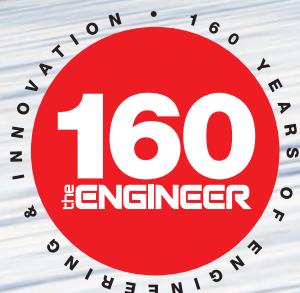


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## Cold facts

### The automotive industry's annual trip to the ice

#### Two of a kind

Contrasting approaches to engine efficiency for the race circuit and the city streets

»18



#### Crosstown traffic

Crossrail 2's managing director on new plans for tunnelling under the capital

»26



#### Stronger inside

EEF head Terry Scuoler on the manufacturing industries' case against Brexit

»12



»50

#### Careers feature

The prospects for engineering jobs in the resurgent nuclear sector





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Introducing a smarter way to increased productivity:  
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## this issue

Volume 297  
Issue No.7874  
Established 1856

### news

- 04 Technology** Machine uses 3D printing for swift product-matching
- 05 Technology** Programming so that robots can work in unison
- 06 Technology** Funding for device that can generate electricity from movement
- 07 Technology** Laser-based tracking so aircraft can quickly transmit to surface

### opinion

- 12 Viewpoint** Terry Scuoler, EEF
- 14 Mailbox** Your letters to the editor
- 16 Paul Jackson** Young engineers
- 26 Interview** Michèle Dix, managing director, Crossrail 2
- 29 Scifi eye** Future human invisibility

### features

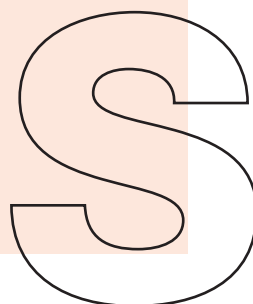
- 18 Cover story** Reinvigorating the internal combustion engine
- 22 Feature** Winter testing propels new automotive technologies
- 31 Simulation**
- 39 Pumps**
- 44 Preview** PD+I
- 46 Preview** Subcon
- 50 Careers** Nuclear
- 57 Archive** The 1900 Paris Exhibition
- 58 Digest** This issue's crossword

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## our opinion

# From road to rail



Such is the level of activity in the electric vehicles sector that readers might be forgiven for thinking that the trusty internal combustion engine is in its dotage, but, as our latest issue makes clear, this is far from the case.

Formula One cars might be hybrids these days, but the bulk of their power comes from a conventional engine; and, like everything in the motorsport world, it's the focus of intense development.

In this issue, we compare the development of the engine that has already won the Mercedes team the first two Grands Prix of the 2016 season with the engine from

an innovative experimental city car designed by a collaboration between Gordon Murray Designs, Shell Lubricants and Swiss-based engine specialist Geo Technology (p18); both designed to convert as much of the chemical energy from their fuel as possible and into kinetic energy, but taking very different approaches. We also take a look at one of the automotive industry's most unusual and seasonal testing sites, on a frozen lake in the frigid north of Sweden (p22).

From road to rail, our interview in this issue features the managing director of what's set to be the biggest civil engineering project in the UK, London's newest underground/overground link, Crossrail 2, which will span the capital from north to south in the coming decade (p26).

"You might be forgiven for thinking the internal combustion engine is in its dotage – this is not the case"

This issue also presents product focuses on novel applications for software simulation (p31) and pumps (p39).

While reading the issue, we urge you to have a think about the projects you've been working on and whether they might be eligible for The Engineer Collaborate to Innovate awards, which launch this month.

Intended to recognise and celebrate the best in engineering collaboration across a variety of sectors, whether that collaboration is between academia and industry, other companies; either within the UK or with international partners, the awards initiative culminates in a conference in November where the winners will present their projects. Details are at <http://conferences.theengineer.co.uk/> and the closing date for entries is Tuesday 31 May. ©

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## DESIGN

# Mix and matching for future design

Machine uses 3D printing for product-matching designs at pace JASON FORD REPORTS

**S**tratasys has launched a machine that quickly produces product-matching designs using up to six print materials and a choice of over 360,000 colours.

The J750 – a new addition to the Objet Connex series of 3D printers – allows for the comparatively rapid creation of prototypes that can include a range of material properties in the same part, as well as delivering 3D printing versatility to produce tooling, moulds, jigs and fixtures.

The company adds that the J750 is expected to improve total cost of ownership by eliminating processes such as painting and assembly that add time and cost to the creation of product prototypes.

Prototypes can be produced in an hour or less depending on size and complexity, giving design teams, engineers and marketers the option to consider a greater range of design iterations more quickly in order to hasten product development.

Prior to its release the J750 went into beta testing with a number of companies, including OtterBox, a Fort Collins, Colorado-based manufacturer of smartphone cases.

Brycen Smith, engineering technician supervisor for OtterBox explained that, prior to the J750, it could take up to three days to prepare a phone case because it would have to be painted and

assembled to a high specification before being presented to customers and other decision makers in the design process.

He said: "We have over 15 series of cases offered with about six to eight different colour combinations in each series. So that's a huge timesaving... this machine can now do it in about 30 minutes to an hour. We're getting several hundred prototype requests a week that we're turning around well within 24 hours.

"About five years ago we were outsourcing some of our prototyping that was taking a couple of weeks, [cost] thousands of dollars and who knew where our IP and case information and security was going at that point?

"To bring it in and save it on that security aspect – the potential of knock-offs and counterfeits of our designs – is priceless."

The J750 can accommodate build sizes up to 490 x 390 x 200mm and operates in three modes, including high speed, which uses up to three base resins and achieves a resolution of 27 microns. High-quality and

high-mix modes both use up to six base resins with resolutions of 14 microns and 27 microns, respectively.

The machine's PolyJet Studio software allows users to choose materials, optimise the build and manage print queues with colour textures loaded via Virtual Reality Modelling Language (VRML) files imported from CAD tools.

Featuring a large, six-material capacity, the J750 keeps the most used resins loaded and ready for printing, thereby minimising stoppages associated with material changeovers. Newly designed print heads mean simulated production plastics, such as Digital ABS, can be 3D printed in half the time of other Stratasys PolyJet systems.

"The vision from our R&D team was always there: that we needed to create a printer where we have a fully realised product coming out of the print that demanded multi-materials, digital material, and digital colour," said Josh Claman, chief business officer, Stratasys. "It's very complicated. You go from two materials to three into six. It's not just that you have exponentially more potential with the machine; it's exponentially more complicated to develop that. There are a lot more algorithms you need to do and the software needs to keep up with that to make it useable and reduce complexity."®



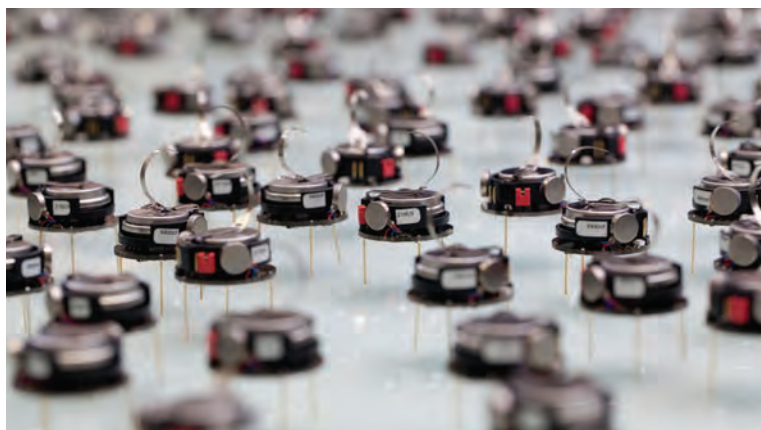
Shoe prototype with full colour



## ROBOTICS

# Programming the robotic swarm

Reducing software bugs caused by human error could improve safety HELEN KNIGHT REPORTS



Groups of robots could carry out complex tasks in a cooperative fashion

**A**utomatically programming swarms of robots to carry out tasks simultaneously could improve their safety and reliability by reducing the number of bugs in their software caused by human error.

Swarms of robots capable of communicating with each other to carry out complex tasks cooperatively are expected to become increasingly important in the future in fields such as manufacturing and agriculture.

Similarly, autonomous cars will need to cooperate while observing rules of operation, but glitches caused by human error during programming are a common feature of computing, with the global cost of debugging software estimated at around US\$312bn each year.

Researchers at Sheffield Robotics have now developed a technique that allows human users to input the task they would like the robots to carry out into a graphical tool, alongside details of what the robots are capable of.

The machine then automatically programmes these instructions and

translates them into a source code that can be used to control the robots, according to Dr Roderich Gross at Sheffield University, who led the EPSRC-funded research.


"The source code executed on the robot is automatically generated by the machine," said Gross. "So what you want to achieve is specified by the human, but then how you obtain it is automatically generated by a machine, and this automation means there is less risk of error," he added.

The program uses a form of linguistics, in which the 'letters' relate to the actions the robots can choose to perform, and the "words" are the tasks they can complete, based on their instructions.

The robots attempt to form a word from the letters – or complete a task by undertaking a set of actions – while the program restricts choice to those letters that will create a valid word.

The team applied its programming method to control a swarm of up to 600 robots to complete a specified set of tasks, in research published in the journal *Swarm Intelligence*. The experiments required the robots to gather together, manipulate objects and organise themselves into groups.

This could be useful where a team of robots is needed to tackle a problem, with each robot completing an element of the overall task.

Gross said: "You could imagine a large field of crops, and the manager of the farm might specify certain... requirements, for example, that every crop should be checked for disease and if necessary a certain chemical should be applied. The robots could communicate with each other to identify the needs of all of the crops and to ensure these needs are met." 

## Newsinbrief

### Budgetary boost

Infrastructure in northern England has received a boost with news that road and rail links are to be improved in the region. Measures announced in George Osborne's recent Budget include approval for HS3, a high-speed rail link between Manchester and Leeds; an assessment of funding requirements for a fourth lane on the M62; and developing a case for a new tunnelled road between Manchester and Sheffield.

### Falling down

Activity in the manufacturing sector dropped off in March, but is expected to rebound in the next quarter, according to the latest CBI *Industrial Trends Survey*. The survey of 471 manufacturers found output volumes over the three months to March falling fastest since September 2009. Eight of the 18 manufacturing sub-sectors posted a decline in output.

### Bionic bonanza

Prosthetic and therapeutic robotic devices will grow into a US\$1.9bn and US\$1.7bn market by 2025, respectively, as an ageing population demands better quality of life, according to Lux Research. The largest markets for the prosthetic robotics such as bionic arms and legs come from countries in Europe and the US, but China will comprise nearly one-third of the total 2025 market.

### All on file

Patents filed at the European Patent Office (EPO) by UK companies rose by 5.7 per cent in 2015 to 5,037, the fastest rate of growth since 2010. Britain now accounts for three per cent of all applications made to the EPO, indicating a strong commitment to research, according to IP specialists Withers & Rogers. Rolls-Royce filed 540 patent applications at the EPO in 2015.

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## SIMULATION

## Shining a 'blue light' on driver assessment

Simulator used to train emergency services

ANDREW WADE REPORTS

Babcock has launched a 'blue-light' vehicle simulator to train emergency services drivers in a safe environment.

Traditionally, training for this type of driving has been carried out on


public roads using vehicle sirens at speed to replicate emergency situations. The simulator will be used to support this real-world training, but will enable instruction and assessment with zero safety risk.

During the project's 18-month development, extensive testing and research was carried out in order to exactly simulate the handling of a fire engine for the initial prototype. The simulator can also be adapted for ambulance and police training by swapping in hardware and software to reproduce those driving experiences.

"What we're bringing to the market is a... product that reflects and meets the changing needs of the emergency services, not just in the UK but

internationally," according to Alistair Cumming, head of training, design and development at Babcock.

A 200° wrap-around screen fully immerses drivers in the simulated environment with accurately rendered side streets that can be checked for merging traffic. On-screen mirrors also reflect vehicles to the rear and the side of the driver.

The software includes 167 miles of urban, inner-city, and rural routes that test driving skills in a range of scenarios. Furthermore, every vehicle has been ascribed its own artificial intelligence and the ability to react to the decisions made by the driver.   
For more on the simulator, turn to the feature on p31

## ENERGY

# Crowd funding is generation gain

Device is able to generate electricity from any form of movement HELEN KNIGHT REPORTS

**W**ITT Energy has exceeded its crowd-funding target to help finance production of a device that generates electricity from any form of movement.

The Plymouth-based company's eponymous device (see *The Engineer*, January 2014 for a previous report) uses two pendulums connected to a flywheel to generate electricity from movement in any direction.

This means it is capable of generating electricity from sea, river, tidal, or wind energy, as well as human or animal motion, according to Mairi Wickett, chief executive officer and co-founder of WITT, which stands for Whatever Input to Torsion Transfer.

"It is based on a transmission that has two pendulums underneath, and it will harvest all movement, whether it is clockwise, anti-clockwise, up and down, or back and forth, and turn it into electricity," she said.

The principle behind the WITT technology is similar to that of the self-winding watch, in which a rotor on a pivot generates energy from the movement of its wearer.

Motion in any direction causes the two pendulums in the WITT to swing. The pendulums are attached to a shaft, which then turns a flywheel in one direction. The flywheel is in turn

connected to a generator, which produces electricity.

WITT is working on a 200W marine version of the technology, with Gibbs Gears and Schaeffler. To this end it launched – and exceeded – a £750,000 equity raise through the crowdfunding platform Crowdfunder.

The companies are building a marine energy device, which will be fitted into a 1.5m sealed sphere and tested in a wave tank in July, said Wickett. "[The marine WITT] is a completely sealed unit and it can

"It can be built from about the size of a grapefruit to collect 5W of power"

Mairi Wickett  
WITT Energy

be built from the size of a grapefruit, to collect about 5W of power, to as large as you want," she said.

The marine WITT energy device could provide power for applications including large-scale survival units, desalination, and offshore fish farms, the company said.

The company, which has patented the technology, is also working with Ricardo, and has additional support from Bristol, Plymouth and Southampton universities.

As well as large-scale renewable energy applications, smaller versions of the technology could ultimately be fitted to soldiers' or explorers' backpacks, for example, to generate energy to power their portable equipment as they march or climb. ☺



The marine WITT energy device

## COMMUNICATIONS

## Mobiles go sky high

Advances in antennas could enable a seamless broadband experience from land to air

Low-cost mobile broadband for air travellers is closer thanks to a £300,000 prize from the Institution of Engineering and Technology (IET), a UK researcher has claimed.

Currently, air passengers have to switch their mobile phones to 'flight mode' and pay an additional charge to access data on their devices. However, according to Prof Yang Hao from Queen Mary University of London, advances in antennas will enable a seamless broadband experience from land to air, at no additional cost.

Prof Hao has already developed several integrated antennas based



'Flight mode' could soon be in the past

on artificial materials to reduce mutual RF interference, weight, cost and system complexity and also co-developed a meta-material to enhance usability through small antenna size, high directivity, and tuneable operational frequency.

The cash injection from the IET will, he said, help take this work out of the laboratory and into the real world. **JE**

## MEASUREMENT

## Get the inside track on British cycle success

Ergometer mimics inertial forces of a velodrome

JASON FORD REPORTS

Technology from BAE Systems and UK Sport could be pivotal to the success of the British Cycling team at this summer's Rio Olympics.

The advanced cycling ergometer was developed by engineers at BAE Systems in conjunction with the team that won nine medals during the summer games in 2012.

The ergometer measures the work rate and energy expended by cyclists and is claimed to replicate the inertial forces of a velodrome more accurately than any other testing tool. Data collected includes gas and blood analysis, enabling testing at high speeds to analyse technique.

"We can help... the athletes tune the amount of power that they generate and actually put through the device," said Nigel Whitehead, BAE's group managing director, programmes and support.

"By having that sort of input during the training, development and working out how best to sit – how posture works to their best advantage – we can tune these things and give a marginal advantage."

The ergometer houses a large variable fly wheel at its rear, with blades that can be adjusted to increase or decrease resistance on the pedals, accurately mimic different gear ratios and generate forces for the cyclist based on their individual load and the track on which they are riding, be it for sprints, endurance rides or road events.

"If you look at the 2012 Olympics alone we contributed an effort to teams that won 19 medals: 10 golds, seven silvers and two bronzes. And, in the Paralympic games, six medals: five golds and a silver," said Whitehead. "We don't know – and will never know – what incremental difference we made but we like to think we were part of that team." ☺



The ergometer measures the cyclists' work rate



## COMMUNICATIONS

# Get back down to the ground

**Laser-based tracking could allow aircraft to quickly transmit to the surface** HELEN KNIGHT REPORTS

**A** lightweight laser-based communication and tracking system that is being developed in the UK could allow aircraft and satellites to transmit information to the ground more quickly and securely.

The Hyperion system, which uses eye-safe lasers with a wavelength of 1,550nm, is being developed by researchers at Oxford University and Airbus Group, with funding from EPSRC and Innovate UK.

With the rise in the use of UAVs for surveillance and disaster monitoring, and the increasing amount of data being produced by on-board sensors on modern aircraft, there is a growing need for a more lightweight method of transmitting this information back to the ground, according to Prof Dominic O'Brien, who led the Oxford team.

Existing point-to-point radio frequency communication systems for aircraft tend to be quite heavy, limiting

A shutter on top of this retroreflector is turned on and off to modulate the beam, encoding it with the data to be transmitted. The device then reflects the beam back to the ground unit for decoding.

"Putting the retroreflector on the UAV allows you to have a very lightweight terminal, and that technology is well suited to optical [communications]," said O'Brien.

The system uses a less-crowded part of the electromagnetic spectrum

**"A retroreflector put on the UAV allows you to have a very lightweight terminal"**

Prof Dominic O'Brien  
Oxford University

than existing RF communication, and is also less vulnerable to interception and jamming, he said. That is because the system uses a very narrow beam of light, which would be virtually impossible to spot. The technology also eliminates the need for a separate tracking system on the UAV, said O'Brien. "You have this beam pointing at the UAV, and the aircraft does not need a means to point it back to you, that is done automatically [by the retroreflector]," he said.

