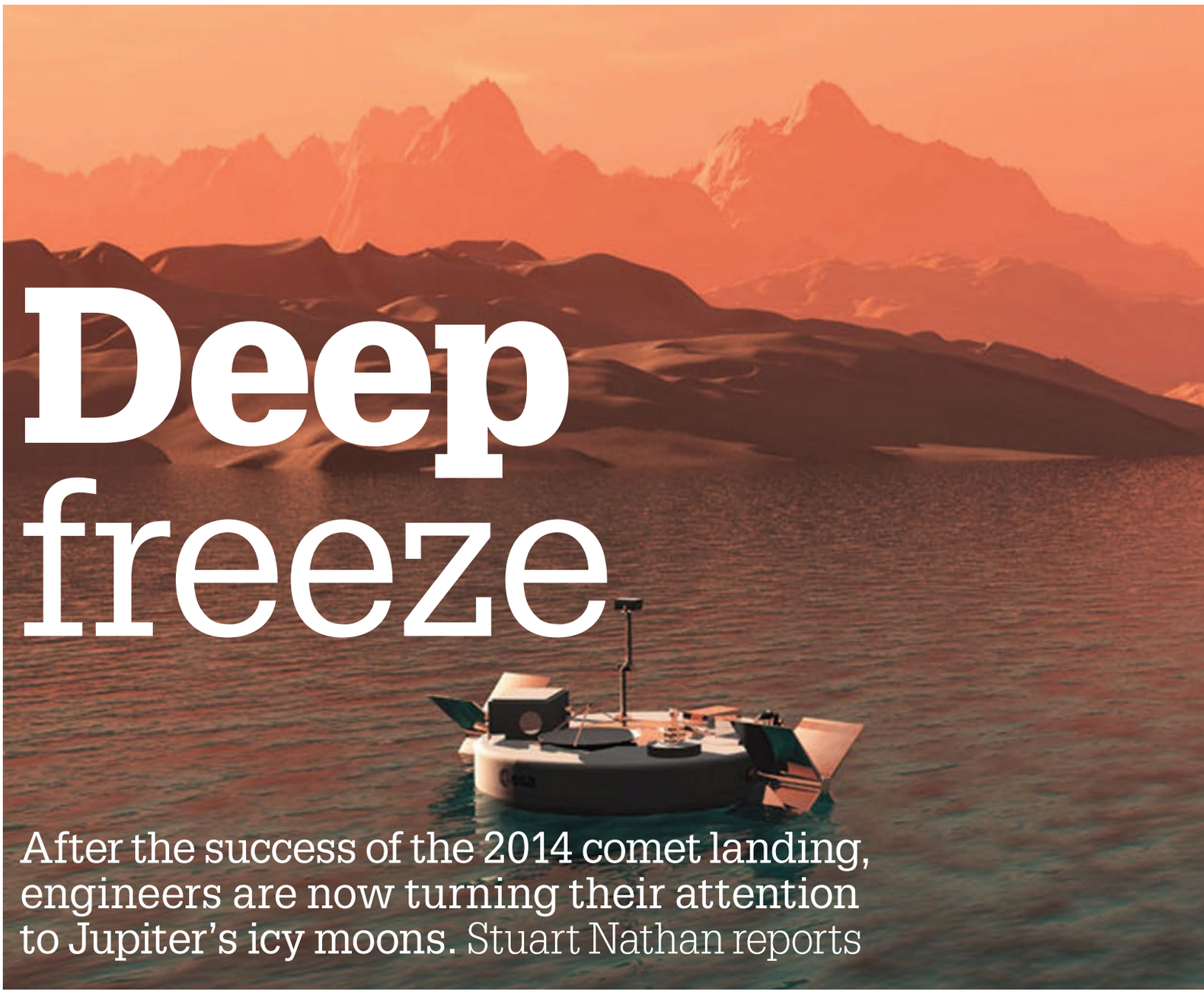
There are already mechanisms in place to apply 'external costs' to fossil fuel. So additional command economy-style restrictions in fossil fuel source development are not required. Also governments need to consider energy security as well as environmental concerns; to do otherwise risks far greater harm to citizens than the projected impact of warming.

Finally, cost needs to be considered — the cost of the effects of warming versus the cost of avoiding warming. Do non-fossil-fuel sources really make financial sense? Is money better spent helping people directly rather than reducing emissions?
Chris Longbottom

■ One has to be very enthusiastic to put an arbitrary set of free market principles above the weight of scientific information based on physical observations.

The monetary value of fossil fuels is rooted in what good they can do us — and if they actually do harm, the value becomes negative, i.e. we would pay to keep the stuff in the ground.

I certainly would. The negative value of coal alone according to a Harvard study falls between, or 17–27 cents/kWh. A genuinely free market that included all the information would have me paying the power company 25 cents and 57 cents/kWh. I repeat, I would be happy to pay this for a clean life. But the free market doesn't offer it; why not?
Alan



Deep freeze

After the success of the 2014 comet landing, engineers are now turning their attention to Jupiter's icy moons. Stuart Nathan reports

For space scientists and other aficianados, there can be little doubt that 2014 was the year of the comet; the European Space Agency's (ESA's) achievement in landing the Philae probe on comet 67/P Churyumov-Gerasimenko dominated headlines, even though the team still don't know exactly where the lander is.

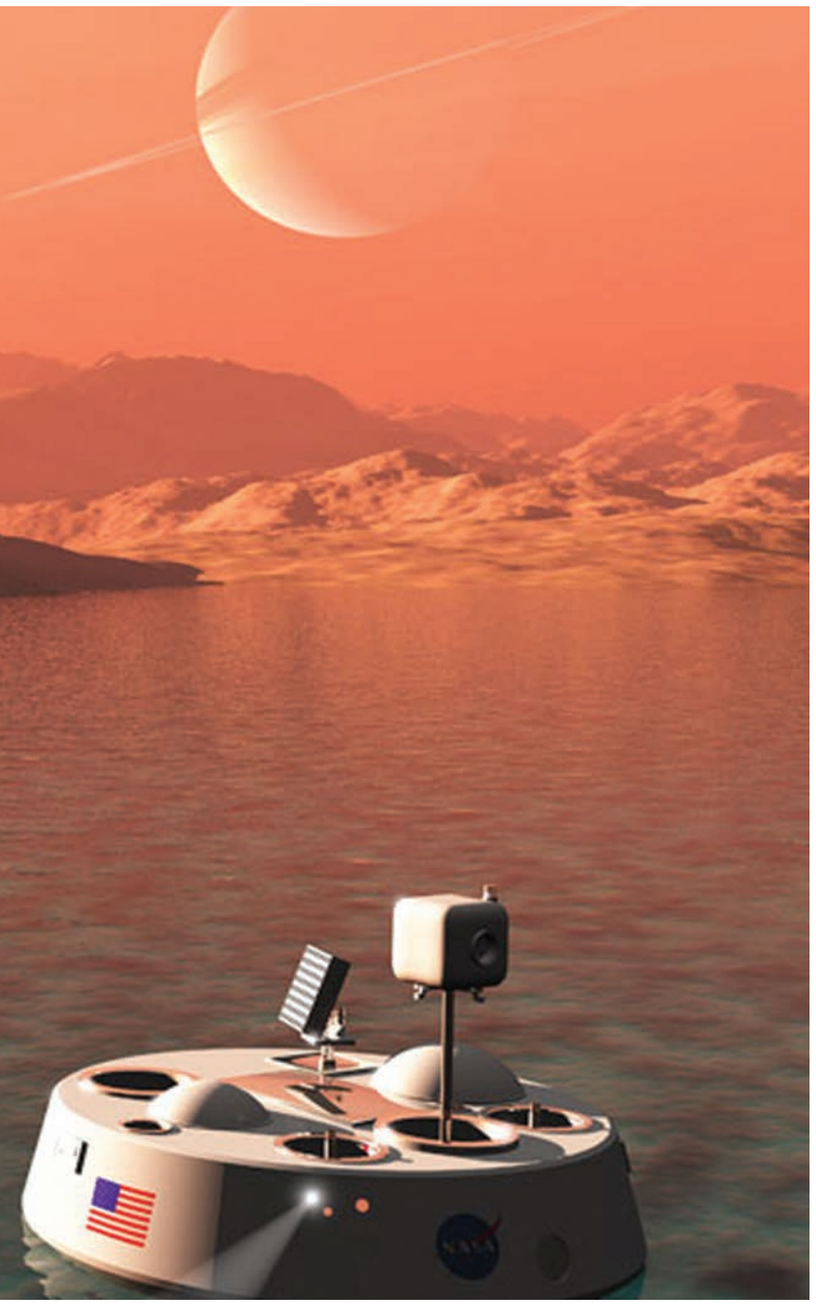
By the same token, 2015 is set to be the year of the dwarf planet. Two NASA probes are to greatly expand our knowledge of these enigmatic miniature worlds: the probe Dawn is preparing for its encounter with the largest of the asteroids, Ceres; while in the far distance, New Horizons has emerged from a long hibernation before a close encounter with Pluto. Neither body has been known as anything more than a smudgy image up until now, and solar system specialists are eagerly looking forward to being able to study more detail on these bodies and learn what they can tell us about the formation of our cosmic neighbourhood.

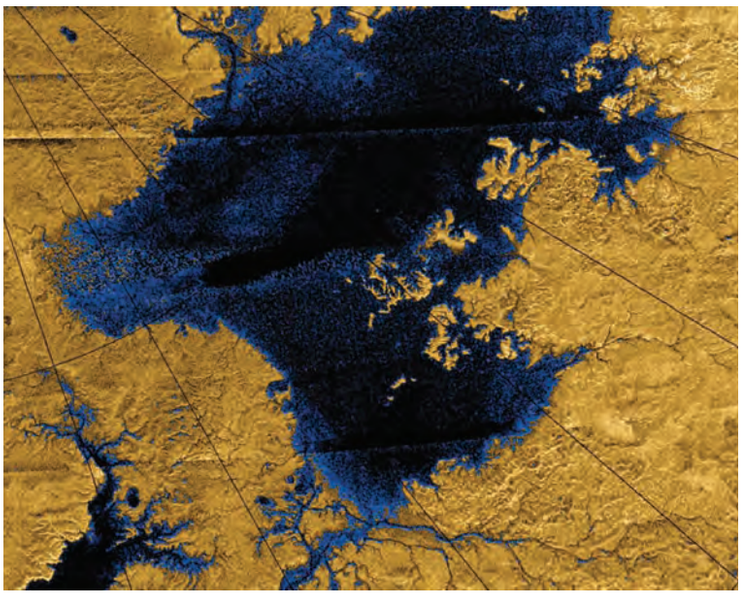
But the nature of Solar System exploration means that, for engineers, the hard work of designing and building these spacecraft was completed many years ago; it takes them so long to complete their journeys that inevitably attention shifts to upcoming missions — at least until the planned encounters actually happen and instruments need to be operated. For NASA and ESA, the next big targets are in the Jovian system of our local gas giant, Jupiter, and its many moons, and the design targets centred around their exploration.

Jupiter has a pivotal history in our understanding of space and our place in it. In the 17th century, Galileo Galilei's discovery and subsequent observation of the four largest moons of Jupiter — now known as the Galilean moons — laid the foundations for his theories of planetary orbits: if these bodies circled their planet, he reasoned; it could not be assumed that Earth was the fixed centre of the universe and could conceivably itself be in orbit around the Sun. His writings on the subject earned him house arrest from the Inquisition, but form the basis for cosmology to this day (and his optical telescope remains an inspiration to engineers).

The moons of Jupiter are still of interest, because they are worlds to themselves with geological activity, atmospheres, weather and, most enticingly of all, water. Although distant from the Sun and so not receiving its heat, they are subject to immense tidal pulls from Jupiter itself, which pummels their cores and heats them from the inside: the combination of heat, water and organic molecules detected in their atmospheres by previous man-made visitors has raised the possibility that they might even harbour life, or at least its vital ingredients; they could therefore give us insight into the development of early life in Earth's oceans.

The three largest Galilean moons — Ganymede, Callisto and Europa — are the targets for ESA's next major scientific mission. Called JUICE (JUpiter ICy moon Explorer), this probe is set to leave Earth in 2022 ahead of its arrival in the Jovian system in 2030, eventually going into orbit





Voyages: **(above) Talise and TiME floating on Titan's Mare Ligeia (top right); (below) Aviatr scouts Titan for landing sites**

"These exploratory missions will pave the way for landers, and these moons are likely to be fantastic places to explore
Dan Andrews, Open University

around Ganymede — although this might seem to be well into the future, such is the nature of deep-space missions that JUICE is very much active now. Its instrument payload was agreed in 2013 and the multilateral agreement between the 16 countries taking part in the mission — 14 in Europe, plus the US and Japan — was finalised last year.

In simple terms, JUICE's goals are to use the Jovian system as a model for gas giants and for the solar system itself, investigating the conditions for the formation of large multi-body orbiting systems, what conditions might influence the development of life and whether gas giants might be suitable locations for habitable worlds. As with most Solar System missions, this will expand our knowledge of the history of our own world and inform exploration of deep space, with the study of exoplanets and their neighbourhoods expected to accelerate and deepen in the next decades with the launch of more powerful telescopes both in space (such as the James Webb Telescope) and on Earth (such as the European Extremely Large Telescope in Chile and the planned 30m Telescope in Hawaii).