The technology could allow UAVs to transmit images to search-and-rescue teams more quickly or speed up aircraft maintenance by sending sensor data down to ground crews. It could also be used by microsattellites in low-Earth orbit. ☐



The Hyperion system

the length of time for which smaller UAVs can fly, he said.

The Hyperion system consists of a ground unit that aims a laser beam up to the aircraft, where it is captured by a lightweight retroreflector.

## SECURITY

## Halo's crowning moment

**US gives university team funding to develop X-ray scanner for airport security**

A team led by Nottingham Trent University researchers has received US\$4.4m from the US Department of Homeland Security to develop a new type of X-ray scanner for airport security.

The project will see Nottingham Trent University continue its work with Cranfield University and Nottingham-based Halo X-ray Technologies to develop the system (*The Engineer*, September 2015). Scattered X-ray signals will be used to identify the unique signatures or "chemical fingerprint" of materials. The system will also use 3D imaging to map objects within luggage.



Airport security could be boosted

Current airport scanners provide an image of an object and give a broad material category, but can't identify specific substances. According to the university, the hollow X-ray beams produce intense material signatures that allow for much more accurate analysis. That accuracy could mean fewer false alarms during scanning, and faster security checks at airports. **AW** ☐

## NUCLEAR

## Keeping an eye on the nuclear network

**Telemetry will be able to aid emergency response**

JASON FORD REPORTS



Hinkley Point B will get the first CEMS

EDF Energy is deploying a new fleet-wide nuclear plant telemetry system to assist response to severe 'beyond design basis' events.

EDF's Continuous Emergency Monitoring System (CEMS) has been developed to help power station operators deal with a wide-scale emergency, which Charlie Hall, senior consultant at Frazer-Nash Consultancy and CEMS project technical lead, defined as an event assumed to have disrupted infrastructure on and off site, such as widespread flooding.

Hall added the project has been reporting to the Office for Nuclear Regulation (ONR). It issued a report in May 2015 that said: "The resilience of systems that provide key emergency data, which facilitates decision-making by emergency responding personnel, is being enhanced through the installation of CEMS."

According to Frazer-Nash, the CEMS enables an operator to use a modular logging and telemetry system without relying on wider station infrastructure to support it.

The reactor-monitoring module connects to a secure satellite communications module. This supplies data that can be accessed by operators on and around the site, plus staff at EDF's Central Emergency Support Centre.

The monitoring module can also communicate with a Deployable Communications and Information System (DCIS), part of EDF's mobile command and control capability.

"In developing CEMS we have had to accept that no matter how resilient CEMS may be it could still become compromised during an event," Hall said in a statement. "For that reason, we've made CEMS flexible. We've used multiple back-up power supplies and back-up modules that can be deployed to replace damaged equipment. And we've adopted secure satellite communications that can send data to portable display units that operate independently of the station's infrastructure."

Hinkley Point B power station in Somerset will receive the first CEMS. ☐

## MILITARY

# Going underground for the full effect

Research considers the impact of landmines and IED explosions

CHRIS PICKERING REPORTS

**R**esearch carried out at Sheffield University has shed some new light on the effects of underground blasts from landmines and improvised explosive devices (IEDs).

Using the university's unique Explosives Arena, a team led by senior geotechnical engineering lecturer Dr Sam Clarke carried out around 250 test explosions using different soil samples. While much of the previous work in this area has focused on desert conditions – which is often considered to be a worst-case scenario in terms of pressure loading and fragmentation – this new study looked primarily at clay soil.

“Sandy gravel may not be the worst total-impulse scenario”

Dr Sam Clarke  
Sheffield University

“The AEP-55 standard [used in most investigations] mandates the use of sandy gravel in soil-based tests. That’s a particularly severe case for dismounted troops and local perforations of thin-walled armour, but what we’ve come to understand is that it might not be

the worst total-impulse scenario,” explained Dr Clarke. “As you increase moisture content in the soil, the pressure distribution becomes more like a discrete wave, maintaining a higher pressure as it propagates outwards; drier soils tend to result in a more uniform temporal loading that decays more rapidly.”

The tests used a series of 17 Hopkinson pressure bars arranged on a flat steel plate 150mm above the surface of a clay test pit. Experimental data from the blasts was backed up

by a numerical model developed and applied as part of a study by the Engineering and Physical Sciences Research Council (EPSRC).

This research will be fed into a wider investigation into the effects of IEDs and landmines on armoured vehicles that is being carried out by the Defence Science and Technology Laboratory (DSTL).

“Through better understanding of how these devices behave with the soil we hope to be able to improve protection against them without increasing weight or cost,” said Dr Clarke. “It becomes increasingly relevant if you consider new materials. Hard targets such as steel may be less sensitive to the distribution of the loading, because you know they’re not going to perforate, so it becomes a total-impulse problem. But if you’re dealing with a lightweight composite structure where localised failure might be an issue then you really do need to know the discretisation of the pressure over the structure as a whole.”



The research has looked at the impact of IEDs in differing soil types

## DEFENCE

## British Army looks down the telescope

Cannon ammunition kept in a straight tube

ANDREW WADE REPORTS

The Ministry of Defence has received the first of 515 new 40mm cannons to be delivered by CTA International (CTAI), which is an equal joint venture between BAE Systems and France's Nexter Systems.

Dubbed the Cased Telescoped Cannon System, the weapons system is being manufactured at CTAI's base in Bourges, France.

According to BAE Systems, ammunition is contained in a straight tube instead of the traditional bullet shape and will deliver an explosive charge up to four times more powerful than the 30mm rounds being replaced.

“This is a significant milestone for CTAI and a proud moment to see our cannon being handed over to the British Army,” said Craig Fennell, managing director of CTAI. “We are the only group in the world that can design and manufacture this type of cannon and ammunition.”

CTAI was set up to explore the development of a cased telescoped cannon solution, and given a contract by the MoD and France's Direction générale de l'armement for the integration of the cannon with the British Army's Warrior tank.

“We are the only group that can produce this type of cannon”

Craig Fennell  
CTAI International

Ammunition for the system is loaded sideways using a new rotating breech system, before turning 90° and then fired. BAE Systems said this helps save space, allowing for storage of additional ammunition and other equipment. Current types of munitions include armour piercing and point detonating rounds.

BAE Systems will be supplying rounds for the British Army through its factories in Washington, Tyne and Wear, and Glascoed in Wales. ©

## MARINE

## Mathematics rides the waves

Computer model could help search-and-rescue boats navigate rough seas

A computer model developed at Leeds University could help radically improve the design and performance of search-and-rescue boats, and other so-called fast ships.

These vessels, which frequently travel at up to 23-30 knots, are particularly vulnerable to waves that amplify suddenly due to local weather and sea conditions. Each

year around 100 ships worldwide are lost or damaged in heavy seas, with around 2,500 casualties in 2013.

The model produces highly accurate simulations how sea waves can affect these vessels, which could help them to better withstand the effects of rough seas.

Dr Anna Kalogirou, who worked on the Leeds University project, said: “We have managed to develop a simulation tool that uses sophisticated mathematical methods and produces fast and accurate simulations of linear wave-ship interactions. Our tool can also provide measurements in terms of wave amplitudes around ships, as well as pressures on ships' surfaces.”



# Redefining Automated Test

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## AUTOMOTIVE

# A mix of old and new technology

**Project aims to assess potential of hybrid and full-electric powertrains** CHRIS PICKERING REPORTS

**F**ollowing the recent announcement of its first all-electric production model, the EV3, the Morgan Motor company is investigating the use of further electrification.

It's part of a three-year project that aims to assess the potential of both hybrid and full-electric powertrains for future models.

Morgan is leading a consortium of British firms, which includes Potenza Technology and Delta Motorsport, backed by a £6m government grant. At first glance, the 107-year-old Malvern manufacturer may appear

an unlikely candidate for advanced powertrain projects. In fact it has a strong track record in this area, backed up by the fuel-cell-powered LIFEcar concept of 2009 and the battery-electric Plus E shown in 2012.

"That particular amalgamation of modern technology and traditional craftsmanship is now very much part of Morgan," said Jon Wells, the company's head of design. "Our cars are competitive on their emissions at the moment, but the requirements are becoming increasingly tough and we need to make sure we're ready for that. We see the use of electric and hybrid powertrains as a means to

keep doing what we're doing in the modern world.

"We're currently investigating hybridising existing OEM engines. Our end goal is to achieve something with production-intent like we have done with the EV3, but at the moment it is very much an R&D project."

Morgan's in-house R&D department has almost doubled in size over the last few years, with around 40 per cent of the company's development time devoted now to advanced projects. Aside from the electronics, the company is also looking into weight reduction. The EV3 has seen the use of carbon-fibre body panels for the first time in a Morgan production car, contributing to an impressive sub-500kg all-up weight – around 35kg lighter than the equivalent combustion engine model.

Contrary to some reports, there are no specific plans for further electric or hybrid production models just yet. The current EV3 draws quite heavily on the Plus E concept, however, and it's entirely possible we could see the same again as the new R&D project takes shape. **Ⓜ**



The EV3 has seen the use of carbon-fibre body panels for the first time in a Morgan car

## SOLAR POWER

## Let there be light

**Organic photovoltaic panels could be used for windows, skylights and roofing**

A consortium funded by Innovate UK is developing building-integrated photovoltaic (BIPV) devices that will generate their own solar power.

The project includes the Centre for Process Innovation (CPI), alongside Polysolar and Merck. According to the consortium, the transparent organic photovoltaic (OPV) panels will be lightweight and low cost, and could be used as windows, skylights, facades and roofing.

"Modern architecture faces a dilemma of wishing to maximise natural-light delivery and reduce building energy consumption," said Hamish Watson of Polysolar.

"With our OPV glazing, we deal with these conflicts while also generating carbon-free renewable energy, thus enabling buildings of the future to be truly zero carbon."

At the heart of the project is an upgraded version of Merck's semi-transparent grey-coloured licon formulation, a ready-to-print organic semiconductor material for OPV. These polymer materials can be processed as liquid solutions, so a wide range of printing processes can be used when producing solar cells, including spin coating, ink-jet printing and roll-to-roll processes. **AW** **Ⓜ**

## RENEWABLES

# Floating through for London solar power initiative

**Array is made up of 23,000 photovoltaic panels**

JON EXCELL REPORTS

A giant floating solar farm that is on the outskirts of London will be the largest facility of its kind in Europe, developers have claimed.

Currently being installed on Thames Water's Queen Elizabeth II reservoir near Walton-on-Thames, the project is the result of a collaboration between Thames Water, and specialist solar developers Ennoviga Solar and Lightsource Renewable Energy, which is funding the initiative.

The array is made up of 23,000 photovoltaic panels, which are being mounted on a pontoon consisting of 61,000 floats and 177 anchors. The 57,500-square-metre structure will cover around a tenth of the surface

"The structure will cover an area that is equal to eight football pitches"

of the reservoir (an area equivalent to eight football pitches).

According to Thames Water, when up and running, the facility will have a total installed peak capacity of 6.3MW and is expected to generate 5.8 million kilowatt hours in its first year. This electricity will be used to help power the nearby water-treatment works.

The project is part of a wider effort by the utility firm to reduce its reliance on the grid. Last year, it generated 12.5 per cent of its electricity requirements from renewables.

Developers are eyeing up the potential of siting them on reservoirs.

Last year, United Utilities installed a 45,500-square-metre facility on the surface of Godley reservoir in Hyde, Greater Manchester. The UK's first floating solar farm, an 800 panel pilot array, was installed on the surface of a reservoir in Wargrave, Berkshire, back in 2014.

Meanwhile, engineers at Japanese firm Kyocera are in the process of building a 180,000-square-metre facility in Japan's Chiba Prefecture that's set for completion in 2018. **Ⓜ**





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# This is no time to be walking away

**UK manufacturers, big and small, depend upon access to the EU, the biggest single market in the world with 500 million people**

**T**he question at the heart of the European referendum is simple, yet fundamentally important: how should the UK engage with the rest of the world and, are we better off economically in or out? I believe there are two critical reasons why

it is imperative the UK remains a member of the EU.

First, political. We are fortunate not to have lived in an era that has been defined by European rivalry division and conflict but one of relative peace, economic prosperity, political security and social stability, much of which is clearly linked to greater co-operation among the nations of the EU.

Were we to leave the EU now when the continent faces challenges, perhaps greater than at any time since the union's creation, from a volatile Middle East, and a turbulent world economy, there is a risk further uncertainty will be created.

Domestically, an English exit majority, with the potential opposite outcome in Scotland, would put even greater strain on the EU. Internationally, leaving would diminish both our, and the EU's, place in the world and significantly affect the relationships we have with overseas countries, especially the US.

The second reason why we must remain is economic. The EU is the biggest single market of its kind in the world with a population of 500 million people.

Our manufacturers, big and small, depend on access to it. Over 80 per cent of EEF members in independent research identified the biggest advantage of membership as providing a base for exporting. Over half of British

chemical and pharmaceutical exports go to the EU, worth some £30bn a year. Almost 90 per cent of British SMEs that export do so to the EU, and almost half of our overall trade goes to the EU.

Almost a fifth of manufacturers benefit from EU support for innovation. When it comes to receiving EU innovation funds, the UK has tended to receive 15 per cent of the total, making us one of the top-performing nations. Consider how many high-quality jobs this supports?

The UK is also the leading destination for foreign direct investment into the EU with the Japanese government having gone on record to say that the attraction of the UK being part of the EU has led to 1,300 companies investing in the UK. Half of all European-headquartered non-EU firms are now based in this country.

If we were to leave, nobody can predict that this attractiveness will remain. It may, or it may not. But what I do know are the facts and benefits of being in the EU now, which have been, and still are, largely positive.

The prime minister may, or may not, have agreed a good deal recently. That's a matter of personal opinion but what he is fighting for is worth having.

The recognition that there is more than one way forward than 'ever-closer political union', the stress on the importance of competitiveness, lower business costs and protection for countries outside the eurozone are important in themselves.

His actions have also shown that if you really put your mind to it you can start to get change. Did anyone really think that overnight everything would change in our favour? This may take time, strong leadership and a partnership with like-minded members. However, we are unlikely to achieve the change by not being members at all while shouting from the sidelines.

Having worked in many forums in Europe I know that we can bring influence and change. Organisations such as the EEF and other similar bodies have done this time and time again.

The job of our elected politicians is to commit themselves to using the power they have to make it work better, rather than make excuses about the limitations they face, and simply give up and take us out into an abyss of uncertainty and risk.

Those who would have us leave have accused those of us arguing to remain of conducting 'project fear'. But it is not 'project fear' but 'project reality'.

**"Research carried out for the EEF shows that almost two-thirds of manufacturers want to stay in the EU and only 5 per cent want to leave"**

Terry Scuoler

Independent research carried out for the EEF shows that almost two-thirds of manufacturers want to stay in and only 5 per cent want to leave. In taking this view they, and the EEF, are not looking at the EU through rose-tinted spectacles and are fully aware of its shortcomings.

They are practical, however, and, on balance, have decided that it is worth remaining with the right way forward being to work to improve the EU for the benefit of all member states rather than simply walking away. ©

**Terry Scuoler is CEO of the EEF**



The job of our elected politicians is to make institutions such as the EU work better



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# Mailbox

## The hot topic

### Where now for UK steel?

#### Online debate in the wake of Tata's decision to offload its Port Talbot steel works

Much of British manufacturing depends on the availability of high-quality steel, which does not come from the Far East. It's not only the steel industry at stake, it's all the high-tech manufacturing companies that depend on it.

**Geoff Kershaw**

One suggestion that I have put to my MP (who ignored it and waffled on about help for families where jobs are lost) was this. Put a green tax on all steel imports. To avoid paying the tax the supplier must produce a certificate showing that the plant where steel was produced met our stringent green rules. To make it tough these certificates would have to be issued by our inspectors following plant inspections. It is not import duty so would not break those agreements or EU law.

**Bill Hawthorn**

UK carbon-reduction targets may be very worthy, but they have been conceived by inexperienced politicians in the Westminster bubble with no concept of the globally competitive world that our industries, such as steel, operate in. It's our duty in the UK to ensure that energy-intensive industries can maintain their costs at a

competitive level or they will inevitably succumb to Asian competition, resulting in substantial and irreversible unemployment.

**Martin Jones**

If we let the steel industry die completely, we will lose it forever, or at best relegate it to a small working museum. There are whole sections of industry that have been lost and cannot be recovered without unfeasible amounts of investment, so we end up buying from abroad. Maybe mothball it until times get better, but don't kill it off.

**Jonathan**

Port Talbot lies on one side of the Bristol Channel, Hinkley Point C on the other. Between the two is the solution to both problems – build the barrage from Aberthaw to Minehead the Royal Academy of Engineering has proposed. The prerequisite for that is a dry dock or two at Port Talbot to facilitate the production of the caissons, pressure vessels and renewable energy engineering for a green future.

**Dave Smart**

As extreme as it sounds, if we want to employ people in this country to actually make things,

we need to protect the domestic market and use the profits to re-invest so that competitive rates for export are maintained. Nobody wants a nationalised millstone but without the domestic market as a foundation, any company/industry will fail. And if we can use coal upon which we sit, rather than import low-quality East European lignite or buy electricity from a German or French company's Chinese-built nuclear plant, we'd have much more control over fuel prices – and create jobs by sinking new collieries.

**Phil Stannard**

The government will do nothing. Steelmakers don't contribute to Tory funds, plants are not in Tory areas and the Tories will do nothing to annoy their Chinese chums. The most we will get is hot air and muttering about market prices.

**John Logsdon**

Previous comments all highlight deficiencies in the government, specifically a lack of industrial strategy. It's unable to deal with the inconsistencies in the way that the EU permits other countries to provide financial support to its industry. The UK wouldn't need subsidy if we were competing on an equitable basis. Perhaps we need a competency test, like ministers think schools should be governed. I don't think the present make-up has anything relevant to offer.

**David Roster**



## In your opinion

### Track record

#### Our comment piece on Crossrail 2 sparked a wide debate on UK transport infrastructure

● London has excellent public transport, so people move there pushing up house prices and filling up the public transport, which means that more is built, attracting more people – if you build it they will come. England is badly unbalanced. An English parliament should be set up in Manchester, drawing with it the machinery of government, lobbying organisations, company headquarters and so on, reducing some of the pressure on London and providing a true northern powerhouse.

**simhedges**

● With Crossrail and Crossrail 2 the powers that be have finally recognised the necessity of good east-west links. Not only does it open new markets and improve existing ones but it increases the resilience of the whole network. What is true for the 20 million who live in London is true for the 40 million who don't. Labour inflexibility and housing hotspots are created by having a transportation network that constrains people to living along north/south corridors.

**Nathan**

### Hands-free HGVs?

#### Government-backed trials of lorry-platooning received a lukewarm reception

● Rather than build HS2 and autonomous lorries, why not spend the money on a new lightweight rail system for 40ft containers, all autonomous, with an average speed of 60kph, with branches into the

major industrial estates and distribution centres, and get the freight off the roads. Maybe it could be mag-lev or some other modern rail tech, but high speed is not necessary, so noise and other HS2 issues would not arise. Our need for high-speed rail in our small country is less than our need for less congestion on the roads. I am convinced that autonomous vehicles are going to cause colossal problems.

**Jonathan Douglas**

● Anyone who has tried to overtake a single lorry in very wet conditions knows the problems with huge quantities of spray thrown up by heavy goods vehicles, the last few yards being particularly dangerous. The thought of trying to overtake 10 lorries, in convoy, in the wet, would fill most people with fear. This is just another mad idea, not properly thought through, by people who do not have any conception of daily driving conditions on our congested motorways.

**Robert Doody**





## The secret engineer

New safety features are being held back by the idea that motor racing should be dangerous



As one of the many fans of Formula One, I am intrigued by the suggestion of adopting an additional structure to protect the driver's head. As a professional engineer I cannot help but question the decision process. The currently favoured option has a vertical 'blade' in front of the driver and on the centre line of the car, the upper end of which has a horizontal element consisting of a half elliptical perimeter rail feeding back to the headrest. It has been widely, and, sadly accurately, compared to the retaining thong of a flip-flop.

Motor racing has become a lot safer over the past 30 years or so but in the open-wheel formulae the driver's head is still exposed. Felipe Massa nearly died a couple of years back when he was hit by a spring that fell out of a car he was following, Henry Surtees was

less fortunate still when hit by a wheel. The severity of injury, even with the additional safety structure, may possibly have been the same in each case but there would also have been a good chance of the errant pieces of debris being deflected.

Looking at it from a purely engineering point of view I believe that as the structure sits in an area of relative turbulence it would add minimal drag. The mounting points are on the existing safety cell so little additional material is likely to be required in the tub and the structure itself will add little weight, albeit high above the roll centre. Finally, I have not seen any problems regarding obstructed vision being reported from the testing. I know that Formula One is all about chasing minute advantages but I wonder if the change in the car would even be measurable across 10 laps in a race?

The problem is that not all those involved are keen to take up the idea – Lewis Hamilton in particular has been vocal in his objections. The main arguments that I can find against it are centred on the aesthetics and the, to me ludicrous, idea that motor racing needs to have an element of danger. I wonder, where are the engineers' voices in all this? I have been fortunate to work in fields where there are inherent risks and an implicit duty to design in safeguards beyond legislative requirements. Assuming that such a safety device is not currently precluded then why not design it in before it is mandatory? Going further, should the adoption of this type of device within the rules get stalled then I say the engineers should take the lead and force the issue. The novel solution, to preserve life where practical, is surely central to our professional values.

● I can see how it might pan out when everything is working fine and all HGVs are operated this way but when there is a mix of platoons and normal trucks I can imagine chaos, particularly if they are all running at the same limit. Also, what are the consequences if one truck gets a puncture causing a swerve of 10 x 44 tonnes at 60mph. The thought of multiple platoons on the M6 filling two lanes is scary – it's bad enough now.

**Pete**

● Taking heavy goods vehicles off the roads and onto rail and using the sea, rivers and other waterways for movement of heavy freight around our island nation must be part of the way forward; not trains of autonomous diesel-powered heavy goods vehicles bringing greater danger, pollution and congestion to passenger vehicles.

**Michael Brooks**

● I can see loads of problems, although it is an interesting idea. Until the trucks are completely

driverless, a platoon can only be a form of adaptive cruise control, and the driver must be ready to cancel it instantly, especially around junctions and other traffic.

**Robert Gregory-Smith**

● Did they not have a copy of the Highway Code to hand when they thought of this idea in the pub? This idea will mean you can have fully integrated mass bad driving with lorries in hunting packs. Just make all lorries drive only on the nearside lane on motorways, banning overtaking, and this will happen automatically, without any additional technology.

**Iain Vincent**

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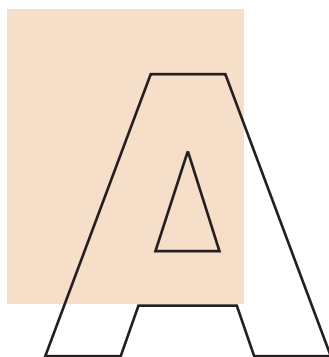


# Future inspiration is a real hot one

The creativity of entries for the recent Big Bang Fair illustrated the excitement and inspiration needed to engage young people with engineering

“It is vital that our education system recognises and reflects the value employers attach to STEM skills”

Paul Jackson



Accessible cars, leaky roofs, a 3D-printed phone case, show jumping and rural road safety were all entries that caught the eye of the panel judging the engineering projects competing at The Big Bang Fair last month.

The winning project ‘David’s Wheels’ saw friends Rogan McGilp (16), Stuart Chau (17) and Ethan Dunbar Baker (15) spend three months designing and building a hot rod. Inspired by Rogan’s younger brother David, who is severely disabled, the car is fully accessible for wheelchair users. It has a lowered floor and a throttle to control movement, meaning you don’t need to use your legs to operate it.

The BBC Breakfast sound engineers were given a challenge of their own when the students were featured the morning after being crowned UK Young Engineers of the Year. Hot rods are pretty noisy up close! McGilp, who says he gets his engineering talent from his mum, hopes to change people’s perceptions about what’s possible for disabled people and inspire more people to make activities and entertainment more accessible to disabled children.

His attitude reflects the general feeling of the employers, educators, presenters and volunteers, who brought science, technology, engineering and maths to life for 70,000 visitors at The Big Bang Fair in the NEC, Birmingham. To inspire people we need to work together, challenge assumptions and think creatively. The fair had inspiration and excitement in buckets, and the message that science and maths subjects lead to great careers was evident throughout.

Those four days at the NEC hosted thousands of careers engagements as industry professionals and careers advisors worked in tandem. For some visitors this was their first conversation about a career in engineering – we want to make sure it isn’t their last. They help young people make the connection between what they learn at school and how those principles are used in the real jobs that shape their world.

Through a recently announced award from the Careers & Enterprise Fund, which aims to bring together more young people and employers, we are now able to scale up the level of our on-the-ground support in three regions. We will use the funding to strengthen our work with employers and schools in the south east and the

north west, and to establish support for engineering employers looking to reach more young people in Yorkshire and The Humber.

It is vital that our education system recognises and reflects the value employers attach to STEM skills and there needs to be greater support for teachers and careers advisors delivering careers information so that they understand the range of available career paths, including vocational/ technician roles.

Without commitment from policymakers to offer that support we are bound to fall short and we must hope that cross-party and cross-department working will lead to closer synergy between education and business. The Sub-Committee on Education, Skills and the Economy co-chaired by Iain Wright and Neil Carmichael is a good example, bringing together members from two separate committees to examine the education and skills pipeline, and the impact on business and the economy. Since its establishment late last year, the sub-committee has announced two key inquiries: one into apprenticeships, the other into careers guidance. Both are essential in addressing the skills gap in engineering and industry employers continue to make clear their views on both subjects.

This collaborative approach reflects the pan-industry support for the Tomorrow’s Engineers programme, which we expect to reach one million young people a year within five years. We look forward to working with even more engineering companies over the next year to give more young people the chance to discover what engineering has to offer. I hope yours will be one of them. ☺

**Paul Jackson**  
Chief executive, EngineeringUK



The winning ‘David’s Wheels’ project at The Big Bang Fair





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# Accelerating from the engine room

**As the internal combustion engine faces its biggest challenge since it was invented, new bespoke designs are helping to reinvigorate the art form.** Stuart Nathan reports



On the face of it, the two cars couldn't look much different: one long and low, with a single-person cockpit and the fins, wings and flaps that mark it out as belonging to the Formula One (F1) grid; the other short, snub-nosed and with two seats enclosed in a simple cabin. Their uses are also markedly different, from zooming around circuits in front of cheering crowds to bimbly around the centre of crowded cities at a leisurely pace. What they have in common is that both use

internal combustion engines that were designed specifically for them and for the particular kind of journey they will make; designed, moreover, to convert as much of the potential chemical energy of their fuel into the kinetic energy of the car and, in both cases, by teams steeped in the disciplines of motorsport. How the teams behind these two engines went about their task, and the different solutions they found, makes for a fascinating contrast.

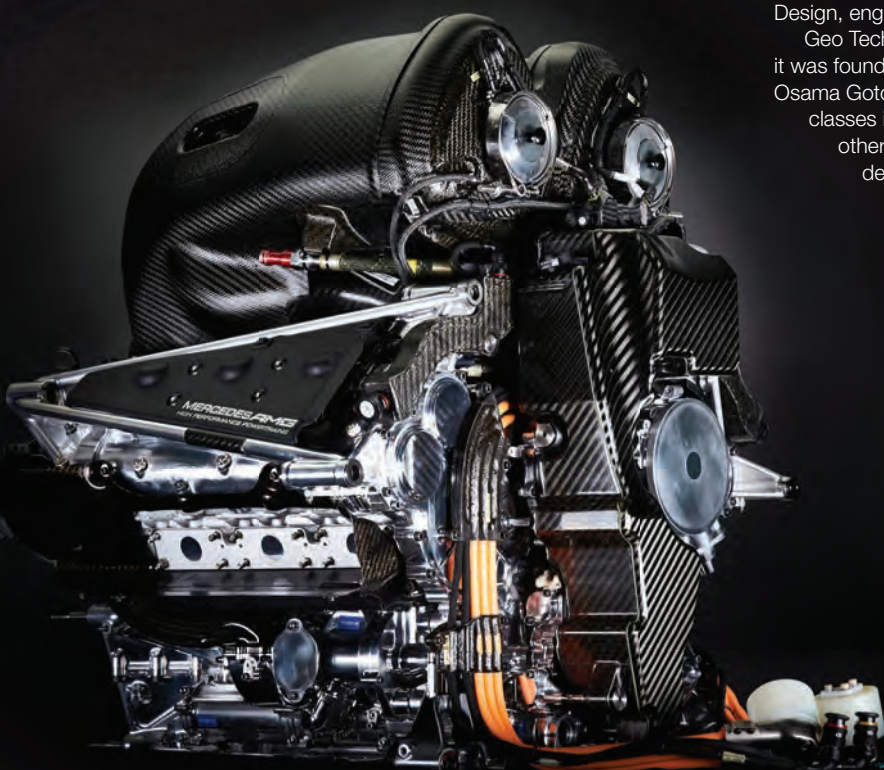
Opinion differs as to whether or not we're now in the final days of the internal combustion engine. But even if it's not on the verge of extinction, it can surely be seen that it's facing its biggest challenges since it was invented. For just over

a century, metal engines containing hollow cylinders where the explosion of a mixture of hydrocarbon vapour and air forces down a piston connected to a shaft that is thereby forced to rotate have been the primary way of converting the energy locked into the hydrocarbon fuel into a rotating motion and thence into the forward velocity of the vehicle in which the engine is housed. In the past decade or two that technology has been increasingly replaced by, or combined with, electric motor technology that is in fact almost the same age as internal combustion technology. However, internal combustion engines still rule the roost in motorsport, because the sheer density of energy locked up in hydrocarbon fuel enables cars to travel at high speeds over long distances while carrying a relatively light load; and in cities, because the established infrastructure of filling stations just makes it so much more convenient than having to locate charging points which, although becoming more common, are still far from ubiquitous.

For Mercedes AMG, the beginning of each racing season brings with it the development of a new engine and this year it brought immediate success: the PU106C engine powered the team to a one-two finish in the season's opening Grand Prix in Melbourne, Australia, with Nico Rosberg taking the victory and his team-mate Lewis Hamilton coming in second. The second of our two engines was just about to make its debut as *The Engineer* went to press, in a city car known as Project M, a collaboration between automotive consultancy Gordon Murray Design, engine specialist Geo Technology and the lubricants division of Shell.

Geo Technology is based near Geneva but staffed by Japanese engineers; it was founded by former director of Honda F1 and R&D manager of Ferrari F1, Osama Goto, and specialises in designing engines for the Moto 2 and Moto 3 classes in motorbike racing, although it also provides design consultancy for other motorsport classes, including F1. Geo's director of engineering and design lead on Project M, Hidehito Ikebe, explained that the priority on the project was to have an economical and comfortable design rather than all-out power, so the starting point for the engine was a unit designed for a standard small car: a 660cc, three-cylinder petrol engine based on Mitsubishi technology. The goal was then to refine its design to remove as many sources of inefficient energy loss as possible, and analysis of engine performance showed that by far the biggest losses came from friction within the engine.

Where the Geo team had a largely free hand, the Mercedes engineers were more circumscribed. FIA regulations for F1 stipulate many of the parameters allowed for power units; they have to be V6 configuration with the cylinder banks set at 90° to each other, weighing no less than 145kg, with an engine capacity of 1.6 litres, rev-limited to 15,000rpm and with fuel flow limited to 100kg/hour. No composites are allowed in the crank case or cylinder block, which must be of cast or wrought aluminium; the crank and camshafts have to be made from iron-based alloys, the pistons from aluminium and the valves from alloys based on iron, nickel, titanium or cobalt. The only thing it seems to have in common with the Geo engine is that it's an evolution of another engine, although in



01





02

this case it's the previous season's power unit, another proven winner, which won Lewis Hamilton the 2015 driver's championship. Another important difference is that while the Project M car is a pure-internal combustion-engine-propelled vehicle, F1 cars are hybrids, with two electrical systems working in tandem with the engine (the kinetic motor generator unit or MGU-K, which can also propel the car via a mechanical linkage before the clutch, and heat motor generator unit or MGU-H, which charges the battery, also subject to a raft of regulations). While this might limit the engineers' room for manoeuvre, it still allows enough latitude for every F1 team to introduce their own tweaks to the engine design.

One key strategy for the Project M engine centres on coatings: two types, solid and liquid. The liquid is,

of course, the engine lubricant, and here Shell's formulators had to tread as difficult a tightrope, balancing between an oil that was not too viscous that it exerted any retarding force on moving parts, but not so runny that it didn't lubricate at all. The way to ensure this was to use a gas-to-liquid oil rather than one derived from mineral oil; building the molecule from scratch allows much more control over its physical properties than trying to distil exactly the right hydrocarbon mixture from the complex mix of crude oil.

The solid coating, meanwhile, is a diamond-like material (DLC) that, Ikebe explained, found its first application around 15 years ago in the machine-tool sector. Discovered during the development of synthetic diamond for use in cutting tools and abrasives, DLC is used to prevent mechanical seizing and impart wear resistance. Its use is

**01/02** The PU106C is a version of a unit that has aided Lewis Hamilton

**03** Mercedes AMG is heavily circumscribed by FIA regulations



03

a result of Geo's motorsport heritage. Ikebe said: "Now, most of the hard-contact components in F1 use DLC; recently, it's become so popular that it is applied even in espresso machines," he said. The components of the valve train were particularly important to treat with DLC, although it was also used on the piston heads. "Generally speaking, the friction coefficient is reduced to around 10 per cent," Ikebe added.

The Geo team also looked hard at the engine components themselves, asking whether the performance of the engine depended on the size of the components. For many of them, the answer was no, so the engineers set about redesigning >>



>> parts of the engine. This reduced the depth of the piston heads by around two-thirds and also radically slimmed down the connecting rods that join the heads to the crankshaft. This reduces weight and also cuts the area of the surfaces that are in contact inside the engine, thereby reducing friction. Other redesigned components included the valve, valve spring, spring retainer, cotter, tappet, camshaft and crank bearing. The precise performance figures for the engine were not available as this issue went to press, but will be covered in *The Engineer* once the Project M car is launched formally at the end of April.

The Mercedes AMG F1 engine is known for a trademark mechanical innovation: its split turbocharger. In most F1 engines, the turbo sits at the 'hot end' of the engine (by the exhaust), and the exhaust gases drive the turbine that in turn runs the compressor, pressurising air to improve the combustion of the fuel. The air being hot when it exits the compressor because of its proximity to the exhaust, it then runs through a convoluted series of intercoolers housed in the engine's side-pods before being conveyed to the intake at the 'front' of the engine and thence into the carburettor.