The JUICE spacecraft will use chemical rockets (carrying about three tonnes of fuel for the 25 planetary flybys, orbital insertions and gravitational assistance manoeuvres it will make during its three-and-a-half years in the Jovian system); a high gain antenna more than 3m across to handle transmission of up to 1.4GB of data back to Earth; and solar panels with an area of around 60–75m^2 to maximise the amount of power from the dim sunlight; there is also a possibility of capturing electrons from surrounding space to generate current.

JUICE's payload includes imaging and spectroscopy equipment working from the ultraviolet to sub-millimetre wavelengths, which will study clouds and characterise ice and minerals on the moons' surfaces; a laser altimeter and a radar sounder to explore the surface of Ganymede, and how the tidal forces affect it; magnetometers to look at how Jupiter's immense magnetic field affects the moons, and how it interacts with Ganymede's own field (this will also study the subsurface oceans believed to exist on the moons); plasma instruments; and gravity field sensors.

One thing JUICE won't do is send anything down to the surface of the moons, but this is an aspiration for future missions. In fact, the teams that built instruments for Philae are waiting with barely restrained enthusiasm to come up with ideas for landers to explore these strange worlds. 'It's a fair assumption that these exploratory missions will pave the way for landers, and these moons are likely to be fantastic places to explore; like nothing we've ever seen before,' said Dan Andrews, one of the team at the Open University responsible for Philae's mass spectrometer, Ptolemy.

In fact, by the time exploratory missions come along, they may be like something we've seen before. The asteroid Ceres is an icy planetoid ->

Many moons: **JUICE is set to leave Earth in 2022 ahead of its arrival in the Jovian system in 2030**

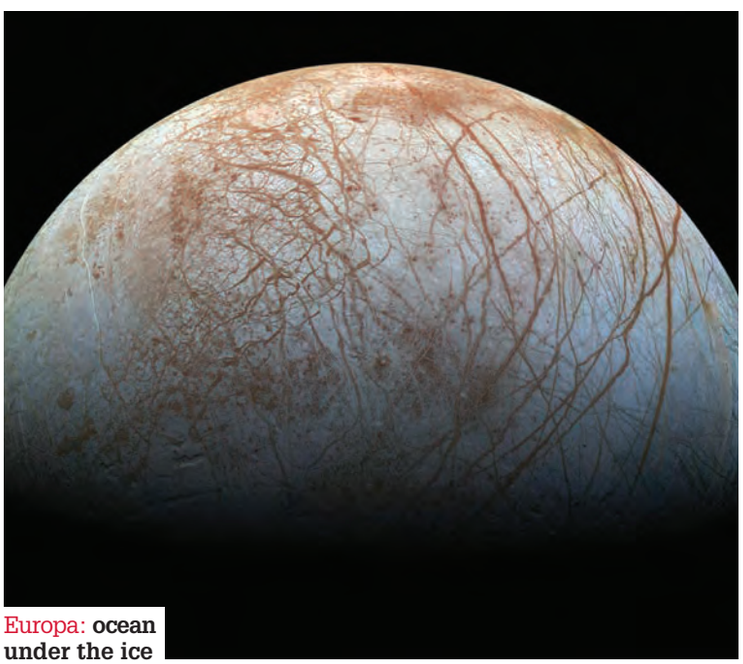
and may also have liquid water under its ice crust. Moreover, we do of course have experience of exploring water environments below ice, where stringent conditions of cleanliness have to be observed: in recent expeditions to drill into lakes in the Antarctic.

So enticing is the prospect of exploring the moons of our gas giant neighbours that several groups are working on concepts for missions to the Jovian satellites and even the more distant moons of Saturn.

Drill systems for icy worlds are among the best-developed ideas. These might be placed in the nose of a 'penetrator', such as those that were planned to crash into the Moon's surface in the UK's MoonLITE mission. Ice penetrators have advanced as far as trials, carried out last year by UCL's Mullard Space Laboratory at Pendine Sands in Wales, where 20kg steel shells were fired at a 10-tonne cube of ice along a rocket track used by Qinetiq to test missiles. The penetrator and its internal components survived the impact.

A penetrator has the advantage of simplicity over a 'soft-lander'; it doesn't have to be slowed down as it drops to the surface, so doesn't need to carry ablative heatshields, parachutes or airbags. In the case of ice, this is a double advantage, as sinking into the surface helps to get drilling started. On Europa, the upper levels of ice are thought to be effectively sterilised by solar radiation and particle bombardment, so investigation has to take place at depth. Europa's ice could be anything from a few to tens of kilometres deep; there could be a slushy layer before liquid begins, and nobody has any idea how deep the water might be.

This effectively limits the ambition of a drilling project, because of the need for cabling to connect the drill and its associated instruments to the surface; it would quickly become too heavy to be practical for spaceflight. The same problem, unfortunately, would almost certainly put paid to any ideas of sending submersibles to explore extraterrestrial oceans.



Europa: **ocean under the ice**

"Several groups are actively working on concepts for missions to the Jovian satellites and even the moons of Saturn

Drills for use on icy moons would have to combine thermal and mechanical operation, to melt through the ice and clear aMareway rocky material embedded in it. Antarctic drills generally work by melting ice to generate a 'reservoir ' of working liquid, which is then heated and pumped to the tip of the drill; this ensures that no foreign substances are introduced to the ice, as it is essentially used to melt itself.

But other moons have no ice to drill through, instead having standing liquid on the surface. One idea to explore such a world is the Titan Explorer (TiME), a lander for Titan that is designed to 'splash down' in one of the methane lakes that have been imaged on the moon's surface and to bob around in the liquid hydrocarbon, taking measurements, looking for evidence of microbial life and even exploring the shoreline.

TiME has already been rejected once as a proposed NASA mission in favour of the InSight Mars probe, which is to launch next year with a lander to study the Red Planet's subsurface geology, possible plate tectonics and core; but its designers, including NASA chief scientist Ellen Stofan and principal investigator Ralph Lorenz of Johns Hopkins University in Maryland, are keeping the concept alive for future mission proposals. TiME would not have a propulsion system, but would need non-solar power, as Titan's clouds are so thick that there's no chance of the Sun penetrating them. The craft would have to be equipped with a nuclear battery, which generates electricity using the difference in temperature between the ambient conditions (very cold on Titan) and a lump of plutonium oxide.

With NASA's budgetary constraints, TiME is unlikely to be practical before about 2040, as is Europe's proposed equivalent, Talise, which would be equipped with rotating paddles to navigate Titan's lakes. Spanish company Sener is investigating propulsion systems.

Another option is to fly; Titan's dense atmosphere and low gravity mean flying would be easier and require less energy than on Earth. One concept from a Franco-US team proposes a prop-driven UAV, Aerial Vehicle for In-situ and Airborne Titan Reconnaisance (Aviatr), to investigate the landscapes on the moon. The team envisage AVIATR as part of a vessel including a space vehicle, entry vehicle and aircraft, weighing 20–100kg and powered by a nuclear battery, which would cruise Titan's skies surveying its surface and sampling its atmosphere. Such a craft would not require significant development beyond current autonomous UAV technology and would therefore be a relatively cheap way of surveying large parts of Titan's surface. One goal could be to locate optimal sites for future landers such as the ones described above.

For more on this story visit **www.theengineer.co.uk**

"Traineeships drive talent into our sector"

Les Ratcliffe, Head of Community Relations at Jaguar Land Rover

Traineeships give employers an opportunity to help build a pool of high quality recruits for their sector. To discover how Jaguar Land Rover are unlocking their future workforce's potential and how you can too, visit **greatbusiness.gov.uk/traineeships** or call **08000 150 600**

BUSINESS IS GREAT BRITAIN

STS

Pneumatic Drum Mixer

Tumbles Drums For Fast Efficient Mixing In Zoned Hazardous Areas

Telephone : 01736 851050
Email : sales@sts-trolleys.co.uk
Website : www.sts-trolleys.co.uk

BETTER INSIGHT, HIGHER PRODUCTIVITY

Are you experiencing barriers within your inspection process?
Require faster throughput from the quality department?
Considering metrology solutions including non-contact inspection?

Whether you're an OEM or a tier 1 or 2 supplier, whether your need is to accelerate your performance, increase productivity, improve margins or reduce rejects or just want an industry experts advise.

Nikon Metrology are hosting an open day dedicated to laser scanning solutions. With external guest speakers announced next week and internal speakers from Nikon Metrology's experienced application engineers we are sure to answer any of your questions.

REGISTER NOW!

To register please email Rebecca Dalmeny sales.uk.nm@nikon.com
Please note, spaces are limited and are on a first come first served basis.
Book early to avoid disappointment.

OPEN DAY

Date: Tuesday 17th February 2015
Time: 10.30am – 3.00pm
(Lunch and refreshments provided)
Location: Nikon Metrology,
Argosy Road, East Midlands Airport,
Castle Donington, Derby, DE74 2SA
Contact: Rebecca Dalmeny 01332 811349
or sales.uk.nm@nikon.com

Nikon

DUGARD Machine Tools

www.dugard.com | sales@dugard.com | +44 (0)1273 732286

Dugard Lunan 1955 Multi Function CNC Lathe

Starting at £18,700, in Stock Now

Also in Stock

Dugard Lunan 12-33 Multi-Function CNC Lathe from **£18,450**
Dugard Lunan 210A, Slant Bed CNC Lathe from **£28,323**

- PC, Fanuc or Siemens controls
- 7.5kW main motor
- 500mm swing over bed
- 1400mm between centres
- 3100kg weight
- 3 range gearbox
- 250mm 3 jaw chuck
- 77mm spindle bore

Dugard Lunan 500A Vertical Machining Centre

Dugard Lunan 500A on Show at Southern Manufacturing

Starting at £19,950, in Stock Now

Also in Stock

Dugard Lunan 600A VMC from **£26,500**
Dugard Lunan 800A VMC from **£29,500**

- PC, Fanuc or Siemens controls
- 1600 x 1840 x 2110mm footprint
- 500/320/400mm X/Y/Z axis traverse
- 10,000rpm spindle speed
- BT40 spindle
- 5.5kW spindle motor
- Linear guideways

Join us at Southern Manufacturing, stand M14

SOUTHERN 15 Manufacturing & Electronics
FIVE | Farnborough | Hants | GU14 6XL
10th to 12th February 2015

Demon weed to energy need

A former cigarette factory in Concord, North Carolina, is being transformed into the home of one of the world's first bulk producers of grid-connected batteries. Stuart Nathan reports

Factory setting: **the former Philip Morris plant is a key piece of Alevo's jigsaw**

They used to call it Marlboro Country. It had — and still has — rolling fields with miles of picket fences and scrub thickets in which wild turkeys try, and often fail, to hide from hunters. But the days when tobacco ruled North Carolina are long gone, and while its demise might have improved general health levels it took thousands of jobs with it.

But employment is returning to Concord, North Carolina, with the giant factory that once churned out millions upon millions of cigarettes for the Philip Morris company under new ownership. Its cavernous halls are still mostly empty, but soon they'll ring to the sounds of manufacturing for a different kind of industry: one that might be set to be as emblematic of the early decades of the 21st century as tobacco was to the first half of the 20th: low-carbon energy.

Specifically, the former cigarette factory is to take on a new lease of life as one of the world's first industrial-scale producers of grid-connected batteries, thanks to a company called Alevo. Founded by Norwegian cloud-computing entrepreneur Jostein Eikeland in 2008, Alevo has been operating in 'stealth mode' for almost a decade, with a new set of technologies and a novel business plan that it hopes will propel it to a leading position in a sector that Eikeland believes will be a crucial part of energy services in the coming decades.

"Alevo's technology is based on novel chemistry that overcomes many of the drawbacks of existing batteries

The former Philip Morris plant is a vital piece in the jigsaw. Comprising three million square feet of manufacturing space in its own wooded and landscaped grounds, it's a huge mass of angular brickwork on a Cyclopean scale, its architecture sometimes seeming to be inspired more by Aztec pyramids than any recognisable commercial building (to the extent that one visiting journalist was heard to remark about how 'Ziggurats could seriously damage your health' to the bemusement of American hosts who didn't recognise the British health warning).

Inside, the building is a maze-like construction of lofty halls (one of which has been used in the filming of the *Hunger Games* movies and the TV series *Homeland*), seemingly endless corridors and low-ceilinged spaces that are best explored by a squeaky-tyred golf buggy. Chipped paintwork is being removed and new utilities installed ahead of ->

the arrival of tooling and other production equipment for the manufacture of individual battery units and arrays housed in shipping containers, known as Gridbanks, many of which are destined for export — even, as Eikeland proudly says, to China.

Alevo's technology is based on novel chemistry that, it claims, overcomes many of the drawbacks of existing batteries that limit their usefulness for grid-scale application. But the actual battery chemistry — the composition of the electrodes, which is what determines the voltage produced by the cells that make up the battery — is a standard configuration of a lithium ion phosphate (LiIP) cell.

LiIP cells are a well-understood, mature technology, but existing versions have inherent problems that make them difficult to use for grid-scale applications. The first is that they degrade over multiple discharge-recharge cycles, becoming less able to store charge and transmit it reliably. Secondly, the electrolytes in lithium batteries — the salts that surround the electrodes and transport ions and electrons around the cell — tend to be extremely flammable organic compounds, making them a risk: one that Boeing, to name one example, found almost catastrophic when batteries in several of its new 787 Dreamliners caught fire shortly after the aircraft entered service.