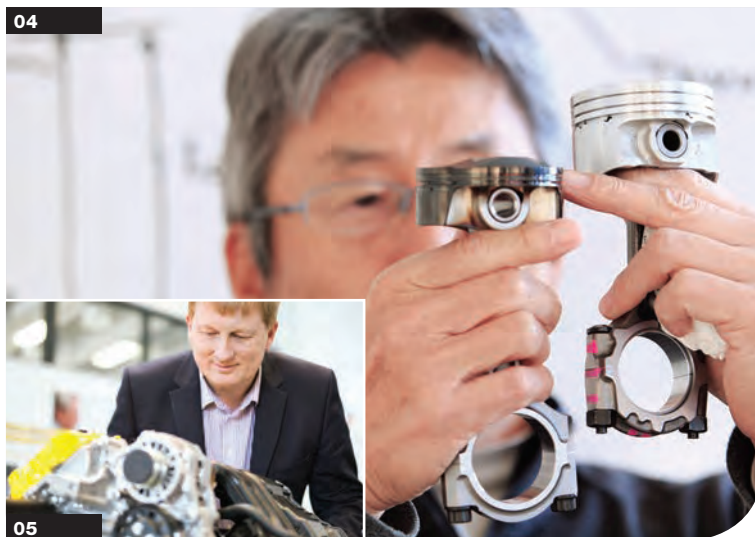
Mercedes does it differently. The turbine remains in the same position, by the exhaust, although it is spun by an electric motor to ensure that it is always at the correct speed even when the engine is running at low power and the exhaust gases don't have enough pressure to turn the turbine fast enough such as when the driver is off the throttle when cornering. The compressor is at the front of the engine rather than being adjacent to the turbine, with the two components connected by a shaft. This produces a cascade of benefits: the air is no longer hot when it leaves the compressor so it doesn't require the intercooler stage and can also be pressurised less as it doesn't have to travel so far before it enters the engine; this reduces the size and weight of the compressor, and also allows the car to be slimmer and lighter by eliminating all that pipework in the side-pods.

Mercedes' philosophy is all about thermal efficiency, explained Andy Cowell, managing director of Mercedes AMG Advanced Powertrains and the leader of the team behind the PU106C engine. "We've all used miles per gallon for decades [to express efficiency], but here we focus on thermal efficiency; that's how much energy in the fuel we can turn into useful work at the crankshaft," he said. "If we go back to 1837 and the birth of the internal combustion engine, that figure was 17 per cent. Over the past 137 years we've crept along and ended up at 29 per cent, which is where we were in 2013 and the normally aspirated F1 engine. The journey we've taken since 2014 [when turbo returned to F1] means we have now got an engine with a thermal efficiency of over 50 per cent."

This drive for thermal efficiency extends to looking at what is happening inside the thermal processes that power the engine itself. Mercedes used CFD to model not only the way the fuel-air mixture flows into the cylinders from the valves but also at the combustion process itself, modelling the shape of the burning gases and the way the explosion front moves through the chamber. This allowed the engineers to design the shape of the top of the piston head in such a way as to optimise the transfer of force from the exploding gases into the piston and transferring down through the connecting rod and into the crankshaft.

One way to sum up these different approaches is that while the Project M engine tries to squeeze all the energy from the exploding fuel into the mechanical

04



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**04** Hidehito Ikebe with the Project M piston head

**05** Robert Mainwaring of Shell Lubricants inspects the engine

**06** F1 engines must operate under arduous conditions

**07** Simulating the explosion inside the cylinder was key to designing the Mercedes engine

"The journey we've taken since 2014 when turbo returned to F1 means we have now got an engine with a thermal efficiency of over 50 per cent"

Andy Cowell, Mercedes AMG

task of turning the crankshaft, the Mercedes team started by trying to make sure they captured as much of the energy from the explosion as possible in the first place. So while the key to the little street engine's success is in modifying components to minimise the areas of metal that are in contact with each other and to make sure those contact areas slip past each other as easily as possible, on the F1 circuit the engineers began by closely simulating the way the vapours inside the cylinder flow around the top of the piston and how the fuel-air explosion blooms around the spark plug and presses down on the piston head.

But Cowell sees the new regulations for the engine as bringing the challenges faced by the race engineers closer than ever to those addressed by their colleagues who design road cars; and although he himself does not design road-car engines, Cowell thinks that there are many innovations his team has used that could be carried into road cars.

It would certainly make for a very different Mercedes. Say goodbye to big engines if Cowell gets his way: the increases in efficiency from downsizing mean that a C-class Mercedes would have a two-cylinder engine, possibly in a V-twin configuration. "You'd definitely go for a very small capacity; less than a litre," Cowell mused. "Let's talk in cubic centimetres, not litres; 400cc, that's a good number. It would have 200hp, and you would definitely have an electric machine driving the compressor. I would take the MGU-K from the F1 engine, so you would have electric machines on the front wheels to absorb braking, and you'd stay with rear-wheel drive because it feels better. And that would lead you to ask, how much is the engine doing? Might we be better off just treating it as a range extender, with the engine running full throttle to charge an energy store, and electric motors providing the motive power?"

Giving Cowell free reign over engine design, it seems we might be edging closer to Project M's vision of what a car should be. It remains to be seen what a die-hard Mercedes customer would think of buying a 400cc car with something resembling a motorbike engine under the bonnet. ☉

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# Driving at the tip of the iceberg

**The winter testing of cars on a set of frozen lakes in Sweden has become a key post in the development of a wide range of automotive technologies.** Jon Excell reports



01

**E**very December, in the far north of Sweden, just a few miles from the edge of the Arctic Circle, one of engineering's more unusual phenomena takes place. As winter's icy grip takes hold and temperatures drop as low as  $-30^{\circ}\text{C}$ , fleets of satellite-guided vehicles take to the frozen lakes that dot this sparsely populated region and begin meticulously etching out strange patterns in the ice. From the air, this complex tapestry of circles and wiggly lines – weirdly reminiscent of the UK crop-circle hoaxes of the 1990s – adds mystery to an already otherworldly landscape. On the ground, thanks to the omnipresent automotive advertising hoardings, its more practical purpose quickly becomes apparent. And, for the next three months, car makers from all over the world flock to the region to test their technology on the unique low-friction (muc) surfaces of these icy test tracks. It's the ultimate proving ground for traction-control systems and drivetrain innovations that are making our vehicles safer, efficient and easier to drive.

By a quirk of geography and fortune much of the activity centres around the small town of Arjeplog in Lapland's Norrbotten County: where the annual influx of engineers, technicians and mechanics sees the population swell from just under 2,000 to almost 4,000 between January and March.

Testing in the region began back in 1973, when engineers from Opel, looking for a suitable spot to put the fledgling anti-lock brake system (ABS) through its

paces, spotted an aircraft runway on the frozen ice of Lake Hornaven: one of Sweden's largest and deepest lakes.

While these early pioneers had limited resources, and little in the way of technical back-up, 'wintertest' is now big business: a major contributor to the local economy and a key staging post in the development of a wide range of automotive technologies.

One firm with a long-term presence in the area is GKN Driveline, the automotive division of UK engineering multinational GKN. And, on a recent visit to the firm's base at Arjeplog's Colmis Proving Ground, *The Engineer* saw first hand exactly why these facilities are so important.

GKN engineer Heinrich Huchtkoetter has been coordinating the firm's winter testing for more than 20 years and has seen it grow from just two or three vehicles and a rented garage, to an intensive programme involving 20 vehicles, eight separate tracks and a permanent team of 20 engineers.

This growth in scale has much to do with a change in technical priorities. Thirty years ago, said Huchtkoetter, the facility was primarily used to test mechanical drivetrain solutions, such as the viscous couplings used to transfer torque in all-wheel-drive (AWD) applications. But today the focus is on the rapidly growing area of electronically controlled traction enhancement systems, and the surface of a frozen lake is the perfect place to tweak and finesse this technology. "To get these right you really need low muc surfaces," he explained. "You need to drive on ice because there you really feel the difference between one technology and another, which in high-muc surfaces is almost impossible."





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“When we started with wintertest it was all about traction and then we found out our systems that improve traction also have an influence on vehicle dynamics”

Heinrich Huchtkoetter

In the years ahead, winter testing is expected to become an ever-more important step of the development process, as environmental legislation puts added pressure on manufacturers to develop alternative powertrain technologies. Indeed, GKN's automotive chief Peter Moelgg predicts that, by 2025, batteries and combustion engines will account for equal shares of a car's power. As many of the vehicles trialled this winter attest – including a hybrid BMW i8 equipped with a GKN-developed electric front axle – this is a far from unrealistic aim.

It's also clear that while electrification was once seen as something of a trade-off between efficiency and performance, this is no longer the case. There's no doubt that torque-vectoring systems such as the eTwinstar (see box on p24) help boost efficiency and safety but equally these systems are leading to significant improvements in performance. Indeed, according to Huchtkoetter, the ability to test these technologies on ice has played a role in improving performance. “When we started with wintertest it was all about traction and then we found out our systems that improve traction also have an influence on vehicle dynamics. The lower the friction on the road the easier it is to tune and calibrate the system.”

It goes without saying that throwing a car sideways round a frozen lake is good fun and these facilities are a great showcase for both customers and the media. But, as GKN's eDrive Systems director Theo Gassmann was quick to

**01** GKN's fleet of 2016 wintertest vehicles

**02** Circles in the snow, Colmis Proving Ground from above

**03** A prototype Volvo XC90 T8 equipped with eTwinstar technology

**04** The test track is created by fleets of precision-guided vehicles

**05** GKN has a team of 20 engineers based at the facility

point out, there's a serious purpose to it all. “People are not just driving on ice, having fun and showing some journalists and OEMs how great the cars are: they have an extended list of test procedures they have to go through and get signed off, and then, eventually, customers are coming along and having a final check and signing off the car.” It's an exacting process: vehicles will typically go through a series of low- and high-mue test cycles before eventually being signed off.

And in order to ensure that the data generated is reliable, it's important that the conditions on the ice itself are as consistent as possible.

This might be relatively straightforward, if ice didn't have an inconvenient habit of melting. But every spring, as the days grow longer, this advanced research facility melts away as if it was never there. And each winter it must be carefully rebuilt to a precise set of specifications. “We use the same layout every year because the tests need to be repeatable,” said Gassmann, “each curve has exactly the same shape every year. You need to know the track and consider that... in the software that you're using”.

As well as the shape of the course, its location on the lake is also important. Although the surface of the lake freezes, the level of the ice changes as water is drawn away to feed a hydro-electric power station on the coast. According to Harald Fjellström, managing director of Colmis Proving Ground, it can sometimes drop by as much as 2m. And if the track isn't in the right place this can cause problems. “It's very important we have the track in the same place because there are stones and rocks in the area,” he explained. “When we started we had no idea how it looked and suddenly rocks started to come up through the track.”

Construction of the course begins in December when the ice is around 5-10cm thick. A GPS-equipped scooter heads out onto the lake, starts to pack down the snow so that it freezes, and marks out the route of the test track. As the ice >>>



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>> continues to thicken, fleets of vehicles are sent out to prepare the track: "At 30cm, small green tractors with snow blowers go and take away snow," said Fjellström. "When we have 40cm then we go in with heavy vehicles, at 45cm with the plough, and at 55cm with the scraper."

Throughout this process, and indeed throughout the testing season, the ice thickness is carefully measured and monitored using vehicle-mounted radar instruments. When the thickness reaches around 65cm, winter testing can begin.

Once the tracks have been created, they are by maintained by teams of technicians, who work in shifts around the clock, removing fresh snow and ensuring that sections of polished ice, the most extreme features on the track, are kept as slippery as possible.

Despite an excellent safety record – no one has ever fallen through the ice – Fjellström's team nevertheless constantly checks the lake for cracks. Interestingly, the colder it gets the more hazardous it becomes. Below -30°C ice becomes more brittle and prone to cracking. "We don't go out with big machines if it's -30°C as the scrapers can remove big blocks," said Fjellström. "The optimum operating temperature is -5 to -15°C."

As the pace of drivetrain technology development continues to accelerate, facilities such as this are set to become ever more important. Indeed, GKN is now considering how it can scale up its activities.



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05 BMW i8 on the GKN test track

06 Proposed Arctic Arc indoor test facility

07 The eTwinster system

"When we have 40cm of snow we go in with heavy vehicles, at 45cm with the plough, and at 55cm with the scraper"

Harald Fjellström

But there are clouds on the horizon. And while the demand for the facilities is increasing, Fjellström is concerned that warmer winters, possibly linked to climate change, might put pressure on the industry in the years ahead.

"We have noticed the autumn is much warmer now when we start. We used to be able to come out on the lake at the end of September, but for the last 10 years the winter has been coming later," he said.

So far, this hasn't affected the start of the testing season, and Fjellström still guarantees a January start, but a trend towards warmer autumns is a concern.

With this in mind, the winter-testing community, has proposed a radical solution: a vast indoor test facility, which would protect and prolong the testing season, ensuring that it makes a year-round contribution to the local economy.

Dubbed the Arctic Arc, this 55,000m<sup>2</sup> facility will feature a range of tracks, and use refrigeration technology to maintain the temperature at a constant -7°C. Located near the existing Colmis Proving Ground, the track will also feature a heated, outdoor asphalt area so that high-mue testing and cold-weather testing can be carried out at the same time.

According to Fjellström, this state-of-the-art facility is expected to be up and running by 2018, and will help keep Arjeplog on the wintertest map for many years to come. ☺

## Indepth

### Plug-in hybrid module raises the bar for electrification

One key technology for GKN's 2016 wintertest programme was eTwinster, a plug-in hybrid module designed to make it simpler to make cars with electric all-wheel drive and torque vectoring.

The technology uses electronic clutches to vary torque across a vehicle's axle, and could make hybrid vehicles more efficient and dynamic, claimed GKN.

It combines the firm's existing eAxe technology – already used on plug-in hybrids, including the Volvo XC90 T8 and BMW i8 – with the twin-clutch torque vectoring technology in the Ford Focus RS and Range Rover Evoque.

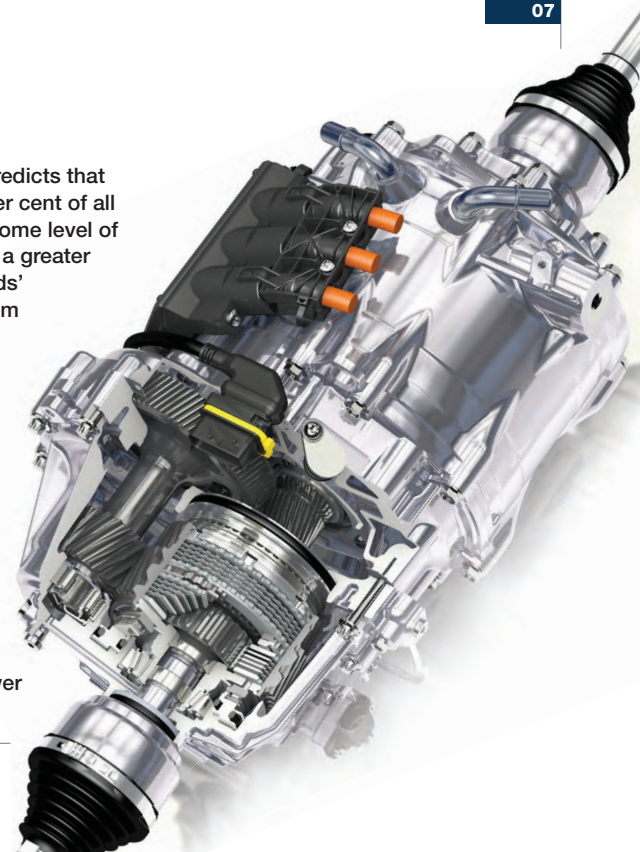
At Arjeplog, GKN demonstrated the technology on a prototype version of the Volvo XC90 T8,

chosen partly because GKN already supplies the vehicle's electric motor module. In the vehicle, a 60kW, 240Nm electric motor drives an electric axle with a transmission ratio of 1:10. A dual-clutch eTwinster system then vectors the resulting 2,400Nm of torque between the rear wheels.

The prototype vehicle demonstrated superior dynamic response and handling on the frozen lake at the heart of the firm's wintertest facility.

GKN Automotive's technology chief Peter Moelgg said: "We believe our system represents the next step forward for the industry: a production-ready way to create higher-performance hybrids that are more rewarding to drive."

The company predicts that by 2025 up to 50 per cent of all vehicles will have some level of electrification, with a greater proportion of hybrids' power delivered from the electric motor. While current mass-production vehicle platforms can only draw around 30 per cent of their energy from a battery, GKN claimed small, torque-vectoring electric axles could deliver 60-70 per cent of the power in future vehicles.





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# Making tracks for the capital

**London's Crossrail 2 chief is looking to build on the momentum and success associated with Crossrail 1. Andrew Wade reports**

**C**rossrail 2, a landmark north-south link across the UK's capital was recently granted £80m in development funding in the Budget, although this is a drop in the ocean next to the project's estimated final cost of £32bn. In a time of continued austerity, figures such as this are eye-watering.

However, Crossrail 2's supporters argue that it will not only bring relief to London's creaking transport network, it will also add huge economic value by unlocking new corridors for much needed housing and development.

Support for the project is widespread. Usual concerns have been raised about London turning into a giant building site, but, as any resident can attest to, the city is in a permanent state of flux. A key factor giving Crossrail 2 momentum has been the success so far of Crossrail 1, recently christened the Elizabeth Line. Due to open in late 2018, tunnelling was completed in June last year, and the project has been praised for the minimal disruption caused in relation to the scope of the engineering works.