Alevo has got around this problem by dumping the organic electrolyte usually used in LiIP cells and developing a new one. Researched at labs in Karlsruhe and Dormagen,

“Existing versions of LiIP cells have inherent problems that make them difficult to use for grid-scale applications

Germany, this is completely inorganic; a gel containing sulphur dioxide and aluminium chloride. This prevents the runaway thermal reactions that can lead to battery fires and explosions in conventional organic-based lithium cells, and has what Alevo claims are two key properties: thermodynamic stability, always returning to the same state following each complete charging cycle with no increase in temperature; and an electrochemical loop to regulate overcharge and 'deep discharge' conditions, which minuses degradation and its related reduction in capacitance. In tests, according to the company, the battery outperforms every industrial performance measure, and there is no change in internal resistance after more than 40,000 charge-discharge cycles.

The Concord factory will produce these batteries in bulk, shipping in the electrode materials, including nickel foam from Japan and China, lithium ion phosphate and graphite from North American producers and the raw materials for the inorganic electrolyte. These will be packed into shipping creates equipped with the power electronics to control charge and discharge.

But for Alevo, this is only part of the story. Rather than positioning itself as just a battery manufacturer, which puts it into competition with established energy sector players such as Alsthom and Korean manufacturers, as well as the ambitions of California's Tesla, which is in the process of setting up a 'gigafactory' to make batteries at a huge scale, Alevo is 'servitising' the sector by establishing itself as an energy storage services provider that happens to build its own batteries. By selling the service rather than the product, it secures an income stream by locking customers into long-term contracts and reduces the initial outlay needed; battery prices are a stumbling block in the establishment of electricity storage capacity, Eikeland said.

Backing up this service is an analytics system, operated by a purpose-built supercomputer with a processing capability of 3 petaflops (3,000 trillion calculations per second). In terms of both processing cores and memory, the A2 System, also located at Concord, is the largest single coherent symmetric multiprocessing system ever built, Alevo claims. This system will be used to simulate electricity grids containing a diverse range of generating hardware — nuclear, fossil fuel and renewable — to identify the best ways to deploy energy storage. This could be for peak smoothing or storing excess energy from renewables, for example.

Battery back-up: **hydro-electric dam**

Does your production equipment include Rexroth drives, motors and control systems?

Bosch Rexroth is the only company that can repair and replace Rexroth products back to the original specification. We can;

- help save you expensive downtime
- help reduce your machinery failure
- offer you bespoke maintenance agreements
- supply a full warranty with our repairs
- provide on site service/fault finding
- deliver training

For more information about how we can help you reduce unplanned downtime, contact our Service team today: **0800 169 6624**

BACK TO NEW
SERVICE EXCELLENCE from Rexroth

Bosch Rexroth Limited,
Broadway Lane, South Cerney, Cirencester, Gloucestershire, GL7 5UH
www.boschrexroth.co.uk/service
service@boschrexroth.co.uk

The Drive & Control Company

Rexroth
Bosch Group

TRESTON
GROUP

Due to their modularity and versatile accessory components, trolleys are easy to design and adapt to suit a multitude of users and applications.

Increased productivity

with mobility

trestongroup.co.uk • tel. 01635 521521

SOUTHERN 15 Manufacturing & Electronics
FIVE, Farnborough, Hampshire, GU14 6XL - 10-12 February 2015
STAND C73

SEE US AT THE SOUTHERN MANUFACTURING & ELECTRONICS SHOW, STAND C73 • 10-12 FEBRUARY 2015, FARNBOROUGH

Energy advocate

timothygreen
Director, Energy Futures Lab, Imperial College London

Education
1986 BSc, Electrical and Electronic Engineering, Imperial College
1990 PhD, Electrical Engineering, Heriot-Watt University, Edinburgh

Career
1982–83 Trainee, Mining Research and Development Establishment
1990–94 Lecturer, Heriot Watt University

Green joined Imperial in 1994 and has held positions such as director of undergraduate studies and deputy head of the department of electrical engineering. He became director of the Energy Futures Lab in February 2014 and is leader of the Engineering and Physical Sciences Research Council hub in energy networks.

The head of Imperial College's influential Energy Futures Lab is optimistic about the UK's prospects. Stuart Nathan reports

It takes only a brief look at Tim Green's office to determine his interests in the engineering of energy. His shelves are dominated by a piece of vintage monitoring equipment — a wide, smiley face made up of two analogue dials and a semi-circular lever track — next to which are two highly polished, brass-and-steel model Stirling Engines. 'Well, I am an engineer,' he says with a shrug.

The Energy Futures Lab operates almost as a virtual department within Imperial College. 'Energy doesn't pay any attention to traditional boundaries,' Green said. 'People from different faculties have to come together and work with, and learn from, each other. You can't pick up this stuff in a vacuum.'

Such conversations are necessary to ensure projects proceed. For example, a basic knowledge of chemistry is needed for carbon capture and storage, as is process engineering to turn it into an industrial process that can be implemented and scaled up. For the storage side, geosciences and geology are necessary, while a knowledge of the electricity system is essential to work out how CCS would need to operate. 'The people in one discipline don't necessarily know or need to know about the others,' Green said, 'but our job is to pull all that together within Imperial and make sure all the parts work towards the goal.'

Just as important is advocacy. 'We have to project our capability into government, for policy input, and also into companies that might be interested in the technologies we work on and how they might be progressed.'

This multiple focus is vital. 'We have to connect between the disciplines and outside, especially into economics and government,' he added. 'We've got people in our business school who've looked at how financial incentives encourage the development of different technologies, and they gave evidence for the recent hearings into whether the UK is providing illegal state aid for nuclear.'

Talking to industry is also

> **"Universities are seen as trusted sources. If we were seen as lobbyists for technologies, we'd lose our credibility**

crucial in making sure academics are on the right track. 'We want to work with the major corporates to understand what influences their designs, how two things like space and efficiency play against each other. That means we can go back to our research knowing that sometimes cost might not be the overriding factor; power density might be more important, for example.'

Green maintains that the UK has been uncommonly lucky. 'We founded the industrial revolution on coal, then when that began to run out we found North Sea oil and gas. Now that attention has turned to the harm all those hydrocarbons might have caused, we find we're rich in renewable resources as well, with plenty of potential for wind. Plus our history of oil and gas has left us with depleted wells for carbon storage.'

In his view, the UK has a duty to put this abundance to good use. 'It's remiss of us if we don't exploit all these things.'

An issue for those who advise policymakers is the dominance of generalists and those with

Commissioned: **an artist's impression of Hinkley Point C nuclear plant in Somerset**

non-technical backgrounds in UK politics. 'MPs are not in denial; they understand the importance of these issues and they do know that they need a great deal of help to grasp these issues,' Green said. 'Universities are seen as trusted sources and must try to adopt that role. They aren't seen as lobbyists for technologies — we have to be careful there, because if we do that, we lose our credibility.'

The academics' role is to engage with politicians and government departments. 'Ministers will take briefings from civil servants, so we have to make sure the civil servants are well-informed,' he said. Mechanisms such as the Smart Grid Forum, set up by DECC, play a role in this.

Facing the public is another matter. Green doesn't see much of a problem in academics being 'captured', as he puts it, by corporate interests. 'I have worked with National Grid and so on; their business is regulated by Ofgem and they look for evidence of what they should invest in. By the same token, I've seen colleagues take positions with Ofgem and yet they have projects funded by National Grid, to whom Ofgem might not be favourable. I haven't seen companies attempt to manipulate in that way; they need unbiased opinion as much as anyone else does. But public perception is quite a different matter.

'People do assume that if you've done research with a company that you are then their mouthpiece, and that is much more difficult. Especially if you're analysing energy needs and making recommendations that might affect people's everyday lives. You need to be very careful.'

Given the strong opinions on this issue, the university's position is seen as highly relevant. 'We have to look at the evidence and provide some view on all the issues around water use and contamination and how you can complete gas wells, looking at all the engineering and so on.'

Unconventional gas is a case in point. Green lives near the proposed fracking sites close to the Sussex Weald. 'One good thing is that it has reconnected people with where energy comes from; even people who are passionately against shale are becoming more informed about PV or wind, for example. There's an understanding that you have to be for something if you're against something.'

Green thinks there are many unresolved issues in the UK's energy sector and accepts the importance of developing and embracing new technologies. 'There's a lot to be said for having a diversity of sources for technical, financial and geopolitical reasons, so you have to make progress on all fronts,' he said.

'We're now at 16 per cent renewables, from five per cent three or four years ago; that's a steep rise and we still have more to go, with large wind farms at Dogger Bank and Hornsey... But we've still got to replace decommissioned nuclear and coal — building Hinkley Point C doesn't compensate for the closures of old nuclear plants — and that throws the role of gas into focus. The future of gas is still a huge, unresolved issue in the UK. Do we import LNG or exploit shale at home? That's very strongly in the public arena.'

In his own speciality of power and control electronics, there are issues around connecting Europe's energy grids. This, he believes, will become increasingly important to make best use of nation states' resources — for example in energy storage, where Norway has a surplus of pumped storage capacity — and to balance oversupplies of electricity in some regions with scarcity in others. Energy is no respecter of boundaries, be they disciplinary or national.

"People who are passionately against shale are becoming more informed about PV or wind. You have to be for something if you're against something

Winds of change: **wind farms are flourishing in the UK. The future role of gas is uncertain**

For more news, comment & features visit **theengineer.co.uk**

What's in store?

An expert panel answers your questions on the future of carbon capture and storage. Stuart Nathan reports

Carbon capture and storage (CCS) is increasingly seen as a prerequisite to the continued use of fossil fuels. If you can't prevent carbon dioxide (CO_2) reaching the atmosphere, the argument goes, then you can't burn the fuel. But CCS has still never been demonstrated at full scale and its costs are uncertain.

We invited readers to pose their questions on CCS to experts in industry and academia. This selection of questions was answered by Tim Bertels (TB), manager of the CCS portfolio at Shell; and Niall McDowell (NM) and Paul Fennell (PF) of the Energy Futures Laboratory at Imperial College London.

■ What's the parasitic load associated with the absorption, stripping, compression and transport of the recovered CO_2 to storage and where will the additional power generation capacity come from?

NM/PF: CCS plants require energy for flue gas fans, amine recirculation pumps, amine regeneration, CO_2 compression, CO_2 dehydration, auxiliaries, etc.

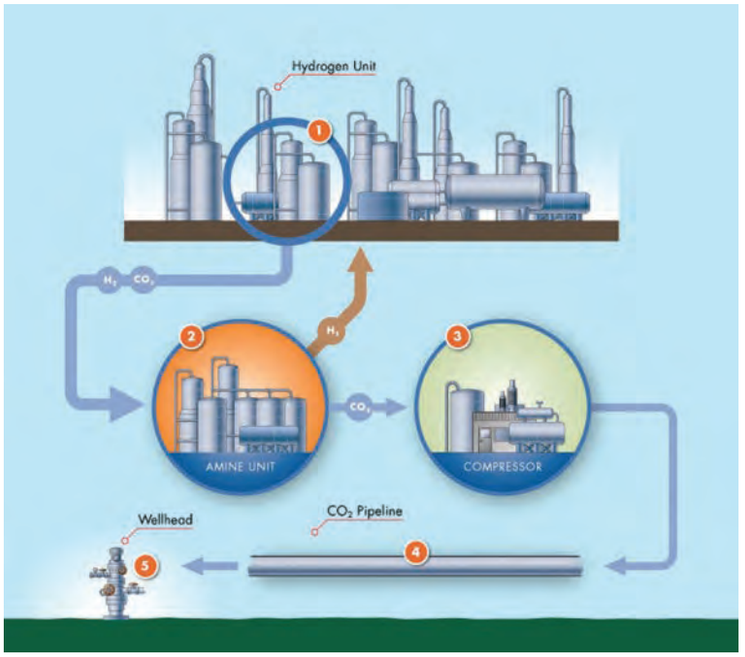
The amount of energy needed is broadly equivalent to the tonnes of CO_2 to be captured and compressed. The parasitic load, as loss in thermal efficiency, of specific power plants is dependent on the efficiency and CO_2 intensity of the unabated plant; for example, a coal CCS plant needs to capture and store more than twice the amount of CO_2 per megawatt produced than a gas CCS plant.

Values of nine to 12 per cent/20 to 29 per cent for coal and six to 11 per cent/10 to 18 per cent for gas power have been reported for the net efficiency penalty (percentage lower heating value, or LHV) and the relative decrease in efficiency (percentage).

This really depends on the material used, but on average a number of about 20 per cent is about right. So this means that if the power plant was 40 per cent efficient (in terms of conversion of fuel energy to electrical energy) without CCS, it will be about 32 per cent efficient with CCS. This will be reduced as CCS technology improves. A reasonable aim would be to have technologies demonstrated at scale that halve the penalty by 2030.

■ What is the main driver of private funding into CCS — concern for climate change or enhanced oil recovery (EOR)? If there was no gathering pressure under UNFCCC (especially Paris 2015) to drastically reduce CO_2 emissions from all sources, would the petrol- and coal-based industries be putting any money into environmentally motivated CCS?