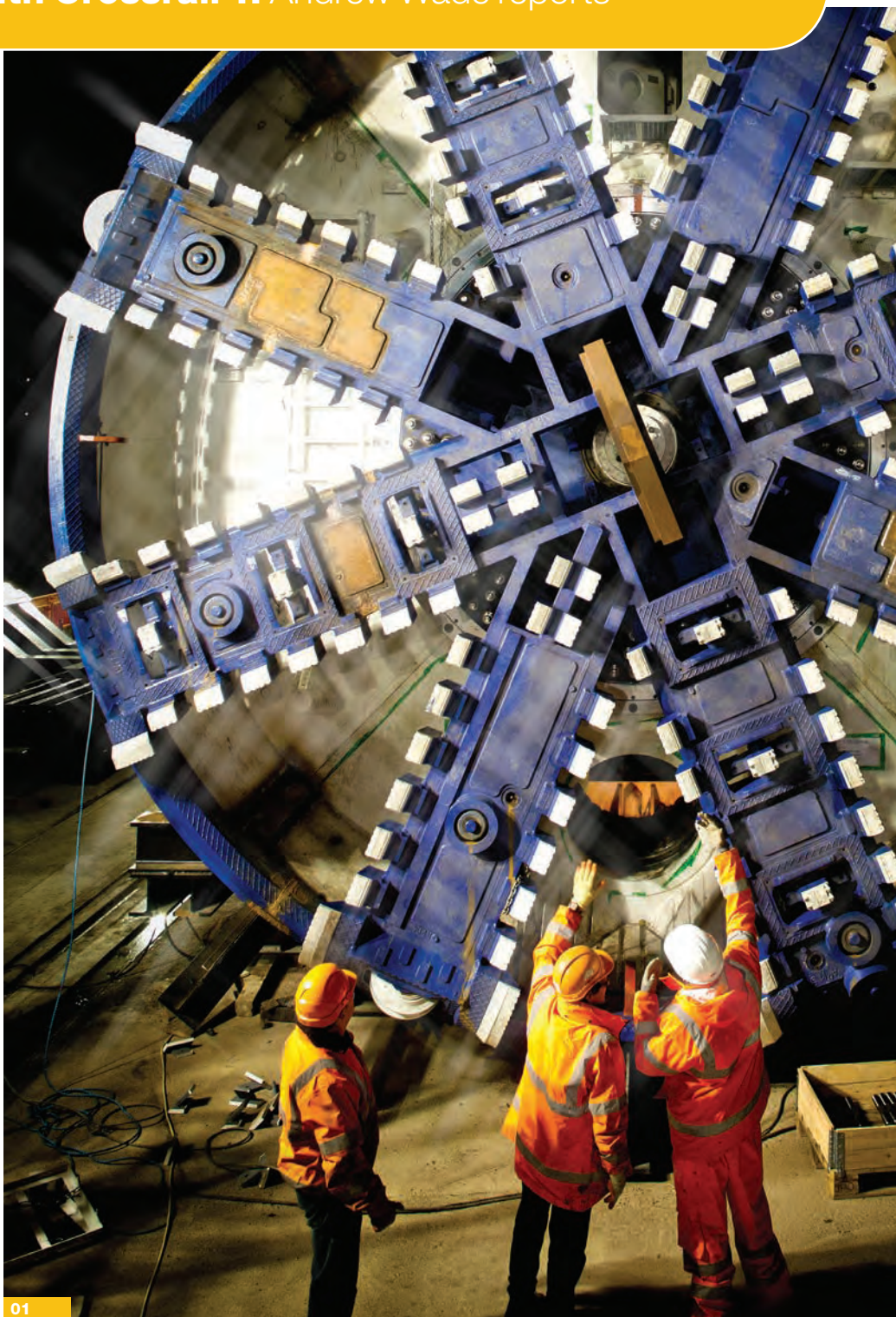
"The fact it's been a success makes it easier for us in having some of the conversations with people about the construction of Crossrail 2 and how it won't be as disruptive as people may have feared," Michèle Dix, managing director of Crossrail 2, told *The Engineer*. "It's great that there's a live scheme out there that people can see and visit, and understand how it has worked."

The core central section of the line will run underground from New Southgate and Tottenham Hale in the north to Wimbledon in the south, but the exact route is yet to be finalised. One point of debate is whether the line will travel via Tooting Broadway or Balham. The former was the original preferred option, but complications with soil at Tooting led to the Balham route being put forward. A final recommendation won't be made until the summer at the earliest.

"The challenge that we have in the south of London is the fact you've got the Wimbledon fault lines," said Dix. "There you go from clay, to sand, to pebbly stuff, and that makes building a station in those conditions much more difficult."

"We've had quite a lot of consultation responses wanting us to still consider Tooting Broadway, despite the concerns expressed, and we are doing studies to further understand the engineering challenges, as well as the socio-economic impacts of both stations before drawing any conclusions."

During the most recent consultation over 10,000 comments on the Balham station were submitted, with nearly 9,000 raising issues or concerns. Only one station



01



**01/02** When work on Crossrail 2 gets underway the assumption is that the tunnels will be drilled to the same 6.2m diameter as Crossrail 1

**03** Different size tunnels in the Crossrail 2 project may help increase the ventilation flow

– King's Road Chelsea – attracted more attention. It received almost 15,000 comments, with over 85 per cent of them containing issues and concerns.

Long considered a key location since the proposed Chelsea-Hackney (or Chelney) line that predates Crossrail 2, the King's Road station has proved highly controversial. On the plus side, it would help connect a long underserved part of the city to the underground network, improving links to the nearby Royal Brompton and Royal Marsden hospitals, and helping to reduce road congestion. But with no London Underground or National Rail links already in place, residents argue the brand-new £1.2bn station would be a folly, causing unnecessary disruption to the area.

In a report produced in March, the National Infrastructure Commission (NIC) said the station “does not provide the strategic interchange or crowding relief provided by other stations”. An alternative at Imperial Wharf has been mooted, but, for now at least, King's Road Chelsea remains firmly part of the project's plans.

“A station at King's Road would have local benefits,” Dix said. “It would serve an area that's not served by public transport at present – the King's Road itself, the shopping area and the hospitals that are subject to redevelopment. Growth will take place in the future and the King's Road station would help. But what the NIC has asked us to do is to look at the costs of Crossrail 2, and to look at each of the central stations to understand the case for each.”

There appears to be no apprehension with regard to the Eastern branch. Although it will not form part of the initial development, calls are already coming from east London boroughs for a commitment to the extension. A spur running from just north of Angel to Hackney Central has already been safeguarded, and if/when it goes ahead, will likely run through Newham and into Essex. But with plenty of development already underway in that part of the capital, eastward expansion is not an immediate priority.

“There might be a case for an Eastern branch at a later date,” said Dix. “Many eastern boroughs feel that there is. But it wouldn't be part of the first-phase scheme. It's just not developed. There's no route alignment, there's no engineering work. To get to the stage where we are with the core scheme – we've been looking at this since 2009, and we've had four rounds of consultation already.

“Part of our case to the DfT [Department for Transport] needs to be that we've exhausted all other possibilities.

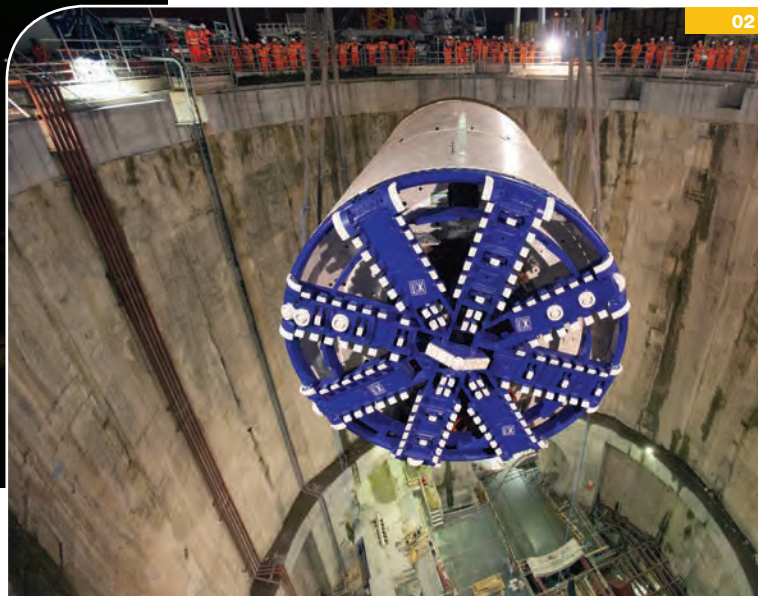
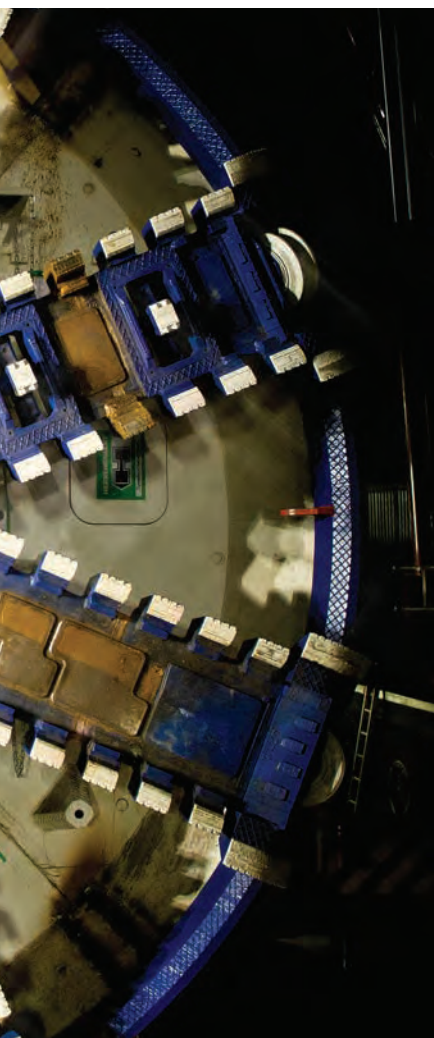
“A station at King's Road would serve an area that's not served by public transport at present”

## CareerCV

### Michèle Dix Managing director, Crossrail 2

#### Career

- Started her career at the Greater London Council and became a chartered civil engineer through its transport planning graduate scheme.
- Later went on to work for Halcrow Fox, where she became a board director.
- Joined TfL in 2000 as co-director of congestion charging.
- Became managing director of planning at TfL in 2007, responsible for leading the planning strategy on the future transport needs of London, coordinating the implementation of local plans and borough partnerships, and developing major scheme initiatives.
- Appointed managing director of Crossrail 2 in February 2015 and is currently responsible for developing Crossrail 2, and gaining funding and powers.



It's not just a case of 'oh, let's just have a big scheme in the south-west to north-east corridor'. It's reviewing that corridor to relieve the south-west mainland trains, to resolve the problems of increased congestion in the centre, and open up the whole of that north-east corridor.”

When the work finally does get underway, the current assumption is that the tunnels will be drilled to the same 6.2m diameter as Crossrail 1, with the same rolling stock running on both lines. One area that Dix and her colleagues may look to alter is the venting shafts, where a slightly different size tunnel may help improve the ventilation flow. It's one of many decisions on the table in an upcoming cost review to investigate where potential savings can be made in the overall scheme.

The NIC report recommended that London raise at least half of the project finance itself. Dix is confident this figure can be met through a range of similar levies taken to fund Crossrail 1. Furthermore, she believes the long-run return to the Treasury on its funding will end up being a multiple of the initial outlay.

With the line unlikely to open before 2032, those receipts won't be seen anytime soon, but this is exactly the type of long-term investment required to prevent gridlock in the capital. Here's wishing it every success. ■



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# You ain't seen nothing yet

**Novelist Jon Wallace considers the science fiction implications of engineering stories that have caught his eye. This month: picturing a future of human invisibility**

Last month *The Engineer* featured news about that enduring love of science fiction writers, invisibility. Engineers from Iowa State University, it reports, have developed a stretchable polymer material formed of rows of split ring resonators, embedded inside layers of silicone sheets. Together they create surfaces that trap and suppress radar waves. Researchers claim the technology could be a stepping stone towards invisibility cloaking.

This is one of many 'meta-material' stories that have appeared in recent years, as researchers race to develop truly effective invisibility cloaks. We future followers lap this stuff up, intoxicated by click-bait headlines: 'Harry Potter cloaks made real' and 'The Invisible Man is coming': illustrating both the continuing fascination invisibility holds in popular culture, and the way the trope straddles both fantasy and sci-fi.

There's something existential about invisibility tales: sight is our most evolved and powerful sense, the primary data by which we interpret the world and our place in it. Invisibility is a core speculation, one of the first 'what if' questions we ask ourselves: what if I could not be seen?

Small wonder that it holds an eminent place in founding sci-fi and fantasy works: Wells' *The Invisible Man*, and Tolkien's *The Lord of the Rings*. Each established canons from which following works have struggled to escape; each well illustrates the genres' differing approach to story. The One Ring causes the wearer to vanish because of magical forces beyond human understanding. Wells' invisibility, to the contrary, is borne out of human ingenuity.

Still, their essential attitude to the idea is much the same: both associate invisibility with the crushing of an individual's humanity. Closely tied to this gloomy outlook are tales where the power is the realm of cold-blooded hunters – cloaked Klingon Birds of Prey, and the Predator.

Invisibility also has associations with confused adolescent lust – boyish fantasies of sneaking into the girl's locker rooms. But equally powerful at that developing age, for both sexes, is the constant, uncomfortable sense of being observed – much

amplified in this era of blanket surveillance and social media. Studies show the illusion of invisibility can be a powerful treatment for such social anxiety.

We might develop a story about some teenage prodigy who perfects an invisibility cloak to escape the exposure of a horrific Facebook shaming. Brooding in isolation, she plans to use her power

Might it bring about a social revolution? One story could follow the emergence of a subculture that rejects our Facebook world, holding invisible parties and going on invisible dates. Our main character enjoys true love with his unseen partner, until they strip away their mantles, and love is shattered.

Or, as invisible crime spirals out of control, might the surveillance society turn from the eye to the nose? Picture a topsy-turvy nation where power of detection has passed to the snouts of genetically engineered super dogs; where police chiefs are talking canines, bribed with bones and squeaky toys, and men mere administrators – power flipped from one end of the leash to the other.

A pity that engineering has so far failed to deliver convincing invisible tech; as Douglas Adams stated, the technology involved in making a thing invisible is so complex it is much easier to favour the "Somebody Else's Problem Field", which relies "on people's natural disposition not to see anything they don't want to, weren't expecting, or can't explain".

Indeed invisibility-cloak projects can be anticlimactic upon closer examination, hamstrung by context

and needing to be tuned to particular waves, viewed from certain angles.

And what kind of story does that inspire in the sci-fi mind? Certainly it makes military applications seem like wasted effort. Imagine an alien world torn by a war of attrition. One side attempts to break the deadlock using invisibility cloaks, only effective if the wearer moves very, very slowly. Thousands of soldiers inch across no-man's land, only to be mown down by a forewarned enemy, equipped with 'tuned' binoculars – a grisly, re-enacted Battle of the Somme.

But away with such dystopia. Engineers are plotting paths Wells and Tolkien couldn't have imagined. One thing is certain; science fiction hasn't seen the last of invisibility. ☹

**Jon Wallace is a science fiction author living and working in England. His new novel, *Steeple*, is published in paperback. Check out his website [jonwallace.co](http://jonwallace.co)**



The Invisible Man was borne out of a process of human ingenuity

"Invisibility is one of our core speculations, one of the first 'what if' questions we ask about ourselves"

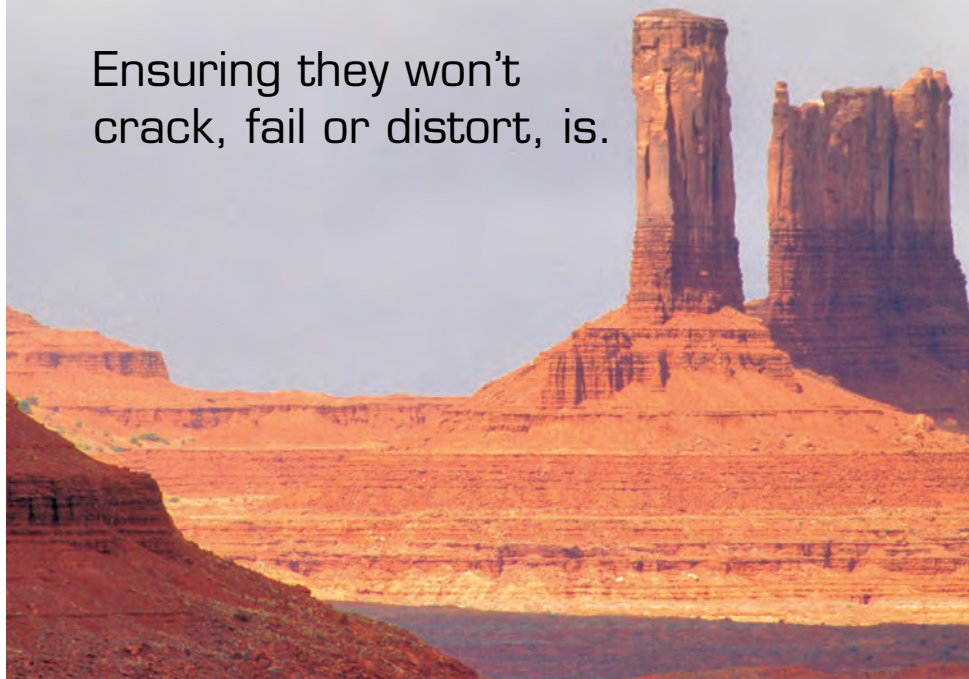
Jon Wallace

to take revenge on those who humiliated her but having infiltrated their most intimate moments realises how miserable and lonely are their lives, and leaves them be, seeing the world more clearly than before.

And what of a time where invisibility is freely available, a zip-up, all-over, skin-hugging suit?

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# Virtual emergency

**An emergency vehicle simulator developed in the UK will accurately replicate 'blue-light' driving.**

Andrew Wade reports

**S**imulators play a crucial role in many different types of vehicle training, from nimble fighter aircraft to the vast lumbering cargo ships and tankers that roam the oceans. While it seems obvious to invest in simulation training for these multi-million-pound machines, the same economic and safety factors don't tend to come into play for driving.

Although driving simulators have been around for decades, experience on the road is the preferred method of learning. For the 'blue-light' drivers of emergency vehicles, however, practising their skills

on real-life streets can pose a risk for them and other road users. That's one of the factors that led engineering services company Babcock to develop a simulator specifically designed to replicate the experience of emergency services driving.

Its recently launched fire-truck prototype is the culmination of 18 months' R&D. Featuring a 200° wraparound screen, the simulator will not only facilitate emergency driving in a safe environment, it will also enable training tailored to specific incidents. According to Alistair Cumming, Babcock's head of training, design and development, this will enable more focused instruction, complimenting real-life training rather than replacing it.

"Say you're not particularly good at zebra crossings," he explained to

*The Engineer*. "What we can do is have zebra crossings on the simulator and keep replaying approaches to zebra crossings, so that you get plenty of repetition and plenty of experience. If you're out on the road you might need to drive for another 30 or 40 minutes until you find another zebra crossing."