Capturing attention: **Shell's CCS test facility in Norway**



NM/PF: I think the main drivers for private funding are: (a) an interest in being an informed consumer/user of this technology in the event that a sufficiently high carbon price (or similar mechanism) is in place to incentivise its deployment; (b) an interest in opening this potentially lucrative market and being able to supply equipment; and also (c) EOR.

However, as EOR is predicated on accessing the cheapest possible supply of CO_2, one wouldn't target power plant CCS in the first instance, except in the absence of other options and with a very high oil price.

■ **CCS is said to not be viable until there is a competitive price for carbon. What indications are you receiving from various governments that this situation will improve for you?**

NM/PF: As academics, this doesn't really affect us directly as the question is posed. However, the current carbon price floor in the UK in addition to the China-American deal in this space is cause for optimism.

■ **Once carbon is stored in geological formations, will it leak out? And if so, how long does stored carbon take to become harmless to the environment?**

NM/PF: Assuming that the storage location has been properly chosen and managed, it is highly unlikely that it will ever leak out. Therefore, once it has been sequestered, it is essentially harmless. The formations that we will be storing CO_2 in are not 'empty'; they are porous rocks, currently full of water. Once the CO_2 dissolves into the water, it is no longer buoyant — so would tend to sink, not rise.

Finally, over the course of perhaps 1,000 years, the CO_2 reacts with the rocks to form carbonate minerals — these are in general some of the most stable rocks there are. You might as well ask whether we are worried that the white cliffs of Dover ($CaCO_3$) will spontaneously liberate the CO_2 associated with them.

■ **The carbons that we intend to capture are in the form of CO_2 (mostly, I guess). Will the CCS cause imbalance in composition of atmosphere — i.e. reduction of some and increase of some?**

NM/PF: No. It will prevent an increase in the amount of CO_2. Essentially, some people worry that we will suck O_2 out of the atmosphere with the CO_2. Think of it this way: CO_2 is 400ppm and O_2 is 210,000ppm. If we burn enough carbon to increase the concentration of CO_2 in the atmosphere to 500ppm (which is sufficient to raise global temperatures by 2°C), we drop the concentration of O_2 to 209,900ppm (i.e. by 0.05 per cent) — hardly noticeable. In any case, the drop is a consequence of the combustion of the fossil fuel, not anything we do with the CO_2 formed.

■ **What is the monetary cost of CCS per megawatt-hour of electricity generated from coal, oil and gas?**

TB: The short- and long-term per-megawatt-hour electricity cost of low-carbon fossil power from power plants where CCS is applied will be dependent on many factors — among others the capital and operational cost of both the power and the CCS parts of the plant.

First-of-a-kind-demonstration CCS plants will have higher costs than the anticipated costs of CCS plants in the commercial phase. Substantial cost reductions through learning curves when a large number of these plants will be built are probable — supported by the evidence from the multiple commercialisation of analogous technologies.

One UK-based source for both low-carbon fossil power costs and the sources for cost reduction upon commercialisation is the CCS cost reduction task force report, which builds on the regularly updated comprehensive DECC cost of generation studies. Both gas and coal power costs are reported. Oil power costs are less relevant, as the use of oil for power generation is very small in the EU. The report also shows the cost of CCS-per-megawatt-hour electricity as the additional costs of low-carbon fossil CCS power versus the unabated plant. At comparable plant utilisations, gas power generally has a lower additional per-megawatt-hour CCS costs as less CO_2 needs to be captured and stored on a megawatt-hour basis.

NM/PF: Unfortunately, this doesn't have a simple answer. The correct answer will ultimately depend on a lot of other factors external to this discussion (the price at which financing is available, for example). Current estimates put gas plus CCS at about €100/MWh and coal plus CCS at about €110/MWh.

■ **What is the monetary cost of CCS per tonne of CO_2?**

TB: The cost of CCS per tonne of CO_2 is the difference between the per-megawatt-hour electricity cost of low-carbon fossil and the unabated power plants divided by the amount of CO_2 captured and stored per megawatt-hour low-carbon fossil power produced.

Coal power generally has a lower-per-tonne-of-CO_2 CCS cost with the economy of scale and higher CO_2 concentrations in the flue gas. Analogous-to-Q6 first-of-a-kind CCS costs will be higher than commercial-phase CCS.

One source for future per-tonne-CO_2 CCS costs are the Zero Emission Platform CCS cost studies.

NM/PF: See above, but a reasonable cost might be £70 per tonne now, or £35 per tonne with newer technology.

However, the important point is that the increase in cost of the overall electricity supply system to 2050 (assuming decarbonisation) is lower by a factor of two to three if CCS is included. This is because it is necessary to build huge ->

Building up energy: **equipment in Shell's Norway plant**

quantities of electricity storage for times when the wind is not blowing or the sun not shining. Fossil with CCS allows a cheaper overall supply system with guaranteed ability to respond to demand (and increasingly supply) variability.

■ What are the methods used to separate the CO_2 from nitrogen and unused oxygen?

TB: I assume you could use absorbants, or you can pressurise and cool the exhaust until the CO_2 becomes a liquid. This means the CO_2 is already under the pressure required for disposal, but the energy used to compress the nitrogen needs to be recovered — perhaps by improving the carnot efficiency of the generator.

Current commercially available flue gas CO_2 capture systems apply lean amine in absorber towers to selectively remove CO_2 from the flue gas (which contains nitrogen and residual oxygen). CO_2 is separated from the loaded amine in regeneration columns, after which the CO_2 is compressed and dehydrated.

The concepts of pressurising CO_2-containing gases (such as flue gas) followed by partial expansion/cooling, to freeze out and separate CO_2 as particles are progressed in different 'cryogenic' technologies in R&D programmes globally. Some examples are given in a recent DoE transformative CO_2 capture technologies workshop, although alternative technologies are also progressed.

These technologies require energy to compress (and/or cool) the large flue gas streams, where expansion (and/or heat exchange) is applied in some to recover a part of this compression energy.

Both the compression of large flue gas streams and energy recovery will require equipment of substantial sizes. The carnot efficiency of coal and gas power generation technologies has been improved significantly over the past decades. Efficiency integration of amine and alternative technology CCS plants with the unabated power cycles is an option and has been studied

"Cryogenic technologies are at an early demonstration phase and need development and scale-up

in different programmes. All these 'cryogenic' technologies are at early demonstration phase (and thus not commercially available) and need development, scale-up and conformation of their capital and operating costs and energy penalty competitiveness versus commercially available technologies.

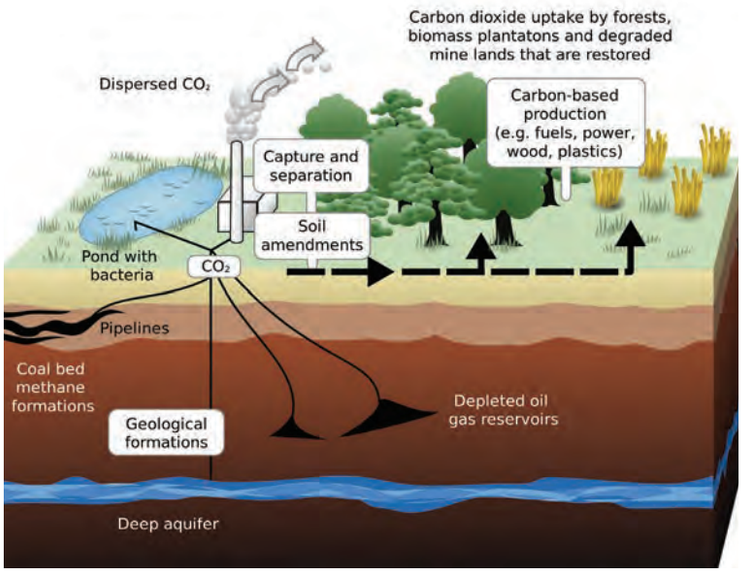
NM/PF: I think that this is a discussion about CO_2 separation in post combustion, not oxyfuel. Hence there are a large number of technologies under trial, from scrubbing with liquid solvents to novel absorbent technologies.

■ What are the most promising non-solvent absorption-based technologies for carbon capture (i.e. mineralisation, synthetic fuel production)?

TB: Alternative regenerative CO_2 capture technologies (for CO_2 storage) are being researched, next to the solvent-based ones. These are, among others, based on sorbents, membranes and cryogenics.

It is too early to tell which are the most promising ones and it's likely different technologies may prove to be preferred for different applications such as coal and gas power plant retrofits or new-builds, hydrogen production plants, CO_2-containing process streams, etc. As such, the development of a broad portfolio of technologies should be progressed.

Non-regenerative CO_2 capture technologies such as mineralisation or synthetic fuels are different applications with different drivers. Mineralisation needs a large flow ->



of solids per ton of CO_2. Synthetic fuels from captured CO_2 are technically feasible. However, it needs to be recognised that the process requires energy that will add substantial costs, especially when a low-carbon or renewables energy source is used. Furthermore, the captured CO_2 will be released again during use of the fuel.

NM/PF: Mineral carbonation is a adsorption technology. It is the ultimate fate of the CO_2 when injected into a saline aquifer (i.e. in CCS). Many people don't consider it promising for CO_2 capture owing to the vast amount of raw material (two to three times more rock than the amount of coal burned in a power station) that is required and that requires a significant amount of energy to grind it up. Synthetic fuels are not a CO_2 capture technology, as once you've used the fuels the CO_2 is then re-released to the atmosphere (you can either claim to have decarbonised a power station or your produced fuel — not both).

Essentially, why not charge an electric vehicle using decarbonised electricity — the CO_2 never makes it into the atmosphere. Also, the efficiency losses in the system to convert CO_2 to a fuel and then to use the fuel in an internal combustion engine mean this is a huge white elephant.

■ What are the prospects for CCS that can be retrofitted to existing power stations, rather than purpose-built plants with integrated CCS?

TB: Existing power stations can be retrofitted with post-combustion CCS on their flue gas. Often the steam and power needed to run the capture plant can be drawn from the power plant utilities system.

The scope and complexity (and thus costs) of the retrofit will be dependent on the state and the CCS readiness level of the power plant. CCS readiness can be defined at different levels with available plot space, installed tie-ins, CO_2 pipeline corridor, etc. It is probable that it will not be attractive to retrofit old coal plants with lower efficiency and a limited residual technical or economic life.

NM/PF: Post-combustion options are best here — amine scrubbing or calcium looping, for example.

■ Given the timescales that are demanded by international agreements, is it your impression that markets such as India and China will look to the west to buy technology; or will they develop their own, and even license it back to Europe and the US?

TB: This will depend on which countries progress first and fastest in demonstrating CCS at scale in real projects. In any case, the position of CCS markets such as India and China (currently not in the same stage of CCS demonstration) will change over time; it is likely that in the first instance, for the first set of large-scale full-value chain demonstration projects, India and probably China will look to buy technology from countries (and companies) that are more advanced in developing and demonstrating CCS technology.

Over time, this may change if markets such as India, and especially China, and potentially also other developing countries, would have accelerated their in-country CCS technology demonstration and development and would become exporters of novel CCS (capture) technologies. For example, Europe — with the exception of the UK and Norway — is currently lagging on CCS demonstration.

> **"The scope and complexity of the retrofit will be dependent on the state and the CCS readiness level of the plant**

NM/PF: In the near term, the technology development seems to be mostly led by western companies, in addition to some organisations in South Korea and Japan. In the longer term, bearing in mind that this technology will be used until at least the end of the century, it seems inevitable that Asia's manufacturing base will begin to play a larger role. We are starting already to lose our position as leaders, as other countries begin to take notice of climate change.

■ Which has greater potential: pre- or post-combustion CCS?

TB: With the differences in CO_2 sources in different industries and CCS on existing and new-build, it is probable that the different CCS technologies will develop and find their place. Specifically, post-combustion will be suited to retrofits and pre-combustion may have its place in low-carbon hydrogen production.

NM/PF: It depends on the timescale and the particular niche. In the short to medium term, it would appear that post-combustion technologies are more viable than pre-combustion technologies. It doesn't do to forget about oxyfuel combustion options either.

■ What's the current biggest roadblock to CCS implementation, and how might this be overcome?