Simulators for emergency services driving do exist, but Cumming claims many of them lack the realism required for effective training. While they can be useful for imitating certain situations, they fail to replicate what it's like to sit inside a fire engine and handle a vehicle that weighs 12 tons.

"The big difference with this is that you're actually in a fire engine, you're actually sitting inside the cab of a fire engine and it becomes immersive," he said. "The only way that simulation can actually be effective as a training tool is if you're immersed in it."

Fundamental to this is the way in which traffic in the Babcock simulator reacts to the emergency vehicle and the decisions the driver makes. Just as in real life, certain cars will respond differently to the presence of blue lights in their mirrors and the approaching glare of a siren.

"The bit that no one's ever done before is this artificial intelligence >>

**01** Babcock's simulator features a 200° wraparound screen





>> reacting to blue-light users,” said John Fuller, a London Fire Brigade (LFB) Emergency Response Driving (ERD) instructor for 15 years, and another of Babcock’s key figures behind the simulator concept.

“The reason they’ve never done it before is because it’s so complicated, with millions of variations. First off, we wrote a mapping document of the rules we would expect people to adopt in different scenarios. Bear in mind they’ve got to be mapped to what [people] do wrong, as well as what they do right. Then we worked with a team of software developers to get the mapping – the experience I’ve got in my head about what people will do – to get the software engineers to make that happen on the screen... we had quite a few people who said it couldn’t be done.”

That process resulted in some features that Babcock claims have never been achieved before. Vehicles in other simulators are typically just window dressing travelling blindly on rails, unresponsive to environmental factors. However, each individual vehicle in the Babcock simulator has its own AI model, ‘thinking’ independently and reacting to the movements of other traffic.

This traffic populates a variety of different terrains covering 167 miles, including urban, inner city, and rural roads. These are divided up into different ‘runs’ that can be shuffled and swapped into any order, providing an almost infinite variation of routes to test drivers. Environments are geo-typical rather than geo-specific, with some layouts from the real world copied but with altered characteristics to prevent drivers making assumptions from personal knowledge and experience. Layouts were specifically selected to provide a complete range of challenges, with different types of intersections and junctions.

“It means the driver gets exposed to an awful lot more than they would do if they were street driving,” said Cumming. “It’s much more challenging, much more testing. And that’s why you can be confident that when you come out of the simulator, it’s a better and more effective experience than somebody who’s just learned to drive in a road vehicle.”

When it comes to driver immersion, precise simulation of handling is just as important as responsive traffic. In order to accurately reproduce the movements and feel of a fire engine, Babcock worked with Motion Simulation, which played a key role in developing the software and hardware. Together, they conducted a series of tests so that the handling physics of the simulator would match those of a fire truck as closely as possible.

Using several fire appliances fitted out with cameras and measuring instruments, the team designed a testing regime that involved braking, acceleration and handling runs. These runs were carried out with the vehicles both fully loaded and empty, under wet and dry road conditions.

“We did everything three times to give us an average,” Fuller explained,

**03** Former fire brigade driving instructor John Fuller has helped develop the system

“and then we got a full set of performance figures so we know exactly, on a real fire appliance, it will brake exactly from that speed to that speed in that amount of distance. We know that’s a fact because we tested it and we’ve got all of the data there.

“It threw up a few surprises. It brakes far better than any of us would’ve bet money on. We were all checking our figures... and the software engineers were asking us if we had our figures right, but we could show them all the engineering data.”

Although the initial prototype has been set up for a fire appliance, the same testing will take place on cars and ambulances so that the full range of blue-light vehicles will be covered. Hardware and software tweaks will allow the simulator to mimic the handling of each vehicle, with adjustable elements, including the ride height and steering wheel. The underlying software can be modified for both left- and right-hand driving, opening up international markets in Europe and North America.

Babcock is also working with the Royal Society for the Prevention of Accidents (RoSPA), with the company’s instructors required to gain a national diploma in Emergency Response Driving Instruction. Plans are also in place to have the simulator and its courses accredited by RoSPA.

“We are delighted to be working with RoSPA to gain accreditation,” said Fuller. “We want to make sure these drivers get to jobs in the safest and quickest way they can.”

“You can be confident that when you come out of the simulator, it’s a better and more effective experience than learning to drive in a road vehicle”

Alistair Cumming, Babcock



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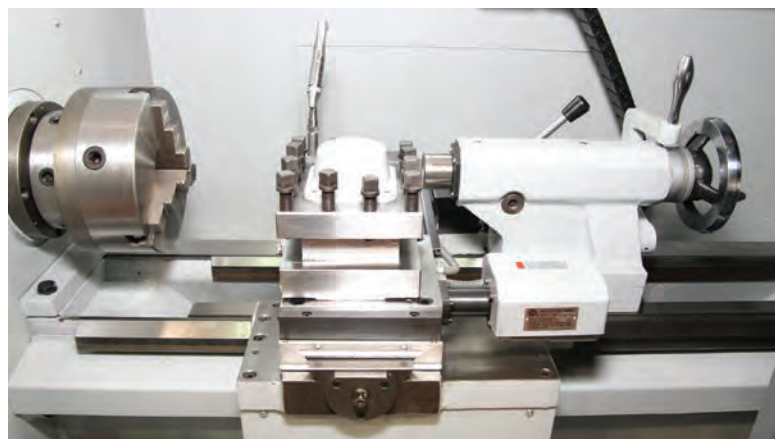


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# Striving for accurate analysis of large complex assemblies

**Modeller has automated search and extract tools to find eligible bodies.** Supplier: ANSYS

Accurate structural analysis of large, complex assemblies has traditionally been problematic although this might change with SpaceClaim Direct Modeler (SCDM) from Ansys.

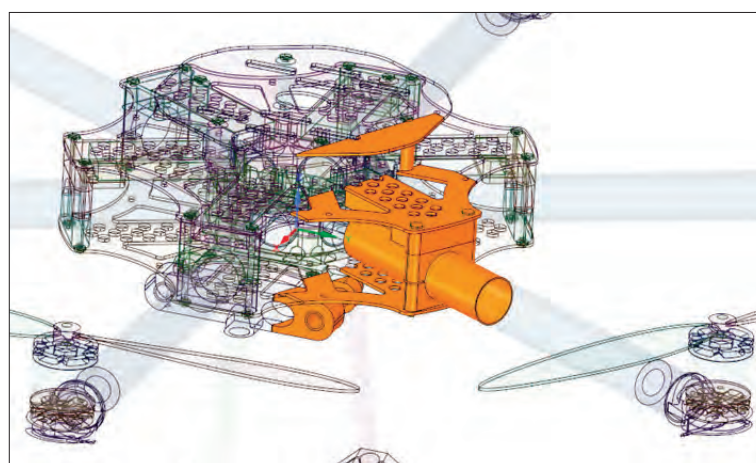
Structural analysis technology has evolved with users able to take advantage of the ability to mesh and solve simpler, representative geometry with complex models reduced to 1D (beam) and 2D (shell) elements.

However, the use of beams and shells in structural analysis requires a robust tool equipped with various geometry extraction techniques and connection capabilities.

The first challenge of geometry simplification is the actual extraction of beams and shells. Furthermore, some 3D geometry may not contain perfectly aligned walls with an obvious shell (or midsurface).

The automated search and extract tools built into SCDM find all eligible solid bodies fitting the search criteria. In the case of geometry not having

obvious shells to extract, SCDM will infer and give users several options of the final shell geometry. Also included in SCDM are advanced search



capabilities that let users organise, separate, and modify certain bodies from others.

After extraction, all elements must have proper junctions and intersections to ensure adequate meshing. In many cases, extraction of representative geometry is a simpler step than ensuring the necessary connections. Some models lend themselves to minor extension and trimmings of beams and shells, and, in those cases, SCDM is equipped with automated tools to find possible problem areas, and automated correction options. Manual edits are possible and an option exists to infer connections and create imprints on geometries that do not intersect.

Finally, users utilise beam and shell geometry to solve relatively straightforward load conditions but certain areas of high-stress concentrations render this particular process inadequate.

Users want the ability to quickly solve large, simple load areas using beam and shell geometry, but reserve traditional 3D meshing for subsections of higher stresses. SCDM solves this multifaceted approach by letting users extract beams/shells, and further extract solid geometry from localised regions. ©

# Simulation gets involved in a very dangerous business

**Team works on better ways to safely locate and remove landmines and IEDs.** Supplier: COMSOL



Clearing minefields is a dangerous business. Methods include ploughing the ground with armoured vehicles, to using dogs, rats and even honeybees to locate the buried explosives. Increasingly, however, technology is playing a more prominent role in minesweeping, with ground-penetrating radar (GPR) used for electromagnetic detection.

But with recent developments in landmine-cloaking technology, identifying buried objects through traditional GPR has become much more challenging.

To address the issue, Dr Reginald Eze and George Sivulka from the City University of New York — LaGuardia Community College and Regis High School, used COMSOL Multiphysics to create an intelligent subsurface-

sensing template. This template enabled the research team to devise better ways to safely locate and remove landmines and IEDs.

When setting up their model of the mine-strewn area, the researchers needed to ensure that they were accurately portraying a real-world landmine scenario. They started with a basic 2D geometry and defined the target objects and boundaries. The different layers of the model featured a homogenous soil surface with varying levels of moisture, as well as air, and, of course, the landmine. Physical parameters in the model included relative permittivity; relative permeability; and the conductivity of the air, dry soil, wet soil and TNT.

The COMSOL simulation results pointed out the differences in scattering patterns depending on the above parameters. For example, as the depth of the target increased, the scattering effects became more negligible. The relation between how deep the mine was buried and the scattering showed a clear connection to the soil's interference with the wave. This gave the team a better idea of the remote sensing behaviour, offering potential for increased accuracy in landmine detection and removal. ©

# Software is getting to grips with the naval lifecycle

**Platform will be used to manage submarines, frigates and aircraft carriers.** Supplier: Dassault Systèmes

French naval defence and energy firm DCNS has chosen Dassault Systèmes' 3DEXperience platform to manage the entire lifecycle of its products: from new-generation submarines through to frigates, patrol vessels,

aircraft carriers and landing platform docks (LPDs).

Dassault claims that the software, which will be used by DCNS to manage everything from conceptual design, through to engineering,

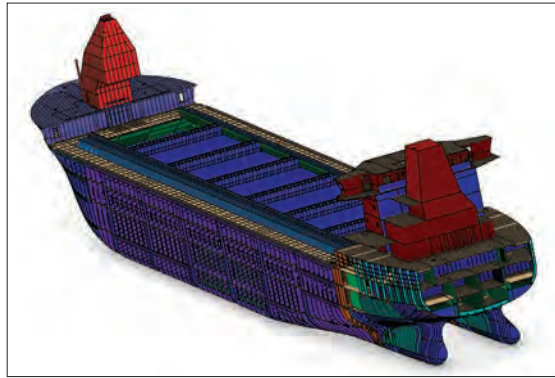
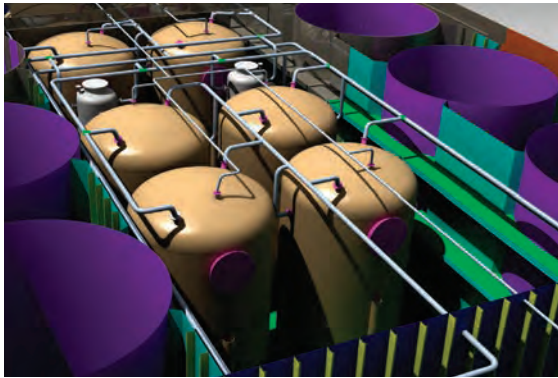
production and maintenance, will improve operational performance and competitive edge on a global scale.

According to Dassault Systèmes, the technology will prove to be critical in enabling DCNS to manage the

extreme complexity and high-level integration of technologies, including nuclear and conventional propulsion systems, radars, missiles and communications materials.

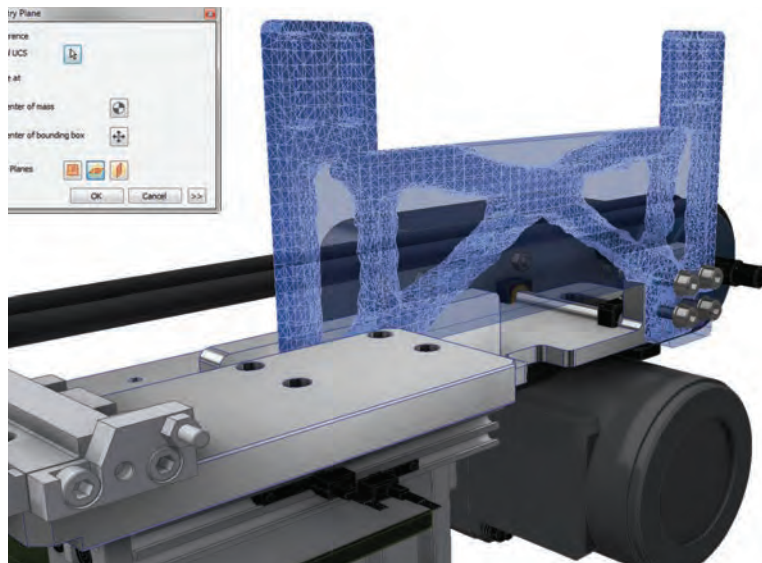
The firm added that the roll-out will help DCNS provide its clients, industrial systems and equipment partners, and supply chain with the most modern cooperation tools and digital interface. "Agility – the capacity to provide timely, reliable and efficient answers to our clients' demands while insuring world-class system integration and operational, cost-effective lifecycle solutions – is a significant competitive advantage," said Herve Guillou, president and chief executive officer, DCNS. "Our cooperation with Dassault Systèmes and its transformational marine solutions provide a practical roadmap to achieve our ambitious goals from now on."

Bernard Charlès, president and CEO, Dassault Systèmes, said: "The marine and offshore industry at large is going through a new dynamic of innovation as the open seas are becoming more strategic than ever. The DCNS decision to adopt the 3DEXperience platform to create a virtual twin of its products across all lifecycles will set a new level of performance in the naval sector." ©



# Enhancement is the name of the game for new releases

**Autodesk 2017 releases are now starting to become available.** Supplier: Man and Machine



Man and Machine has announced that Autodesk 2017 software releases are now starting to become available, which includes AutoCAD 2017 and Inventor 2017.

AutoCAD 2017 software arrived in March 2016 to give users many capability enhancements, including the ability to work more efficiently across connected devices. Inventor 2017 also followed in March.

The software's creator, Autodesk, stated that AutoCAD 2017 has been designed to help users stay at the forefront of design. Phil Read, managing director, Man and Machine, is equally enthusiastic about this and other releases due this year.

He said: "The releases bring new features depending on the specific software product being announced.

"These features bring in new functions or enhanced capability to drive design efficiencies, productivity improvements and collaboration benefits. Within basic AutoCAD, for example, the new 2017 release helps users to work across connected desktop and mobile solutions, while adding features that support PDF imports natively within the application.

"With Inventor 2017 improvements arrive in sketching, part modelling, assembly management, surfacing and sheet-metal capability."

Autodesk added that Inventor 2017 delivers new design and comms tools aimed at supporting customers' ever-expanding needs.

"The manufacturing industry is witnessing an evolution of the role of the mechanical engineer. They are no longer solely responsible for the design of complex mechanical systems, but are often also tasked with complete product definition, design and delivery," said Derrek Cooper, director of the Inventor product line. "With this latest version of Inventor, Autodesk is delivering new capabilities aimed at supporting all aspects of this expanding role."

Revit/Building Design Suite 2017 updates will be available this April. ©



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# Breathing new life into hydroelectrics

**It may be mature technology but hydro is still a promising solution to the UK's energy-storage problem.** Helen Knight reports

It can be hard to imagine after the travails of a typically blustery winter, but the wind does not always blow in the UK.

This means the country's increasing number of wind turbines, which provided 11 per cent of our electricity supply in 2015, are not always spinning at times of peak demand. Conversely, the wind often blows at night, when demand is low.

This can make life very difficult for the National Grid, which has to ensure there is always sufficient electricity available to meet demand. Last year, for example, UK wind farms were paid £90m not to produce energy at times of low demand.

Although the supporters of renewables counter that the difficulties of incorporating them onto the grid have been exaggerated, since wind speeds tend to vary across the country at any given time, thereby helping to balance out supply, the problem is likely to grow as their use increases.

To tackle this problem, two government-funded reports, both published in March, argue that electricity storage will need to play a significant role in the UK's future energy mix.

The reports, by the National Infrastructure Commission and the Carbon Trust, both argue that energy storage could ease constraints on the grid by allowing excess electricity produced by generators to be siphoned off and used later when demand is higher.

This could save the UK electricity system between £2.4bn and £7bn a year by 2030, depending on the regulatory framework in place.

The most mature of all the available energy-storage technologies is pumped hydro, in which low-cost electricity is used to pump water uphill to a reservoir at night, and the water is then allowed to flow back downhill during the day, to drive a turbine.

In order to utilise all or at least a significant portion of the available renewable energy, we will need a storage technology with a large capacity, according to Prof Ånund Killingtveit, department of hydraulic and environmental engineering at the Norwegian University of Science and Technology.

"Storage is expensive, and [pumped hydro storage] is really the only technology that can supply large, grid-scale storage at a low cost," he said.

What's more, the technology can respond to demand in a matter of seconds, he said. "With an ability to respond almost instantaneously to changes in demand or supply, pumped storage is an essential component in the electricity network."