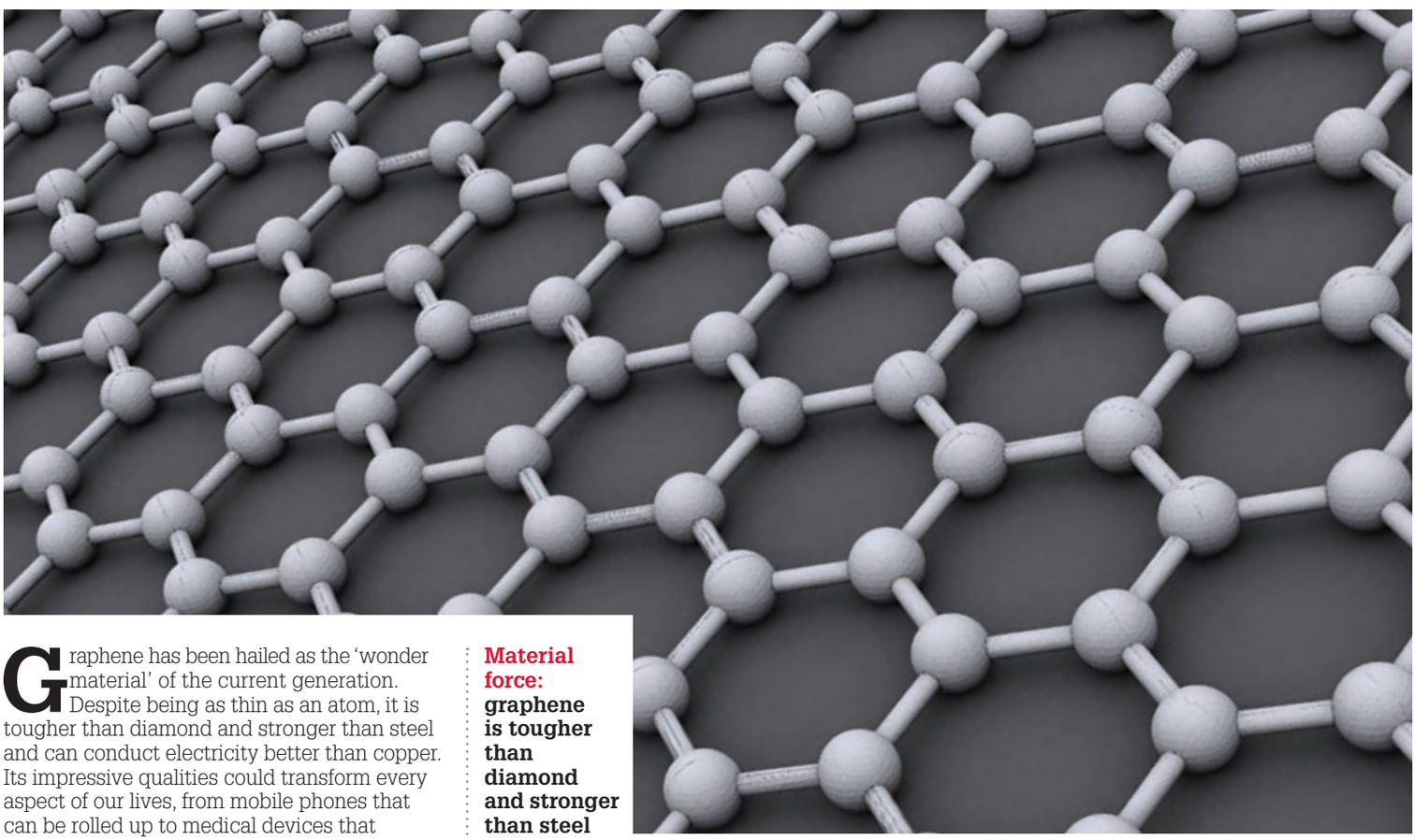
TB: CCS is a combination of technologies deployed solely for climate change purposes and — with reference to question three — CCS won't really be viable until there is a competitive penalty for carbon emissions or a price on low-carbon products produced with CCS (electricity, among others). The absence of either of these in most countries is the biggest roadblock to implementation of CCS at scale.

NM/PF: Financing the projects, and here the most important thing is credible, long-term commitment from government. Also, misguided opposition from some environmental organisations.

On the rocks: **the white cliffs of Dover**

Setting standards

UK researchers are developing advanced graphene measurement techniques that could hasten the commercial applications of the revolutionary material. Ellie Zolfagharifard reports



Material force: graphene is tougher than diamond and stronger than steel

Graphene has been hailed as the 'wonder material' of the current generation. Despite being as thin as an atom, it is tougher than diamond and stronger than steel and can conduct electricity better than copper. Its impressive qualities could transform every aspect of our lives, from mobile phones that can be rolled up to medical devices that connect directly to neurons.

Since its discovery in Manchester a decade ago, almost 12,000 patents and patent applications have been filed for the material. Now, companies are beginning to put it to commercial use. Head NV last year introduced a graphene-infused tennis racket. Meanwhile, Apple, Saab and Lockheed Martin all have plans under way to develop graphene membranes and circuits in the near future.

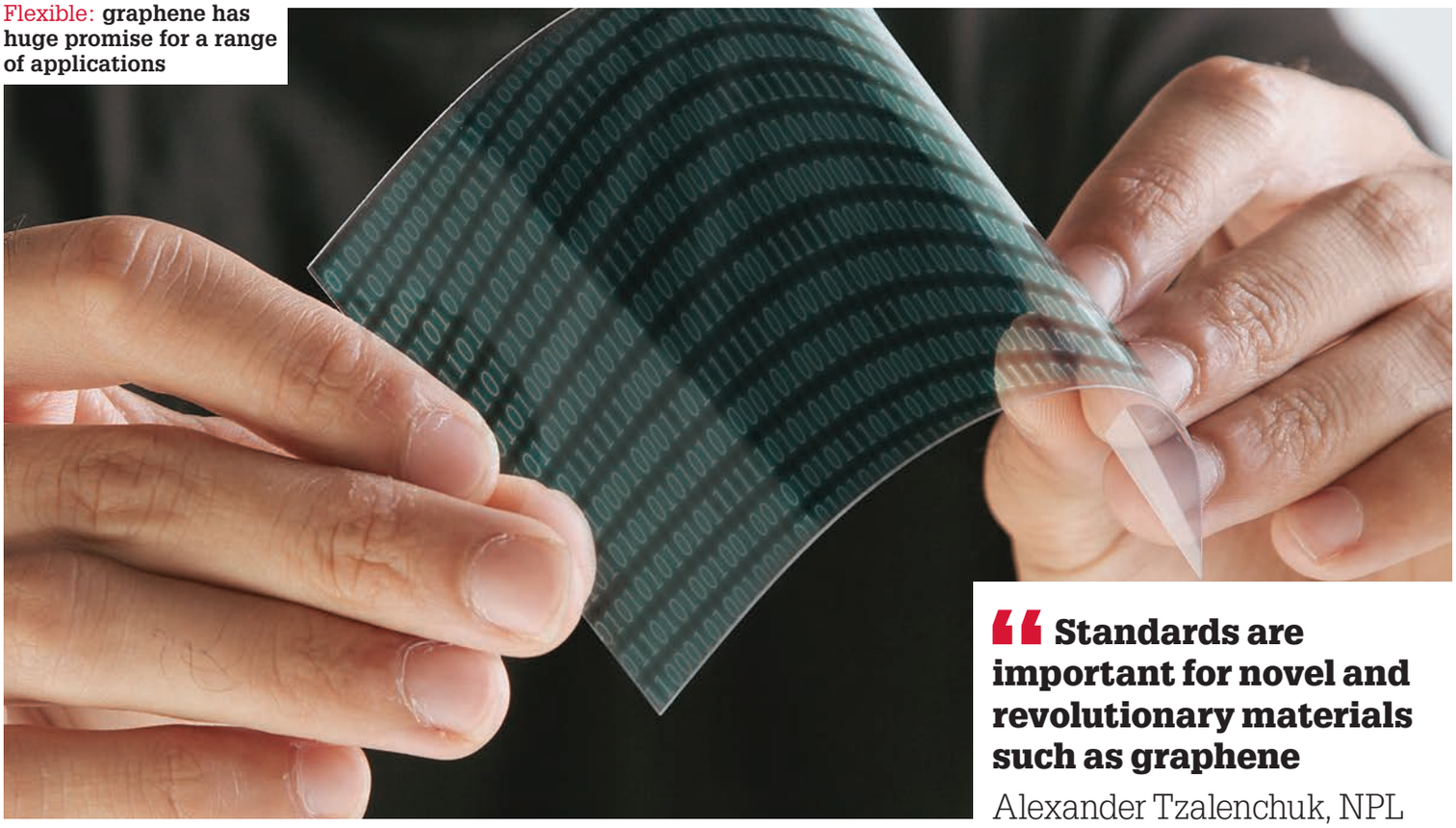
But excitement for its applications has so far been tempered by a big flaw; there are no standards for the material. 'Standards are particularly important for novel, revolutionary materials such as graphene,' said Alexander Tzalenchuk, a National Physical Laboratory (NPL) fellow. 'There is a lot of hype surrounding it and it is very easy to undermine confidence.'

For instance, a company may claim that a product has graphene in it, when it is in fact graphite. 'The material may not be as strong as you would expect, or would not conduct heat or electricity as well, or would not hold as much electric charge,' said Tzalenchuk. 'Before any standard can be developed, we need to understand what kind of material we are dealing with and how it can be characterised.'

But characterisation has so far proved tricky. Graphene in its pristine form is just one layer of carbon atoms. This may sound simple, but its electronic, optical and mechanical properties are governed by complex quantum behaviour. As well as this, graphene's characteristics are sensitive to the environment, making the measurement of its features particularly difficult.

In November, 20 scientists working on graphene at NPL signed an agreement with Manchester University to provide the measurement capability necessary

->



Flexible: **graphene has huge promise for a range of applications**

> **"Standards are important for novel and revolutionary materials such as graphene**
>
> Alexander Tzalenchuk, NPL

to characterise graphene. 'Currently we are working towards research projects where either a combination of existing methods or completely new online characterisation techniques could be developed as a result,' said Manchester University research associate Antonios Oikonomou.

Researchers already have a number of techniques to investigate graphene's properties. One of the most common is Raman spectroscopy, in which a laser is used to shine onto the graphene and measure the reflected radiation. This radiation shifts in frequency and provides scientists with information about the material's layers. Another technique is atomic force microscopy (AFM) in which a very sharp tip is scanned over graphene atoms.

'All these techniques are now well understood; however, they all suffer one big downside: they are very impractical to use in a manufacturing environment for various reasons', said JT Janssen, a principle research scientist at NPL. 'With Raman and AFM, you can only investigate minute areas of the graphene — not much use for a 32in display.' Instead, NPL is working on characterisation techniques that can be used in real time on large amounts of graphene.

One technique is a microwave measurement. Although graphene is transparent, it interacts strongly with microwaves, even though their wavelengths are 100,000 times longer than light. As a result, if a graphene film is placed in a microwave field, it will disturb the field. The extent of the disturbance is an indication of the sheet resistance and conductivity.

'At present, these methods have been developed in a lab environment,' said Janssen. 'There will be challenges to integrate the measurement system in a production environment where there may be higher levels of noise, interference and environmental variations. Our existing system uses quite expensive instruments, but we are developing a much simpler and cheaper version that is more suited to the production line.'

According to Lux Research, sales of graphene will grow from £5.7m ($9m) in 2012 to £80m ($126m) in 2020. If the UK gets the standards right, it could gain a large slice of the market. For now, it seems the government is providing its backing. In March's budget, chancellor George Osborne pledged investment in graphene, describing it as a 'great British discovery that we should break the habit of a lifetime with and commercially develop in Britain'.

Oikonomou believes the real benefits of graphene will be in its use for 'green' technologies, such as membranes, lightweight composites and batteries. 'I strongly believe that a combination of the material's unique properties with innovative application design driven by social needs could lead to useful products and processes,' he explained. 'It is the need to solve a problem that leads to disruptive and innovative technologies, and there are no larger needs than the ones that we face on a global level.'

indepth

The process of developing standards for graphene

There are a number of committees that have to agree on proposed standards for graphene. For example, the committee of International Standards Organisation (ISO) for nanotechnologies, TC 229, has 34 participating and 14 observing countries. Another committee, the International Electrotechnical Commission (IEC), which mainly focuses on electrical and electronic products, has 14 participating and 18 observing.

Each committee has working groups that deal with issues such as terminology, measurement and characterisation, health and safety and material specs. 'Trust me: only to have everyone in a room to agree for the terminology and nomenclature of graphene takes lots of effort,' said Manchester University's Antonios Oikonomou.

'Fortunately, there are already under development standards related to graphene, such as the ISO/NP TR 19733, named as "Matrix of characterisation and measurement methods for graphene", or the IEC 62607-6-2, which deals with the evaluation of the number of layers of graphene. The only thing I can wish for is effective communication between the interested parties, which will speed up the standardisation process.'

For more on this story visit **theengineer.co.uk**

Manchester Metrology LTD

Portable Measurement Solutions

THE ONE STOP METROLOGY SHOP

FARO ARM, GAGE, LASER TRACKER HIRE

PROBES, PROBE KITS & ACCESSORIES

TRAINING ON FARO, DELCAM AND ABERLINK SOFTWARE
ONSITE INSPECTION SERVICES

MANCHESTER METROLOGY LTD
UNIT 12
GREENSIDE TRADING CENTRE
GREENSIDE LANE
DROYLSDEN
MANCHESTER
M437AJ
Tel:-01616378744
Fax 01614250944

WWW.MANCHESTER-METROLOGY.COM

Plastic potential

The UK is leading research into plastic electronics — but how much of that is being converted into commercial success? Ellie Zolfagharifard reports

In 1989, Prof Richard Friend and his colleagues at Cambridge University found that certain plastics could be made to generate light when wired up to an electrical source. What they had discovered in their quiet lab was the basis for plastic electronics. Little did they know that over the next decades their accidental discovery would spawn an emerging industry described as 'one of the most important British innovations of the 21st century'.

Plastic electronics, also known as organic and printable electronics, describes carbon-based, organic materials made using printing processes on flexible surfaces. 'Because they're plastic, they are cheap; they can be integrated into almost anything,' explained UCL material scientist Mark Miodownik during the 'Great British Innovation Vote'. 'What they promise is a world of objects that can display information that can interact with you, can sense who you are, and that is going to change everything.'