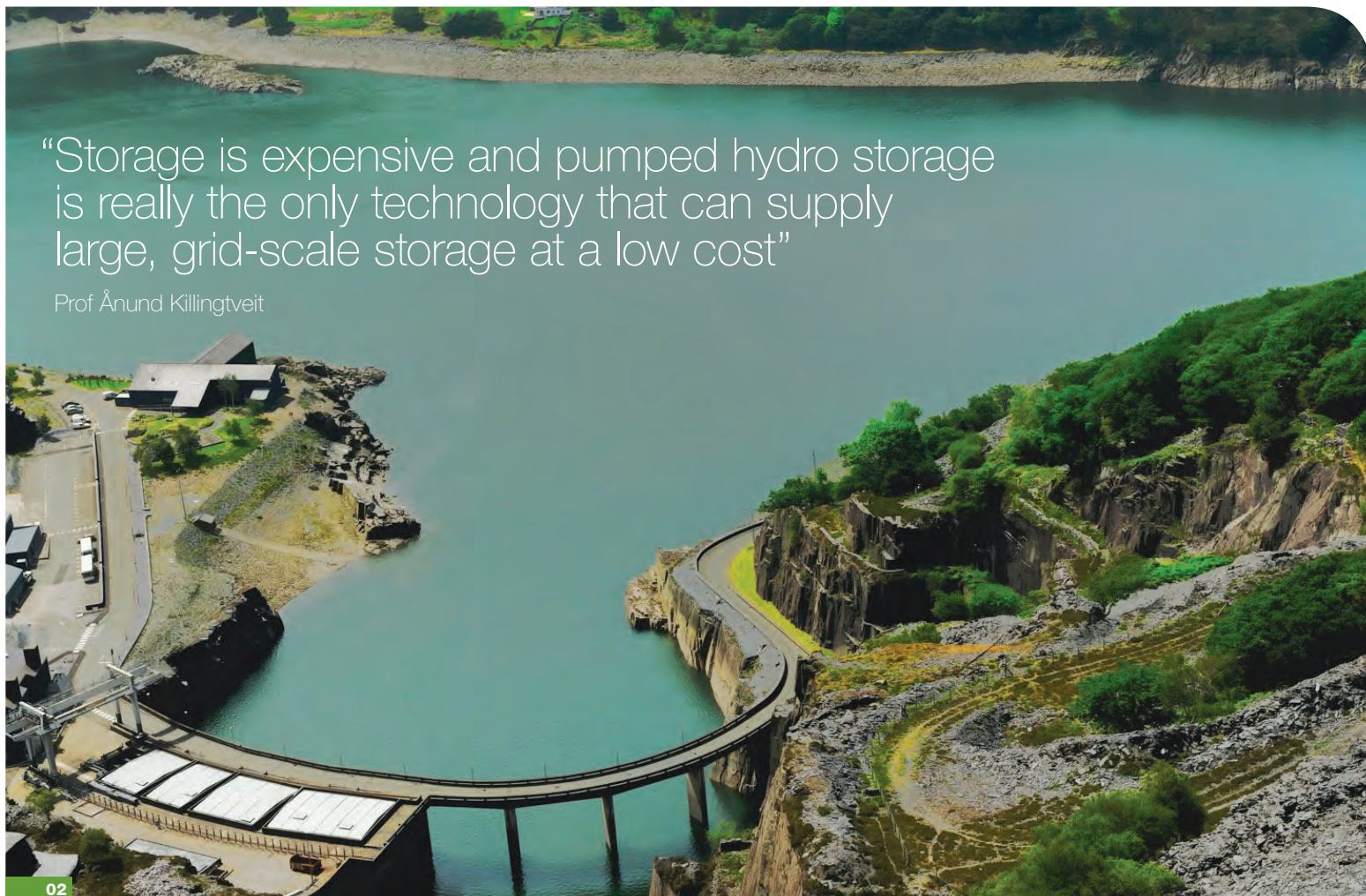
As a result, there is growing interest in increasing the UK's pumped >>





“Storage is expensive and pumped hydro storage is really the only technology that can supply large, grid-scale storage at a low cost”

Prof Ånund Killingtveit



02

>> hydro storage capacity. Scottish Power said recently that it could add 400MW of on-demand electricity to the UK market by building a new dam in front of the existing one at its Cruachan plant near Oban, if it can secure a guaranteed floor price for its use from the government.

Meanwhile, UK firm Quarry Battery is seeking planning approval to build a new 99.9MW pumped hydro energy storage facility at Glyn Rhonwy in Snowdonia in Wales.

The project would see two disused slate quarries converted into the upper and lower reservoirs of the pumped hydro plant, according to Dave Holmes, managing director of Quarry Battery.

The plant will be equipped with two reversible-speed Francis pump turbines, which will act as a pump in one direction, to push the water up the hill, and as a turbine in the other, to generate electricity.

But it will differ from the existing pumped hydro stations in the UK in its use of a variable-speed drive, said Holmes. This should allow the plant to operate much more flexibly.

Variable-speed drives enable turbines to operate at peak efficiency over a larger portion of their operating band. They also allow a plant to quickly vary the amount of power it consumes in pumping mode, meaning it can be used to regulate the frequency of the grid by drawing off more or less electricity as required.

“This fast response can allow for compensation of power fluctuations and damping of power oscillations, and thereby improve the stability and frequency control of the power system,” said Killingtveit.

While the technology itself is not new – variable-speed pump turbines were developed and used in Japan in the

1990s – the age of many of the world’s pumped storage plants means it has yet to be applied in the UK.

For example, the UK’s largest existing pumped hydro station, 30-year-old Dinorwig in Snowdonia, has six single-speed turbines that can generate up to 288MW, said Holmes. However, the turbines cannot generate any less than 133MW, as operating at this level causes them to stall.

“With our scheme we will have a variable-speed drive, which enables us to go anywhere we like, from -100 to +100MW,” he said. “This allows us to be much more flexible, to follow the load and to carry out frequency regulation more easily.”

This will be particularly important at the quarry storage facility, where the reservoirs are deeper than conventional pumped hydro sites, said Holmes. This means there is a considerable change in pressure between the start of the day, when the upper reservoir is full and the lower reservoir empty, and the end of the day when the reverse is true, he said.

To cope with this, Glyn Rhonwy will need a slightly over-sized turbine, with a wider operating range than

**01** Scottish Power’s Cruachan plant

**02** Dinorwig, the UK’s largest existing pumped hydro plant

conventional plants. The variable-speed drive will help to manage this, said Holmes.

In a conventional, single-speed pump turbine, the magnetic fields of the stator and the rotor are coupled, and always rotate at the same speed. In a variable-speed machine, in contrast, the magnetic fields are decoupled, for example, by using a frequency converter between the grid and the stator winding.

The technology is more expensive and complex than traditional single-speed pump turbines, which operators will therefore need to take into account when weighing up the benefits of upgrading existing pumped hydro storage plants, or building new ones, according to Killingtveit.

But with the growth in the use of renewables, the greater flexibility that is offered by variable speed technology could allow pumped storage facilities to provide a larger, and far more lucrative, range of services to the grid.

Used in this way, the technology could give this most mature form of energy-storage battery a whole new lease of life. ☐





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# Surface specialist works on a plan to fine-tune pumping

**Process involves the careful pumping of latex emulsion.** Supplier: Michael Smith Engineers



Highway surface specialist Bituchem Building products turned to pumping expert Michael Smith Engineers to help fine-tune a process involving the careful pumping of latex emulsion.

The Gloucestershire firm manufactures a range of products to protect highway surfaces, and to enhance the quality of these products it uses a process whereby it pumps latex into its bitumen lines with the latex metered in proportion to the bitumen flow.

Latex emulsion – which consists of micro-particles contained in an aqueous medium – can be a tricky substance to pump. It's extremely shear-sensitive, and therefore requires pumps that can reliably deliver a low shear rate and, because contact with air leads to polymerisation, also requires a seal-less pumping design.

The requirement was to pump between 2-20 litre/minute of a latex solution with a viscosity of around 600cP at 10-bar discharge pressure. The capacity was to be adjusted using an inverter and the pump speed altered in proportion to the flow through the bitumen pipeline.

Following discussions the team specified and purchased a Wanner Hydra-Cell, seal-less, positive displacement high-pressure diaphragm pump, Model G25.

The pump, which featured a stainless-steel wet end and operates between 70 and 650rpm, was installed around a year ago and has worked well on the latex pumping application ever since.

John Shirley, engineering manager at Bituchem said of the operation: "We were aware of the problems involved when pumping latex and thanks to Michael Smith Engineers' understanding of our requirements and recommending the most suitable type and model of pump, it is working perfectly. We have not had any issues from day one, the pump saves us time as we now add the latex as part of the overall process. We also appreciate how the pump operates with the combination of low speeds and medium to high pressures." ☐

# Moving on down the path of single-use fluid technology

**Ensuring the efficient supply of pharmaceuticals for clinical trials.** Supplier: Watson-Marlow Fluid Technology

A Cancer Research facility has adopted AsepticSU single-use fluid path technology from Watson-Marlow Fluid Technology Group to ensure the efficient supply of pharmaceuticals for clinical trials.

Used with two Flexicon FP50 automated filling and stoppering machines, AsepticSU has helped South Mimms-based Biotherapeutics Development Unit (BDU) to eliminate the need for cleaning validation and simplify traceability of applied product contact components.

BDU is a Medicines and Healthcare Products Regulatory Agency (MHRA) licensed facility that develops, processes and produces novel Investigational Medicinal Products (IMPs) for phase I clinical trials that are sponsored by Cancer Research UK.

"Put simply, we're a clinical trial supply unit within the charity, and we have our own filling lines in a sterile environment," said John Emerson,

deputy production manager. "As a result, exploiting the benefits of disposable, single-use technology such as AsepticSU made sense."



AsepticSU is a sterile, single-use fluid path honed for aseptic filling. Used in combination with Flexicon filling machines it helps eliminate the risk of contamination in high-purity filling applications.

Importantly, single-use technology simplifies the validation process, making it the preferred solution over traditional hard-piped systems with piston pumps that require complex cleaning validation.

"As the liquid being filled is not in contact with any mechanical parts, permanent pipework or the external environment, there is no risk of cross contamination," said Emerson. "In terms of traceability, all of the documentation is provided with the validation pack from Watson-Marlow, which makes our job much simpler. Before we had AsepticSU we were either performing manual pipetting or using external resources."

Sterility is guaranteed as all parts are double bagged and pre-sterilised using a validated gamma irradiation process, which eliminates the need for costly laminar air-flow assembly areas, autoclaves and labour for the on-site assembly and sterilisation of filling accessories. ☐



# Vacuum pump is aiding the cause of fine print

**Variable-speed-drive rotary vacuum pump helps cut energy costs.** Supplier: Atlas Copco



A Sheffield printing plant is predicted to cut more than £10,000 from its annual energy bill after installing a new VSD-driven vacuum pump from Atlas Copco.

Polestar is Europe's largest independent print organisation. The company's £100m purpose-built Sheffield Gravure plant produces around 2.5 million catalogues, magazines and brochures every 24 hours, including weekly television listing titles and a variety of national newspaper supplements.

A vacuum system plays an essential role within the transfer of work from the presses to the print finishing and bindery operations. When faced with major repairs to one of the existing vacuum pumps, the company consulted Halifax-based Pennine Pneumatic Services (PPS).

"We pride ourselves on using the latest technology and continually look at ways to save energy, which is why it made absolute sense to accept PPS's recommendation to trial a variable-speed-drive rotary screw vacuum pump," said Simon Robinson, engineering manager at Polestar Sheffield.

"The Atlas Copco GSH900VSD+ has proved a resounding success and the projections are for major savings on our energy bills over the course of a year."

Of the three existing units, the two smaller fixed-speed vacuum pumps previously used by Polestar Sheffield were running at approximately 20kW an hour (one rated at 11kW and the other at 9.7kW combined). The single GHS VSD+ vacuum pump that replaced them is a 15kW unit, which operates at approximately 20 per cent load, equating to just 4kW. Based on an operation of 8,000 hours per annum, the estimated savings are expected to exceed £10,000.

Harnessing advanced technology while maintaining reliability has been key to Polestar Sheffield's success in the print world, which has helped the firm win the prestigious ERA (European Rotogravure Association) printing award.©

# Keeping a tight lid on spillages in the dairy

**Check valve deals with any chance breakaways.** Supplier: Dixon Group

Dixon Group's new Hygienic Breakaway Check Valve came about off the back of a chance encounter with two engineers from a UK dairy company, followed by an insightful observation from a member of the dairy's staff.

At last year's PPMA show the dairy engineers recounted a story to Dixon representatives about a recent incident where a tanker driver had driven off while still attached to the delivery hose. This all-too-common occurrence resulted in piping being ripped out, and a re-install that took four days and cost thousands of pounds.

Ike Topselvi, hygienic product manager for Dixon Group Europe, was quick to point out that his company supplied a product that would have enabled the dairy to be

back operational within 10 minutes, at a fraction of the cost of the repairs.

A site visit was arranged, with a Dixon sales manager successfully demonstrating his company's Hygienic Breakaway Coupling. In the unfortunate circumstances of a tanker driving off while still connected to the loading pipe, the break load bolts are the only items that need to be replaced in the aftermath.

Staff at the dairy were impressed. However, someone raised the point that it would be an even better product if it not only avoided damage, but also shut off the flow of milk to minimise



waste. It was this suggestion that led to the development of the Dixon Hygienic Breakaway Check Valve, a single unit that has a diverted breaking point tailored for a particular break-load. Upon breakaway, the check valve closes, protecting the loading bay pipe system, as well as keeping product spillage to an absolute minimum.

The new product comes in sizes of 2in, 2.5in and 3in and, according to Dixon, can be easily retrofitted to any loading bay. A 13kN break load bolt is standard.©

# Designs on our industrial future

**This year's two-day PD+I conference in London will be carefully considering a theme of design thinking for the contemporary world and beyond**

R

unning from 18-19 May at London's America Square Conference Centre, this year's PD+I conference will be underpinned by the theme: 'Design thinking for now and beyond.'

One of the key events in the industrial design calendar, the two-day conference will be chaired once again by Chris Lefteri, internationally renowned authority on materials and their applications in design.

Another familiar face welcomed back is Gus Desbarats. Founder and chairman at Alloy and chairman of the British Industrial Design Association

(BIDA), Desbarats joins the speaker line-up this year with a keynote that asks the question: What is BIDA doing for the UK's industrial-design professionals?

On his involvement with PD+I 2016, Desbarats commented: "BIDA has supported PD+I since its earliest planning stages, so we are delighted with the ongoing success of the event. It is proof positive that the UK has a strong industrial design community with many good reasons to come together. We look forward to seeing everyone there."

"The event is proof positive that the UK has a strong industrial design community"

**01/02** PD+I allows delegates to get under the skin of the latest new trends, technologies, materials and processes in the world of industrial design

According to PD+I organiser Crain, the conference is the only event of its kind that truly allows delegates to get under the skin of the latest new trends, technologies, materials and processes in industrial design. The show is also claimed by the organisers to be a platform from which to discover new opportunities and to apply them to future commercial growth.

Delegates and speakers from Europe, North America and Asia are being drawn in from well-known brands, design leaders, as well as personalities from the worlds of advertising, management consulting and technology.

Confirmed topics include: Nobody needs another designer; How design can contribute to the prosperity of nations; The art of the unexpected; Proportionate protection; The future of urban mobility; From crystal ball to cultural forge; and Happaratus. A series of case histories and factual stories will consider how design thinking is changing and being utilised by the industry for product and industrial designs of the future, appealing to delegates of many disciplines.

With more than 200 delegates expected to attend, the potential for networking and building invaluable contacts within this specialist area is second to none. For more information, visit [www.pdesigni.com](http://www.pdesigni.com) ©





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# Take the initiative for supply chains

**Subcon remains the only UK event that is solely dedicated to contract manufacturing supply chains and outsourced engineering services**

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ubcon, the UK's showcase for the contract and subcontract manufacturing supply chain, returns to the NEC, Birmingham, from 7 to 9 June, with more than 400 exhibitors and a set of new initiatives to make the event even more valuable to visitors and exhibitors alike.

These have been developed in response to discussions with senior buyers, suppliers and industry stakeholders to ensure that both visitors and exhibitors can get the maximum value from their time at the show.

Now in its 40th year, Subcon remains the only UK event solely dedicated to contract manufacturing supply chains and outsourced engineering services, and has doubled in size over the past four years.

It covers the complete spectrum of advanced manufacturing, from machining and metal-forming, through to electronics, plastic moulding, casting, forging, treatments, additive manufacturing and – with its own dedicated zone this year – composites and materials.

The spread of market sectors covered by Subcon is equally broad, with senior purchasing, production and supply-chain managers attending from industries that include aerospace, automotive, medical technology, transport, oil and gas, marine and general engineering.

**01/02/03** Those in attendance at Subcon are given a broad spread of market sectors

New at Subcon 2016 are dedicated zones, making it easier to find key suppliers. As well as the composites and materials zone there are also specific areas focused on contract electronics manufacture, manufacturing software, turned parts (in association with the British Turned Parts Manufacturers Association), castings (in association with the Cast Metals Federation) and Surface Engineering (in association with the Institute of Metal Finishing).

In the international supplier zone there will be pavilions featuring subcontractors from the Czech Republic, Spain, Italy, Portugal, Latvia, Turkey, India and China.

Popular features launched at last year's Subcon are also back on the agenda. The Advisory Drop-In Centre gives SMEs access to expert advice on the critical areas for business success, including skills, innovation, exporting and access to finance, while the free-to-attend industry reception provides an ideal opportunity to



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“2016 will offer more than 400 exhibitors and a set of new initiatives”

network over drinks and canapés.

In addition, select buyer visitors who attend Subcon 2016 will be invited to become part of the Buyer Programme, enabling them to search and select exhibitors based on the sectors they serve, services and approved accreditations and pre-book meetings. The personalised diary system will ensure buyers have a productive time at the show, ensuring meetings with the right suppliers.

Complementing these customer-focused activities, a specially commissioned series of Subcon conference presentations will address key technology and supply-chain issues. These include the role of additive manufacturing in supply chains, adding value to procurement, identifying skills gaps and engineering lightweight structures. ©

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# Making for a good supply-chain player

**Andrew Evans, who is head of purchasing at an automotive components manufacturer, explains what he's looking for from new suppliers**

I am often asked what is needed to become an automotive supply company. Unless there is a known business need where you have been contacted then the answer is quite simple: cost.