By printing electronics directly onto substrates, scientists are hoping to pave the way for products such as smartphones that can be rolled up, intelligent packaging to monitor food products and low-cost solar cells integrated into buildings. Plastic electronics were worth around £6.7bn ($10bn) worldwide in 2012, most of which were in display technologies. IDTechEx, a market analyst, suggests that by 2022 the total market will be worth more than £38bn ($60bn), rising to £222bn ($350bn) by 2032.

The UK is hoping to exploit its head start in the technology, which has its roots in Cambridge. In the last five years, Innovate UK has invested £40m ($63m) in research into plastic electronics. The government has also backed a number of 'centres of excellence', including the Cambridge Innovation and Knowledge Centre (CIKC) and the Centre for Innovative Manufacturing in Large-Area Electronics. Figures show that last year 33 universities and 134 companies in the UK were involved in the development of some type of plastic electronics material.

'The potential for plastic electronics to change the way we interface with electronics through wearables and the "Internet of Things" is very significant,' said Paul Cain, head of business planning at Plastic Logic. 'Taking the displays industry as just one example: in the future, displays will not be made of glass, and we look back on the days when we had to use glass in fragile phones and tablets out of necessity. The UK has leading expertise through the supply chain, from organic materials companies to process and product companies with world-leading expertise in plastic electronics.'

Cain's group is a spin-out from Friend's pioneering research on the material. The company is currently working on the development of low-cost, printed plastic electronic logic circuits for use as the backplanes of e-ink readers. Commercial applications for these flexible displays today include wearable displays such as smart bracelets, secondary displays for mobile devices and digital signs that can be folded. But there are even more exotic technologies waiting in the wings.

'The "Internet of Things" megatrend is ultimately sensor driven, and plastic ->

Cleanroom: **Plastic Logic has helped give the UK a head start**

Image credit: © Plastic logic

> **"The potential for plastic electronics to change the way we interface with electronics through wearables is very significant.** Paul Cain, Plastic Logic

Below:
a researcher from Cambridge Display Technology
Right:
Plastic Logic's flexible colour display

> **"The plastic electronics community has not reached out beyond its borders to interact with potential users of the technology**
> Technology Strategy Board

electronics enable sensors and sensor circuits to be integrated almost anywhere on any surface, curved or flat,' said Cain. 'Some of the really exciting applications relate to this, combining, for example, fingerprint sensors with displays on a single credit-card-sized piece of plastic, in form factors simply not possible with conventional electronics. There are some exciting developments that we will be announcing in early 2015.' But some argue that the UK needs to be doing more to translate its world-leading research into plastic electronics into a commercial success.

Richard Jones, author of *Soft Machines: nanotechnology and life*, points out that Cambridge Display Technology — another company spun out from Friend's research — is in fact wholly owned by a subsidiary of the Japanese chemicals company Sumitomo. While research continues on plastic electronics, Jones argues that actual device development is happening elsewhere. For instance, South Korea's Samsung Galaxy S now has an organic light-emitting-diode screen. Meanwhile, rather than establish its first production facility in the UK, Plastic Logic headed for a site near Dresden in Germany.

In the Technology Strategy Board's recent 'Enabling Technologies' report, the group highlighted the fact that UK plastic electronics still have immature supply chains. It claims that innovative companies, often small and medium-sized enterprises, are not engaging enough with end-user manufacturers who should be users of the technology. 'In part, this is because the plastic electronics community has not reached out beyond its borders to interact with potential users of the technology,' it argued. This is now beginning to happen, however. Oxford Photovoltaics, a spin-out company from Oxford University, has pioneered a low-cost, sustainable, transparent solar cell coating that can be printed on glass. The coating can be used on the glass facades of commercial buildings to convert sunlight into electricity and is then able to power the building. It was set up by Dr Henry Snaith in 2010 to commercialise work in his lab. 'We're making rapid progress towards commercialisation and expect to sign the first licensing deal with a glass manufacturer during 2015,' said chief executive Kevin Arthur.

As the UK government focuses on areas such as graphene and synthetic biology, plastic electronics researchers are hoping that commercial success elsewhere will help drive more investment in the technology at home. Its potential to transform everyday lives has already captured the imagination of scientists — and combined with economic success, it could soon do the same to policymakers.

infigures

The UK is well placed to have a major impact on the sector

£70m
has been invested by the UK government in university projects of direct relevance to plastic electronics

$60bn
is the predicted global worth of plastic electronics by 2022

More than 33
universities and 134 companies in the UK are involved in the development of some type of plastic electronics material

Image credit: © Plastic logic

For more on this story visit **www.theengineer.co.uk**

PROTECTING YOUR ELECTRONICS

Products & Services

Products:

- EMI Ferrites
- HEM Sorb-Shrink
- Honeycomb Vent Panels
- Corrometer

Production Services:

- Gasket Design Tool
- Gasket Proto-type Service
- Flat Stampings
- Form-in-place Gaskets
- Fabrication & Manufacturing
- Down Packing

HITEK
ELECTRONIC MATERIALS LTD

+44 (0)1724 851 678 sales@hitek-ltd.co.uk www.hitek-ltd.co.uk

---

totalboardsolutions

With over 100+ years combined industry experience; we at TBS have been supplying our unique design services across all industry segments from defence to telecoms since 1998.

From concept through to manufacture, TBS can integrate at any stage into your design process.

We provide:

- PCB layout
- Library development
- Schematic capture
- Consultancy
- Black box design
- Software migration
- Training
- Mechanical design
- Thermal analysis

Contact Andy Critcher, Total Board Solutions Ltd, Loddon View, Lower Earley, Reading RG6 7YA

email: pcbdesign@totalboardsolutions.co.uk
tel: 01183 778 550 mobile: 07785 578770

www.totalboardsolutions.co.uk

RELEC ELECTRONICS LTD

Programmable Power Supply 800 to 3000W AE/AEK Series

Relec Electronics are pleased to announce the availability from stock of the 800 to 3000W AE & AEK series fully featured single output power supplies with remote control setting and monitoring via RS232, RS485 & I^2C.

Compact size enclosed cases with integrated cooling allow easy incorporation in a wide range of industrial/process control and telecom/datacom applications. Universal ac input, excellent built in protection, an operating temperature range -20° to +60°C with full safety & EMC approvals enable these power supplies to be fitted to equipment for worldwide use.

The AE/AEK series are available with standard outputs of 12/15/24/30/36/48 and 60Vdc (200/250/400Vdc units available on request) and can be used with up to 8 units in parallel to provide scalable and redundant systems up to 24kW. The implementation of a constant current, current limit also make the AE/AEK units ideal battery chargers.

The true power of the units are harnessed when used in conjunction with an RS232 interface card giving users control over output voltage and current limit settings as well as allowing them to query the active status of the units. Queries include output voltage, current, internal temperature, device status, control mode (remote or local) and device identity. Up to 8 units can be controlled simultaneously from a single control PC.

Design solutions for design engineers

Relec Electronics Ltd
Technical sales: 0800 0599 212
e-mail: sales@relec.co.uk

www.relec.co.uk

engineering events & exhibitions

If you are interested in supplying information or advertising in any of *The Engineer* show previews this year, please contact Sonal Dalgliesh on 0207 970 4487 or email sonal.dalgliesh@centaur.co.uk

FEBRUARY

AutoAero 2015	FIVE, Farnborough	10–12 Feb
Southern Manufacturing & Electronics 2015	FIVE, Farnborough	10–12 Feb

MARCH

Medtec UK 2015	ExCel, London	3–4 March
Ecobuild	ExCel, London	3–5 March
Fastener Fair Stuttgart	Stuttgart, Germany	10–12 March
Maintec 2015	NEC, Birmingham	24–26 March

APRIL

Commercial Vehicle Show 2015	NEC, Birmingham	14–16 April
National Electronics Week	NEC, Birmingham	21–22 April
Sustainability Live 2015	NEC, Birmingham	21–23 April
Med-Tech Innovation Expo	Ricoh Arena, Coventry	29–30 April

MAY

All Energy 2015	Glasgow, Scotland	6–7 May
Product Design + Innovation Conference	Tower Hill, London	20–21 May
Electronic Warfare Europe 2015	Stockholm, Sweden	26–28 May

JUNE

The Engineer Design & Innovation Show	NEC, Birmingham	2–4 June
The Advanced Manufacturing Show	NEC, Birmingham	2–4 June
Subcon	NEC, Birmingham	2–4 June
Plastics, Design & Moulding 2015	Telford Exhibition Centre	16–17 June
Plastics Recycling Expo 2015	Telford Exhibition Centre	16–17 June
Plastics Packaging Show 2015	Telford Exhibition Centre	16–17 June

SEPTEMBER

The Energy Event 2015	NEC, Birmingham	15–16 Sept
PPMA Show 2015	NEC, Birmingham	29 Sept–1 Oct
TCT Show	NEC, Birmingham	30 Sept–1 Oct
Northern Manufacturing & Electronics 2015	Event City, Manchester	30 Sept–1 Oct

NOVEMBER

Aero Engineering Show 2015	NEC, Birmingham	4–5 Nov
Automotive Engineering Show 2015	NEC, Birmingham	4–5 Nov
Composites Engineering Show 2015	NEC, Birmingham	4–5 Nov

New horizons

Opportunities at engineering consultancies aren't just about civil engineering. Julia Pierce reports

Aviation: **Frazer-Nash has been modelling impact damage on the Airbus A350 XWB**

With the recent announcement of another round of large government-backed civil engineering projects, in the shape of the Road Investment Strategy, engineering consultancy firms are busier than ever. However, alongside these high-profile activities, consultancies commonly associated with civil and structural engineering projects are increasingly bringing their range of expertise to bear on a number of challenges across various sectors. This has created opportunities for those with the right professional and personal skills to diversify and get involved in some unusual and interesting projects outside of what might normally be viewed as 'typical' consultancy work.

One of the firms at the forefront of developing such roles is Frazer-Nash Consultancy, which has been working on a research contract with the Defence Science and Technology Laboratory's (DSTL's) Centre for Defence Enterprise, looking into the possibility of developing a novel armour-attachment system. This is intended to enable the rapid fixing and removal of armour modules onto any military vehicle. The resulting technology should be highly configurable so that different levels of protection can be applied to a wide range of service vehicles, depending on the level of threat to them. A separate project in the same sector is looking at how to protect soldiers in vehicles from underbelly blast injuries to their lower limbs, such as those sustained when hitting an improvised explosive device (IED). Elsewhere, in the civil aviation sector, the company's engineers have been collaborating with Airbus to model impact damage on the new A350 XWB, with particular focus on the behaviour of composite components during bird impacts with different speeds and angles, as well as the impact of tyre damage.

> **"We look for people who want to excel at what they do and are committed to being the very best in their field**
> Deborah Ford, Frazer-Nash

Julie Wood, global leader of the planning and project management team at Arup, is not surprised that engineering firms are now stretching themselves in this way. 'The skills

we have as engineers are very valuable — we are natural problem solvers, and as our careers progress we get an idea of what's important for clients — even though that may not be what the client originally had in mind,' she said.

She herself progressed from a traditional engineering role to something more diverse over her career. 'My background was in civil and structural engineering, but during my career I have moved from working on site to leading on projects and a client advisory role,' she explained.

While the many civil projects that Arup works on, such as Crossrail and the McLaren Technology Centre, are exciting — 'where else can you take people to see what you've done and actually leave a legacy?' said Wood — the company's engineers are also involved in a number of consultancy projects. 'Arup is known as a design organisation, but it has evolved into more than this over the last 10 years,' she explained. 'My design colleagues are still working on projects such as the Garden Bridge in London, but we have around 1,000 people on our consultancy team in the UK.' This arm of the business has worked on projects as diverse as enhancing the leadership skills of midwives for NHS East England, designing the infrastructure for low-carbon vehicles and creating a pocket habitat for planting wildflowers that can be put on a roof or urban land. 'The habitat is a 250mm^2 hessian sack with seeds in that can be arranged over an area to stop land erosion,' Wood said.

Elsewhere, engineers from Atkins have been involved in a number of unusual projects in the Middle East with an environmental and heritage protection emphasis. Their work has included producing an environmental impact assessment at Barr Al Jissah in Oman to identify a coral community that could have been damaged by a boom in local construction work. As a result of their investigation, the coral was moved onto a specially designed man-made substrate in a location that would not be disturbed. They also prepared a World Heritage Site Management Plan for the historically important Bahla Fort and Oasis settlement — also in Oman — to protect the area from further degradation. The 13km site had been included on the UNESCO World Heritage in Danger List due to the vulnerable condition of its earthen structures, danger from erosion, limited local planning controls and hydrological problems. Closer to home, the company's engineers have been working at the cutting edge of clean energy research, helping to create ITER, the experimental nuclear fusion reactor in southern France, which aims to deliver nuclear fusion on a commercial scale, offering safe, limitless and environmentally clean energy.

Not only are the projects detailed here a change from the norm, and demanding of skills from across a number of disciplines, but this area of the business is also expanding rapidly. 'Our consultancy side will be growing by 300-plus people next year,' said Arup's Wood, adding that movement between roles was also supported by her company to provide engineers with as much flexibility and stretching of their skills as possible. 'Within Arup it's possible to move from any role to another area of the business — we have a "try it out" period, where people can test a role then make the change or revert to their original position, depending on whether they've enjoyed what they do. We take on a larger number of females than other firms, and have a good number of female role models here, too,' she added.

So, who should apply for these challenges? 'At Frazer-Nash, we value individuals who work collaboratively with their colleagues and clients,' said Deborah Ford, head of human resources at the company. 'We look for people who want to excel at what they do and are committed to being the very best in their technical field. For us, a good engineer is someone who is prepared to challenge the *status quo* with their innovative and creative thinking, and as part of the Frazer-Nash team can add real value as they respond to the challenges placed on us by our clients. We're particularly keen to recruit technical specialists with a passion for project management, business development and leading teams,' she added.

It seems that while there may be plenty of work around for those engineers interested in the design and implementation of large civil projects, those seeking something a little more unusual now have an increasing chance of finding a role that challenges them. Whether it is ecology, clean energy or defence that interests you, there's a good chance a consultancy will have it all»

Middle East: **engineers have helped protect Oman's Bahla Fort**

WATSON MARLOW
Watson-Marlow Pumps Group

Watson-Marlow is the global leader in the peristaltic pump market, operating in the biopharmaceutical, water and waste treatment and other industrial sectors. We are the world's leading manufacturer of positive displacement pumps with over 50 years supplying engineering and process expertise and over one million pumps installed worldwide.

Based at the headquarters of Watson-Marlow Pumps Group in Falmouth and starting January 2015:

NEW PRODUCT DEVELOPMENT

MECHANICAL DESIGN ENGINEERS (R&D AND OEM)

We require two ambitious and innovative mechanical design engineers with a minimum 2:1 BSc or BEng and at least five years proven design development experience of taking products from initial concept to volume production. Extensive experience of DFM/DFA, manufacturing processes including plastic injection moulding, precision die casting and precision machining is essential. One position will focus on R&D and platform development, whilst the other will deliver rapid OEM design solutions working to tight budgets and deadlines.

DEVELOPMENT ENGINEER (R&D)

Working within our internationally recognised Tubing Development team, where hose and tubing products are at the very core of our fluid-handling value proposition, we are looking for a degree qualified engineer with extensive experience of new product development to develop our recently acquired Biopure range of products.

ELECTRONICS PRODUCTION ENGINEER (R&D)

We are seeking an experienced degree qualified Electronics Production Engineer to successfully introduce new products and provide test solutions for PCB's, electrical / electronic assemblies and finished product. The ideal candidate will also have a hands-on approach to problem solving and be capable of fault finding and repairs on the assembly cells.

SOFTWARE DEVELOPMENT LEADER (R&D)

A vacancy exists for an experienced Software Development Leader, who will be responsible for the creation of documentation to specify product system architecture and software requirement specifications. This role requires a graduate level qualification in relevant engineering discipline, together with a minimum of 5 years product development experience. Experience in electronic design, software development, circuit testing, digital design and memory interfaces are all essential.

QUALITY

QUALITY CONTROL ENGINEER

Our QC and Vendor Engineering department require a Quality Control Engineer who has a knowledge of measurement and inspection processes, statistical analysis and can work with design and manufacturing engineers to ensure products are fit for a six-sigma environment. You main duties will be to carry out routine inspection and RCCA and create and document CMM processes, including writing programmes and designing appropriate holding fixtures. You will also define and control inspection levels, whilst working with design engineers to agree critical to quality features and working with suppliers to deliver effective RCCA. You will have a minimum of an HNC or HND in an appropriate engineering or related discipline and a history of achieving tight deadlines.

MANUFACTURING

TUBING EXTRUDER / SETTER

A vacancy exists for a Tubing Extruder/Setter to work within our Class 7 clean rooms. You will be required to work a shift pattern equating to 38 hours per week. The ideal candidate will have previous experience of setting and suited to working within a team based environment. This role will require manual handling and lifting due to the nature of the process.

As we are part of an international group of companies, you may be required to travel overseas. In return, we offer nationally competitive remuneration, an excellent working environment in one of the most beautiful locations in the country.

For full details of all our vacancies as well as information on how to apply, please visit our website at http://www.watson-marlow.com/gb-en/about/careers/

Watson-Marlow Bredel Flexicon MasoSine BioPure
A Spirax-Sarco Engineering Company

HUTCHINSON

We make it possible

Technical Sales Engineer

This is an excellent opportunity for ambitious engineers to join an award winning manufacturing company. Hutchinson Stop-choc is one of the world's leading manufacturers of anti-vibration and shock isolation mountings, avionics racking and illuminated aircraft cockpit instrument and display systems.

The Role:

- To identify and develop new business opportunities.
- To build relationships with technical and commercial clients.
- Establish client requirements and specifications through technical/commercial meetings.
- Carry out product selection and analysis using specialist tools.
- Take an active role in product design & development.
- Prepare technical and commercial proposals and present to clients.

You Should:

- Be a qualified engineer.
- Have an eye for detail and be well organised.

The Package:

Full Training, an excellent remuneration package including company car and 25 days annual holiday. The company also offers an excellent pension and private health care scheme.

Please apply in writing stating your current salary to:
sales@stop-choc.co.uk
The Sales Director,
Stop-choc Ltd,
Banbury Avenue,
Slough, Berkshire, SL1 4LR

MECHANICAL DESIGN ENGINEER

CONVEYOR SYSTEMS & PRODUCT HANDLING

Due to continued growth an exciting opportunity has arisen for a Mechanical Design Engineer with previous experience in conveyor systems and/or product handling.

Located in Royston, Hertfordshire and working within a team of 10 engineers your responsibilities include:

- Design of conveyor systems and product handling mechanisms and release to production
- Produce 3D designs, detail drawings and documentation using AutoDesk Inventor
- Design systems based on customer requirements, design for manufacture, design for service and value engineering
- To undertake mechanical design calculations when required.

To be successful in this role you will need:

- 5+ years experience in design of electro-mechanical machinery
- Experience designing conveyor systems and pneumatic systems
- Experience in design for manufacture and manufacturing processes
- Experience of 3D CAD design including production of working designs
- Understanding of relevant UK, European and International standards
- Strong creative & troubleshooting skills, self motivated, passion for design engineering and ability to communicate with both customers and internal teams.

Please send CV, salary requirement & a cover letter detailing your conveyor systems and/or product handling experience to SL-XR.HR@mt.com.

Only successful candidates will be contacted for interviews.
Mettler Toledo Safeline X-ray; Royston, Herts, SG8 5HN
For more Engineering positions, please look on our website www.mt.com

METTLER TOLEDO

SOLIDSOLUTIONS
SUPPORTING EXCELLENCE

USE YOUR ENGINEERING KNOWLEDGE IN A HIGH-REWARD TECHNICAL SALES CAREER

Are you a self-motivated, assertive engineer who may not have considered a role in technical sales? Are you ready for a new challenge and change of direction?

Selling cutting-edge CAD technology requires individuals with the drive and determination to succeed. Our top technical sales people were engineers like you & are now seeing earnings in excess of £75,000.

We are the largest supplier of SOLIDWORKS CAD software. Due to strong growth we are expanding our team - positions are available across the UK & Ireland.

No previous sales experience is necessary as full training, support and development will be given.

SOLIDWORKS

Call **01926 333 777** to arrange an informal discussion with our Sales Director, Steve Oxley.

ENGINEER YOUR 2015

Our in-house team has in excess of 20 years placing professionals into the Food, FMCG and Energy sectors. We work with leading SMEs and global organisations across the UK and internationally, priding ourselves on delivering an honest and transparent service. Please do not put us in the same category as a number of other recruitment organisations; we are not a sales company! We have worked in partnership with a number of candidates and clients for years and will continue to do so. All our consultants have in-depth knowledge of the sectors they recruit and are considered leaders within their field. We take the time to research the businesses we work with and truly understand the candidates we represent.

The business has seen a huge uplift in demand for Engineers across a variety of disciplines – Maintenance, Service, Electrical, Controls, Management, Project, Process Installation etc. We are always keen to speak with engineering professionals so that we can keep them abreast with the very best opportunities. We are also keen to hear from businesses that have requirements of their own and are seeking a recruitment partner they can trust and rely upon. The team are always willing to make themselves available to travel to your site to discuss your recruitment needs and go into detail about how we can deliver the end result you deserve.

MAINTENANCE MANAGER
Nottinghamshire - c£40,000 + Benefits **Ref – 494**
You will provide leadership and direction for a team of Multi-Skilled Maintenance Engineers and will be responsible for all engineering functions on a daily basis. Management of PPM schedules, KPI targets, working closely with the production team, coaching and training and actively encouraging a successful and engaging culture through continuous improvement.

ELECTRICAL PROJECT ENGINEER
Cambridgeshire - £35,000-£45,000 + Benefits **Ref - 514**
Exciting role with a fairly young business that is experiencing double digit growth year on year. You will take charge of a team of highly skilled engineers, working in a CDM environment. You will work on projects within food, medical and heavy industry. Working on Biomas Boilers, Waste Heat Boilers, New CHP Engines and various steam gas pipework aswell as PLCs . Projects range from £50k to £1.5m.

MECHANICAL PROJECT MANAGER
Cambridgeshire - £55,000-£60,000 + Benefits **Ref – 510**
Exciting role with a fairly young business that is experiencing double digit growth year on year. You will work on projects within Food, medical and Heavy industry. Working on Biomas Boilers, Waste Heat Boilers, New CHP Engines and various steam and gas pipework. Projects range from £1.5m to £3m.

ENGINEERING MANAGER
North West London - £55,000-£60,000 + Benefits **Ref - 237**
As Engineering Manager you will report into the Site Director. Within this challenging role you will have the autonomy to make a significant difference to the continued success of this major Food Manufacturing through ownership of the Engineering presence on site and Engineering strategy moving forward. You will be setting and working to KPI's that will cover Quality, Cost, Delivery, Safety and Morale.

TRAINEE TRIDIUM/CONTROLS AND COMMISSIONING ENGINEER
Midlands - £30,000 + Car **Ref - 448**
The ideal candidate will be an enthusiastic engineer that will have experience in the commercial/industrial and M&E sectors and should be looking to forge a career with a growing and dynamic business. Candidates will be trained to develop software and networks on Tridium controllers and BMS devices to coordinate specific energy solutions for a wide customer base including but not limited to utilities, retail environments and manufacturing sectors.

The Sterling Choice

Tel: 01733 391515
www.thesterlingchoice.com Twitter - @sterlingchoice

University of Strathclyde Glasgow

Centre for Doctoral Training in Medical Devices (4 year studentships) for Engineers and Physical Scientists

Doctor of Engineering in Medical Devices (EngD)

We are currently recruiting graduates in Engineering or the Physical Sciences for **October 2015** who have obtained, or expect to obtain, a first or upper second class honours degree to join the ***Medical Devices Centre for Doctoral Training*** at the University of Strathclyde which is funded by the EPSRC. The centre is designed to allow graduates to carry out research relevant to problems in healthcare that can be addressed through new medical devices or related technologies. The students of the centre have the opportunity to work with medical companies and NHS and other clinical groups in state of the art research projects. The projects carried out in the centre have a high degree of relevance to the clinicians, patients and medical companies who are the end users of such research.

Graduates accepted for the centre who are UK citizens will receive a four-year studentship covering living expenses and fees. EU citizens who have been resident in the UK for 3 years or more are also eligible for the full studentship. Fees only support is available for other EU citizens.

Additional information can be found on our website at: http://www.strath.ac.uk/cdtmed and http://www.strath.ac.uk/simd

Applications can be made online at http://pgr.strath.ac.uk

For further information please contact:

Carol McInnes
Biomedical Engineering
University of Strathclyde
Glasgow G4 oNW
Telephone: 0141 548 3781
Email: carol.b.mcinnes@strath.ac.uk

THE AWARDS UK University of the Year

EPSRC Engineering and Physical Sciences Research Council

thestudent ENGINEER

Reach the engineers of tomorrow

The Student Engineer is a new editorial-led careers website from the publisher of The Engineer - helping you connect with the next generation of engineering graduates.