But it's also true to say that this is not the only metric. Behind the decision

to introduce a new supplier a large amount of resource and effort is necessary, therefore the interested stakeholders want to understand the benefit before they start.

I'm looking for a supplier that understands my business – make sure you do your homework on the products that we manufacture. Your company doesn't need to be big but it needs to be forward-thinking, it needs to be profitable, professional, and I need to know that you will be around for the long haul.

Don't start by telling me you're not the cheapest... it really is a turn-off for a buyer. Basically, you are saying you are expensive, and I would be a rich man if I had been paid every time I had listened to this opening gambit.

Of course, your delivery and quality performance will be critically important to any organisation, however most buyers will take these as a given. So concentrate on explaining how your company can be cost-competitive. Sales representatives will verbally explain the great things you do but you may be surprised to learn that in my career I can count on one hand the number of suppliers that can back this up by demonstrating ways to support



*"Your delivery and quality performance will be critically important to any organisation. Concentrate on being cost-competitive"*

Andrew Evans

Make sure that you do your homework on the products your target company manufactures before you approach it for business

our design through cost initiatives, improving delivery costs through supply-chain improvements and a zero parts per minute quality result.

However, if you can show them examples of where you have implemented any of these key initiatives in presentation format or physical examples I guarantee it will stand you in good stead.

Assuming your price has been accepted and the quality and logistics audits have gone well, how do you maintain and grow your business?

More doors will open and your relationship with the buyer will be stronger, so take the time to get to understand the product, process and what KPIs the customer measures itself upon. Be proactive by offering ways to support quality through introduction of outflow prevention, supply-chain improvements and packaging. Cost-reduction ideas that can be implemented will be particularly well received. Many suppliers only offer Value Analysis/Value Engineering ideas when pushed by the customer and then, in many cases, the results are poor, take too long to implement, or simply do not offer enough benefit to make them worthwhile.

A good example of one of our suppliers ensuring its future in this way happened a number of years ago when we changed our packaging supplier from one of the multinationals to a smaller company that could better service our requirements.

This supplier has worked tirelessly to improve. Our business is low volume, small batches with a lot of flexibility with over 400 part numbers. In 2014 we cordoned off an area of our warehouse where the supplier has set up home and a team of people to assemble corrugated boxes to a lead time of one hour, which provides synergy that will make it very difficult for us to want to change.

Finally the sourcing of suppliers has dramatically improved with the introduction of the internet and it's a great way to market your company. If your company does have its own website make sure you keep it up to date and someone in your organisation regularly checks your inbox for prospective enquiries.

If you don't have a website (yes, you are out there) then my strong advice would be to invest your hard-earned cash on a good one to make sure you get a professional job done as this has a major impact on how a buyer views your company.

Finally, good luck. ☺

**The views expressed in the above piece are solely those of Andrew Evans**



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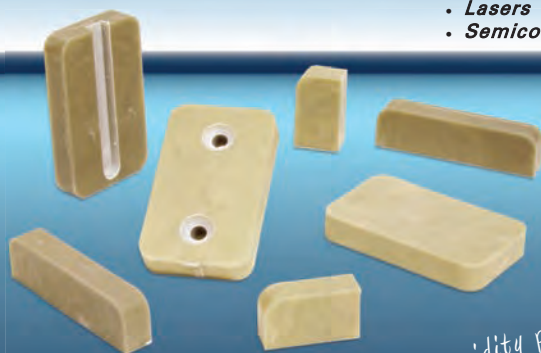
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# Power moves amid all the uncertainty

**Despite continuing doubts over Hinkley Point, there are still significant opportunities in the UK nuclear sector.** Evelyn Adams reports

**T**he uncertainty over Hinkley Point C has been dominating headlines in recent months. Despite a deal from 2013, the future of the proposed £18bn nuclear power station remains unknown. There are concerns about the technology, and of EDF's financial commitment to the project. Earlier this week, EDF announced that a decision on the power station will take place in May – and there are real fears that the ambitious project could be scrapped.

While the Hinkley saga might make it seem as if the

UK's commitment to nuclear power is waning, the industry insists that this is far from the case.

At the moment, the UK boasts 16 reactors with a combined electricity-generating capacity of 10GW. In total, these reactors create a sixth of the UK's electricity, and all but one is due to retire in just seven years. To replace them, £45bn is due to be invested in the first three nuclear power plants that will be built – if plans go ahead – in Somerset, Anglesey and Cumbria.

The trend is reflected globally. Currently, there are 440 nuclear reactors operational in the world, 65 under construction and 337 proposed. As a result, the nuclear workforce in the UK is expected to grow by 4,700 people a year over the next six years. At the same time, 3,900

people are expected to leave the sector. The industry will have to recruit 8,600 engineers a year to make up the shortfall, regardless of whether Hinkley Point C gets funding.

"When you consider the UK's stringent climate change targets, new nuclear power stations simply have to be built to reduce our carbon emissions," said Peter Haslam, head of policy at the Nuclear Industry Association. "There has been much media speculation around Hinkley Point C, but the key point is there is backing from EDF itself, as well as the French and British governments.

"Moreover, there are two other consortia planning to build power stations in the UK: Horizon and NuGeneration. The UK will not change its mind on nuclear now." Haslam points out that the industry is on the brink of a massive new-build campaign with 16GW of new capacity planned. This, along with a decommissioning programme, will provide a wealth of opportunities for talented engineers.

"Decommissioning our nuclear legacy will need engineers for the next 120 years," he added. "There are also plans to develop a geological waste repository in the next 30 years. Looking to the future, the UK could also be developing small modular







02 03

reactors in the next 10 years. We could also be constructing plutonium burning plants to use our stockpile of plutonium.”

The nuclear industry faces some big challenges, particularly at Sellafield and for new-build projects, which will require some of the most advanced manufacturing. Throughout the initial development and construction phase of new plants, there will be significant opportunities

in roles such as project managers, electrical, mechanical, control and instrumentation engineers. More broadly, however, engineers of all skills are needed.

“Aside from the opportunities offered by new plants, our existing plants also require skilled engineers,” said Ben Hough, nuclear recruitment specialist at Matchtech. “[This is] not just as a result of new and ongoing projects but also to fill the gaps left by an ageing workforce. EDF’s decision to extend the lifetime of Heysham, Hartlepool and Torness for another five to seven years will create numerous opportunities.”

There are plans to build a new nuclear plant on the existing site of Wylfa in north Wales. “This hasn’t had the publicity of Hinkley, but will be a major investment project for the UK engineering community,” said Hough. “A second is Nugen. This is a joint venture project based in Cumbria which is headed up by Toshiba and Engie, who are looking to build a new nuclear power station on Moorside.”

Meanwhile, Sellafield, a major employer in Cumbria that reprocesses spent nuclear fuel from plants across the UK, will be needed for the foreseeable future as the UK operates and decommissions more plants. “Keep an eye on the market. There are a lot of eyes on the industry at the moment and we expect that when these projects get

the green light they will need to recruit quickly and extensively,” said Hough.

Owen Davey, a graduate engineer at Mott MacDonald, said he’s gained a great deal from his career so far. “Nuclear engineering careers are exciting and can deliver a range of opportunities,” he said. “They allow individuals to work in challenging areas to the highest level of technical detail and gain valuable experience for a long-term career. Graduates see a career in nuclear engineering as exciting to pursue because it can provide opportunities to solve problems not typically encountered in non-nuclear engineering sectors.”

Davey’s advice is to be knowledgeable about the industry and what nuclear generation involves, including the general process of generating electricity, but also safety and code requirements, and licensing conditions. “More and more are turning to nuclear power, or looking to expand their existing fleet of nuclear power stations. This creates a position for nuclear engineers within the UK to travel abroad for work.”

Haslam said: “If you are interested in entering industry try and learn as much as you can about it. The industry is surprisingly open and there are lots of websites such as [www.world-nuclear.org](http://www.world-nuclear.org) that explain what is going on in the industry and nuclear concepts. Consider joining the Nuclear Institute, which runs a number of events where you can learn more about the industry.

“In no other industry are your engineering skills likely to be in such demand, or to face such a breadth of challenges and innovation.”

“More and more are turning to nuclear power. This creates a position for nuclear engineers to travel abroad for work”

Owen Davey

**01** Artist’s impression of EDF’s proposed Sizewell C power station

**02** Sizewell B, which joined the grid in 1995, is the last nuclear power station to be built in the UK

**03** A final decision on Hinkley Point C is expected in May 2016





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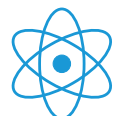
## Senior Seismic Process Specialist

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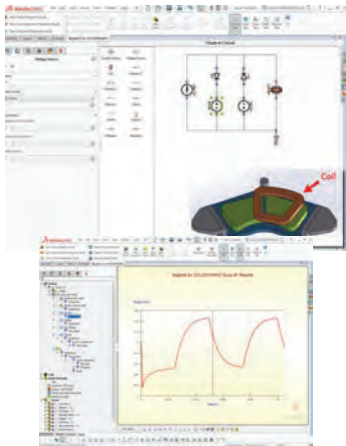


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from the archive | **paris exhibition**

# Century spotlight

**Despite suffering from a chaotic start, the 1900 Paris Exhibition was a landmark event for industry**

**T**he Paris Exhibition (Exposition Universelle) of 1900 was a landmark event for engineering and innovation. Held to celebrate the achievements of the 19th century and usher in those of the 20th, the event saw the public introduced to

iconic inventions such as the diesel engine, as well as cultural developments such as talking films. But while the show's legacy helped shape history, its beginnings were altogether more inauspicious.

When the show opened in April 1900 it was beset by problems, many of which had their origins in the run-up to the event. According to *The Engineer*, several of the temporary buildings due to be constructed for the fair were behind schedule, owing to a shortage of rolled iron. Exactly who was responsible for the shortfall was unclear, with blame being passed along the supply chain.

"Ironmasters were unable to supply what was needed because they could not get pig iron," wrote our predecessors. "The blast furnace proprietors threw the blame on the coke oven owners, and these shifted the burden of complaint on to the shoulders of the colliery companies."

Plus ça change.

Instead of the buildings being completed by the end of 1899, they were still receiving their final touches on the eve of the event. In fact, *The Engineer* reported that on the day before the formal opening it was doubtful it would be possible to admit the public.

"The grounds were a perfect chaos: the various halls were encumbered with enormous piles of bales and packages, and empty crates and boxes obstructed the entrances. Gigantic cranes were swinging around, timbers were being knocked down from scaffolding, and ropes and planks formed a trap for the unwary."

In an attempt to restore some kind of order to the madness, 1,500 soldiers were drafted in to help clear away empty cases, clean up the halls, and make the outside walks presentable. By the time the general

public was admitted on Sunday 15 April, the exterior of the exhibition buildings were reportedly in good shape, but there was little to be seen inside.

On arriving into the Vincennes annexe in east Paris via the main entrance, one was confronted with the US machinery hall. Despite the "vigorous efforts" being made by the US to build up a big trade of machine tools with France, only two or three firms had their stands in "anything like order" as the fair got underway. These included the Ingersoll-Sergeant Drill Company of New York, and the Shaw Electric Crane Company of Muskegon, Michigan. Elsewhere,

"Ironmasters were unable to supply what was needed because they could not get pig iron"

*The Engineer*

preparations appear to have gone more smoothly in the vast hall with railway rolling stock on display.

"Already German four-cylinder locomotives of 70 tons are to be seen in juxtaposition with Hungarian engines and passenger carriages," wrote *The Engineer*, "and a light locomotive, in which steam is raised by petroleum, constructed in Switzerland for the Ethiopian railways."

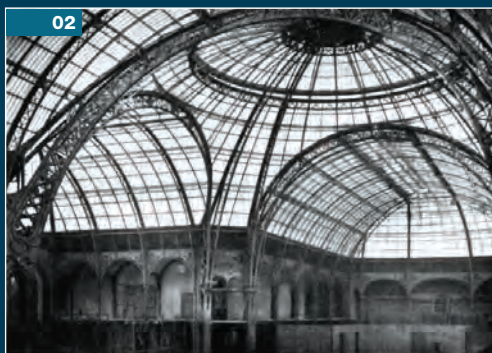
The Paris Exhibition was also the ideal platform to showcase the motor car, which had come to wide public attention with Karl Benz's Patent-Motorwagen in 1886. The technology's increasing popularity in the intervening period led car manufacturers to demand the vehicles be given special preference in the Champ de Mars exhibit just south of the Eiffel Tower, rather than in the relative obscurity of the Bois de Vincennes. At one point, the dispute with the organisers looked like boiling over, with manufacturers threatening to abstain from the exhibition, or even hold a show of their own.

"Up to the very last moment... the leading motor car builders neglected to send in applications for space," said *The Engineer*, "and it was only when the time for sending in entries was extended that they finally decided to take part in the Vincennes display."

Unsurprisingly given the circumstances, the automobile halls were among the least populated at the outset of the exposition. Accommodation for 400 cars had been set aside, but only 30 were reported as being ready for the opening, and not a single one had yet put in an appearance. It's a far cry from the recent Geneva Motor Show, which had its humble beginnings just a few years later in 1905. The 2016 edition saw over 200 exhibitors and countless individual models. An indication, if indeed one was needed, that the Paris Exhibition truly did herald the age of the automobile. **AW** ©



01



02

01 Main entrance to the exhibition

02 Dome of the Palais des Beaux-Arts

## Word of the issue

### Anthony Poulton-Smith explores the origins of the word 'weld'

With a weld being a union of metals, it would seem safe to assume the term could not have been used before the Industrial Revolution. Yet 'weld' had been used since at least the 14th century as the name of a plant used to produce yellow dye *Reseda luteola*, which also gave a name to the place names 'Weald' and 'Wold'.

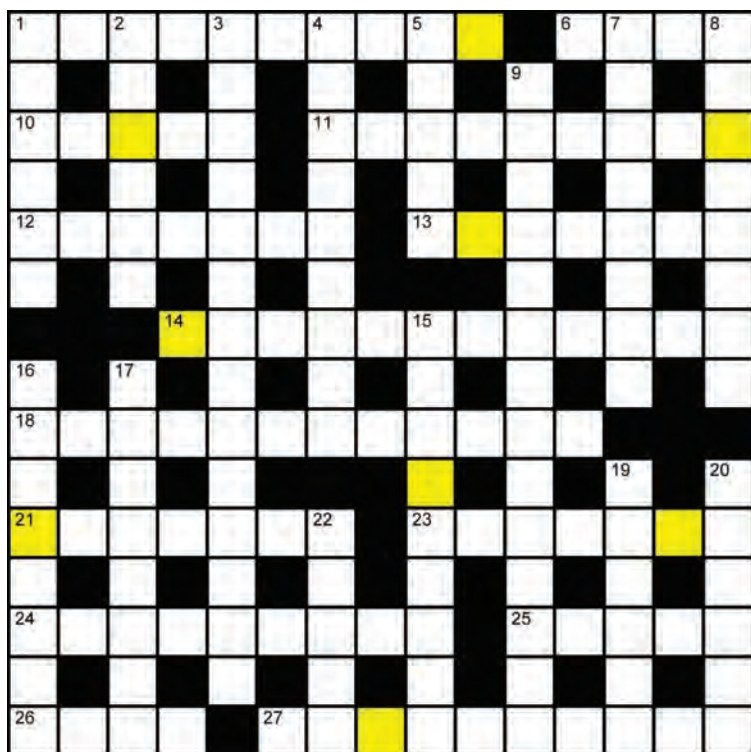
In an engineering sense 'weld' is first seen in a document dated 1590. This early term referred to 'any metal parts united or consolidated by hammering or compression, especially when softened through heating'. Here we can trace it back to 'well' as used with a meaning 'to boil, rise' and always followed by 'up'.

These early references would have been known for hundreds of years in Britain alone for this describes the process where multiple bars of metal were twisted and hammered to form a sword – the constant hammering and heating being a weld.

# Big picture



The latest addition to Boeing's 787 range of long-haul aircraft has started to take shape with Kawasaki Heavy Industries installing circular frames into the mid-forward section of the fuselage. The milestone was achieved on 14 March. To date, the 787 programme has had UK involvement from companies such as Messier-Bugatti-Dowty for the landing gear and steering systems; Eaton Aerospace for the fuel pump and valves-fuel system; and Rolls-Royce for the engines.



## Prize crossword

**When completed** rearrange the highlighted squares to spell out a coat of stucco applied to a masonry wall. The first correct answer will win a £20 Amazon voucher. Email your answer to [jon.excell@centaur.co.uk](mailto:jon.excell@centaur.co.uk)

### Across

- 1 Craftsman who uses timber (10)
- 6 Come to a halt (4)
- 10 Chemically inactive (5)
- 11 Chamber in which a furnace is fired (5,4)
- 12 Glass rooms affording exposure to the sun (7)
- 13 Openings through which fluid is admitted (7)
- 14 One involved in a display of group feeling (12)
- 18 Collection of wheeled vehicles owned by a railway (7,5)
- 21 Be shiny, as if wet (7)
- 23 Cause to separate abruptly (7)
- 24 Causes to burst with a violent release of energy (9)
- 25 Worker on a roof (5)
- 26 Arrange into classes (4)
- 27 Russian chemist who developed the periodic table (10)

### Down

- 1 An odd or fanciful idea (6)
- 2 To a degree exceeding normal limits (6)
- 3 Hindering the penetration of liquid (5-9)
- 4 Move fast (4,5)
- 5 Bacterium that can be a threat to food safety (1,4)
- 7 Sets of carpenter's implements (4,4)
- 8 Force applied to a unit area of surface (8)
- 9 Wealth available for investment (7,7)
- 15 Ridiculed with witty language (9)
- 16 Army units smaller than a division (8)
- 17 Courtyard with covered walks (8)
- 19 Wheel with a groove in which a rope can run (6)
- 20 King of England from 1413 to 1422 (5,1)
- 22 Bind again (5)

March's highlighted solution was mortar. Winner: **Joseph Lyons**



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