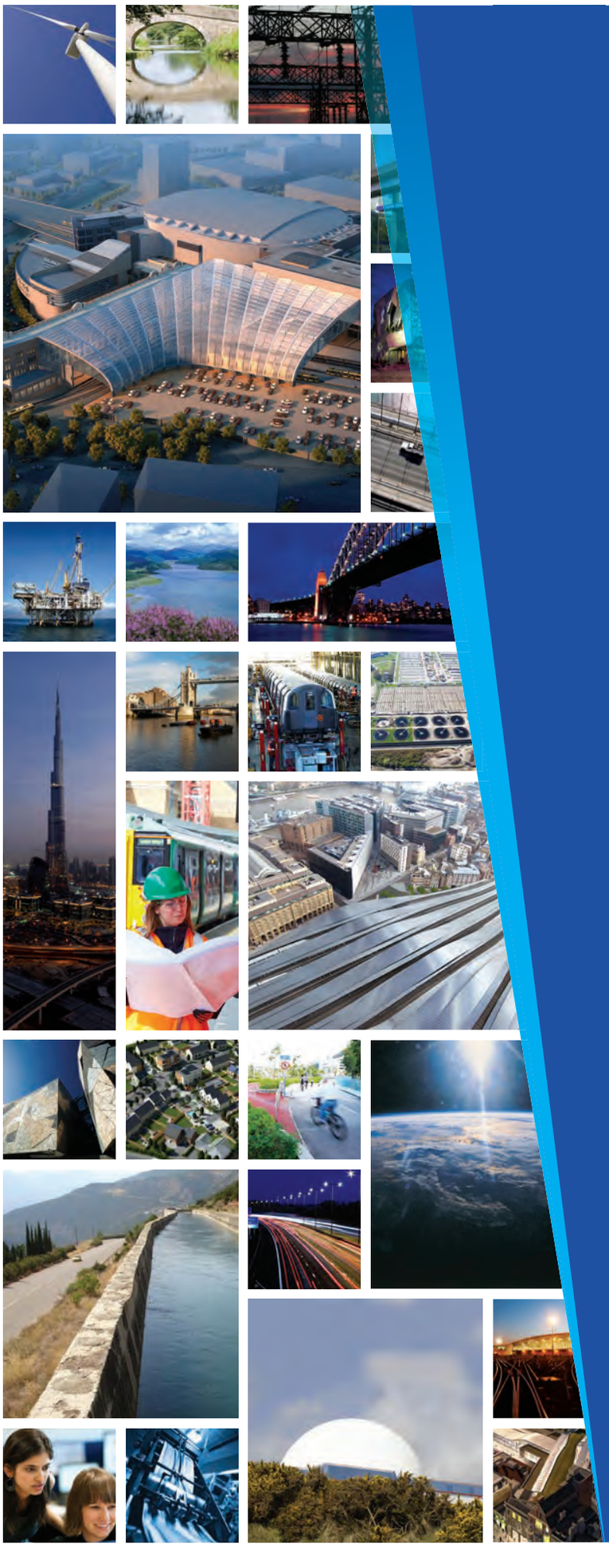
Advertising opportunities available for recruiters. Find out how you can reach thousands of students from the top UK engineering universities via:

- Targeted email and eNewsletter communication
- Prominent exposure on The Student Engineer and The Engineer website
- A minisite dedicated to your company
- Social media messaging delivered from The Student Engineer
- Advertising opportunities in The Engineer digital magazine

www.thestudentengineer.co.uk

For more information please call Mauro Marenghi on **0207 970 4187**
or email **mauro.marenghi@centaur.co.uk**

Follow us on to become part of our growing online community



Hyder

HYDER IS GROWING

Following several outstanding project and framework wins, and transformational acquisitions, Hyder is growing.

We have opportunities for a range of experts seeking professional development and rewarding experiences in:

ENERGY, THE ENVIRONMENT, HIGHWAYS, PROPERTY, RAIL AND UTILTIES.

IF YOU SHARE OUR:

- **Client focussed approach**
- **Commitment to excellence**
- **Track record for delivery**

WE WANT TO HEAR FROM YOU.

Our focus on cultivating diverse teams, our leadership, equality and progression programme (LEAP) and our flexible working makes Hyder a great place to develop your career - whether at graduate or director level.

FOR MORE INFORMATION:
Visit **hyderconsulting.com** or email **UKrecruitment@hyderconsulting.com**

INVESTORS IN PEOPLE

SOUTHERN 15 Manufacturing & Electronics

FREE SEMINARS | FREE PARKING

FIVE | Farnborough | Hants | GU14 6XL

Tues 10th – Thurs 12th February 2015
9.30am – 4.30pm (3.30pm close Thurs)

The UK's largest and longest established Manufacturing Technology Exhibition

Meet over 800 national and international suppliers under one roof in Farnborough this February at Southern Manufacturing & Electronics (inc AutoAero) 2015.

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

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

The exhibition is **free** to attend, **free** to park and easy to get to. Doors open at 9.30am on Tuesday 10th February.

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

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

Tel 01784 880890 · email philv@etes.co.uk

etes Regional Manufacturing Exhibitions

Variety show

This year's engineering event will feature some 800 exhibitors from around the world, alongside a busy seminar programme

Running over three days from 10–12 February at FIVE in Farnborough, Southern Manufacturing and Electronics 2015 will showcase a huge range of engineering equipment, from the latest manufacturing machinery through to a host of electronics design tools and products.

According to its organiser, the event — which is now in its 19th year — will offer a great opportunity to meet some of Europe's top suppliers. To give a flavour of the variety on show, exhibitors at this year's event will include Bystronic, Close Brothers Asset Finance, Nikon Metrology, the CNC training academy and TDK Lambda.

Visitors to the exhibition — which is expected to host around 800 exhibitors from around the world — will be able to make use of 'Technology Trails', which will enable them to identify suppliers from different disciplines that are active within a particular sector. The Aerospace Trail, for example, might include electronics firms and OEM manufacturers as well as precision engineering.

Away from the exhibition floor, a busy seminar programme will see speakers from industry, academia and commerce deliver a total of 28 sessions on everything from valuable business tips to the latest manufacturing technologies.

Running in two lecture theatres, focused on manufacturing and electronics respectively, the programme aims to deliver something to interest anyone involved in industry.

Among this year's presenters, Stefan Knox of Bang Creations — a popular speaker at last year's event — will look at designing for commercial success and new product development.

In other sessions, Wayne Kite of Stanford Marsh will deliver an introduction to 3D printing and will look at the exciting benefits it brings to manufacturers. Meanwhile, Alistair Williamson of Lucid Innovation takes the debate one stage further by looking at how additive manufacturing techniques are driving commercial success.

Meanwhile, Hugh Dunlop at RGC Jenkins & Co will help to demystify patents and trademarks and take a look at how 'Patent Box' can help you save tax.

On a related topic, Rebecca Silva of attorneys Cleveland IP will take a detailed look at protecting your intellectual property through registering your trademarks and designs. This process will then be expanded on in detail in a later session by her colleague Stephen Turner.

Practical applications of manufacturing ideologies such as Lean and Six Sigma will be covered in several sessions. Barry Byrne of Process Management International will examine some of the core concepts and illustrate how these ideas can be applied in manufacturing.

In 'Best Practice and World Class Manufacturing', Ailsa Kaye of Manufacturing Insights will look at the story behind the success of some of the UK's top manufacturers. Tim Scurlock of Automotive Lean Consulting will then illustrate how Lean concepts can be used to target waste by drawing on examples from industry.

The legislative environment is covered in sessions such as 'CE Marking — 2015 and Beyond' with Peter Evans of the CE Marking Association, a review of export controls for the UK's Electronics Manufacturing supply chain by Kings College London and Ken Ball of Tech UK and a look at the latest requirements of the EMC Directive, with Pete Dorey from TÜV SÜD Product Service. Colleague Paul Laidler looks at the legal requirements for machine safety and how they can be implemented.

Entry to the show and also the technical seminars is free. You can find out more at www.industrysouth.co.uk.

Tools of the trade: **a huge range of engineering equipment will be on show**

"Among the presenters at this year's event, Stefan Knox of Bang Creations will look at designing for commercial success and new product development

january1958

The Engineer reported on the development of the English Electric P1 — a powerful fighter aircraft capable of flying at twice the speed of sound

Fighter aircraft are often thought of as the supermodels of the aviation world: all graceful lines and sweeping curves; pure geometry made solid.

The English Electric P1, the forerunner of the aircraft named the Lightning, was no supermodel.

Take a look at a Lightning in an air museum and the word that comes to mind is brutal.

It's a massive, hulking presence, slab sided with squared-off wings that look like sharpened planks, and the gaping shark mouth of the air intake below its angular canopy is matched by its triangular tail-fin, which rises like the ominous dorsal fin of Jaws.

In 1958, the Lightning was still in the late stages of its development; it would enter service the following year. 'It is not possible to say what performance is either required or available from this machine,' said *The Engineer* in its review of aerospace developments, 'but it is widely believed that the design figures for at least maximum speed have been increased greatly during the protracted development programme.' This marked a departure from the previous philosophy of aircraft development — which tended to make only small steps forward with each new aircraft.

> **"The Lightning aircraft is a massive, hulking presence, slab sided with square-sided wings that look like sharpened planks**

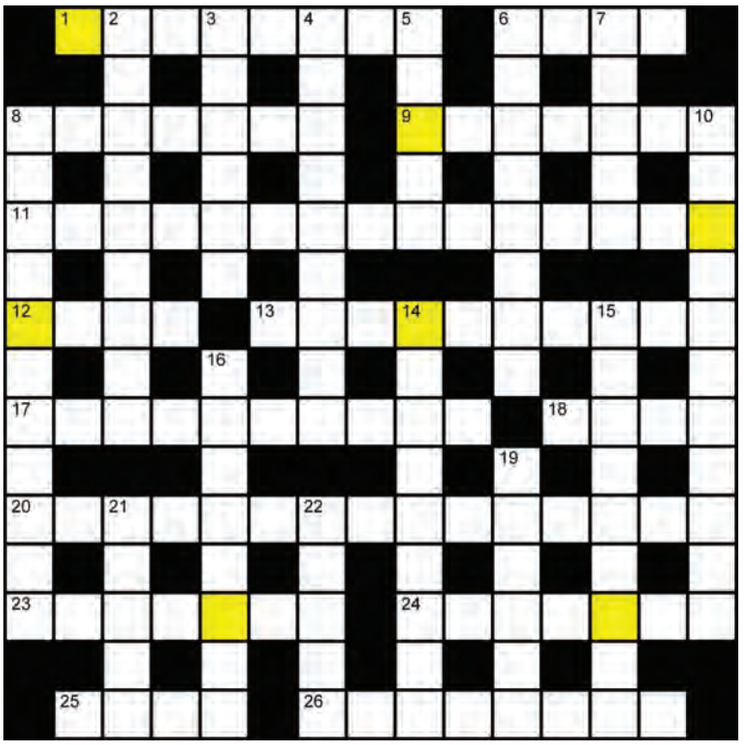
Indeed the Lightning was a notably powerful beast, capable of twice the speed of sound and a remarkable climb rate: pilots described it as like being 'saddled to a skyrocket'. It was the spearhead of the Royal Air Force's interceptor capability for more than two decades, although it was never required to do the job it was designed for: intercepting high-altitude bombers. In fact, it never attacked another aircraft.

The influence of the Lightning continues to be felt today. Later this year, when Bloodhound SSC makes its first test-runs on runways in the UK, it will do so on Lightning tyres, taken from an aircraft that performed exhibition flights in South Africa until 2010. ***SN***

For more on this story visit **www.theengineer.co.uk**

prizecrossword

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



ACROSS

1 Increases proportionally (6,2)

6 Crystalline oxide used to produce calcium hydroxide (4)

8 Main chamber in a nuclear power station (7)

9 Statement involving electric current, voltage and resistance (4,3)

11 Stage at which a substance will receive no more of another substance (10,5)

12 Large number of people united for specific purpose (4)

13 One who buys large quantities of goods and resells to merchants (10)

17 Bringing to a close (10)

18 River in northeast Spain (4)

20 Useful method for solving problems (7,8)

23 Sprung away from impact (7)

24 Quantity upon which a mathematical operation is performed (7)

25 Translucent gemstone (4)

26 Create and charge with a task (8)

DOWN

2 Creator of great skill in the manual arts (9)

3 American metric units of capacity (6)

4 Extended to a greater length (9)

5 Scene recorded by a camera (5)

6 Metal upright supporting an outdoor light (8)

7 Prefix meaning one thousandth (5)

8 Workplace for the conduct of scientific investigation (8,3)

10 Totally saturated with liquid (11)

14 Area for eating within a facility (9)

15 Substance capable of reducing friction (9)

16 Engaged in office work (8)

19 Stone in a natural form (6)

21 Hit hard with a heavy instrument (5)

22 Filled with a great quantity (5)

Subcon

Contract and subcontract manufacturing

www.subcon show.co.uk

theENGINEER design & innovation show

Design engineering solutions for industry

www.theengineer-designinnovation show.co.uk

Advanced Manufacturing

Global manufacturing technologies

www.advanced manufacturing show.co.uk

THE DEDICATED EVENT FOR PRODUCT DESIGN, PROTOTYPING AND INNOVATION

2 - 4 JUNE 2015 | NEC BIRMINGHAM, UK

THREE CO-LOCATED EVENTS, THREE DAYS, ONE COMPLETE MANUFACTURING SOLUTION

Interested in exhibiting?
Email **tedis@centaur.co.uk** or call +44 (0)20 7970 4150 for more information.

Featuring:

theENGINEER conference

Brought to you by:

theENGINEER theENGINEER Supplier Network MWP advanced manufacturing

Mazak

Your Partner for Innovation

[Productivity]

INTEGREX i-100 BARTAC S

Unsurpassed performance.
Unrivalled durability. Zero backlash.

Design innovation in every detail makes the INTEGREX your best investment for increased productivity.

Complete every one of your machining operations from raw material to finished component in one hit, in one setup with the ultimate DONE-IN-ONE machines from Mazak. Equipped with a BARTAC bar feed system, it offers integrated work unloading and conveyor handling of completed workpieces for lights-out and unmanned running.

...It doesn't get better than a Mazak.

To find out more visit our European Technology Centre
email visit@mazak.co.uk

make [it] better

Yamazaki Mazak U.K. Ltd.
Badgeworth Drive, Worcester WR4 9NF

T: +44 (0)1905 755755
F: +44 (0)1905 755542
W: www.mazakeu.co.uk

SEE US LIVE AT

SOUTHERN MANUFACTURING
10-12 FEBRUARY 2015
FIVE FARNBOROUGH STAND Q110