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THE MAGAZINE FOR ENGINEERING DESIGN

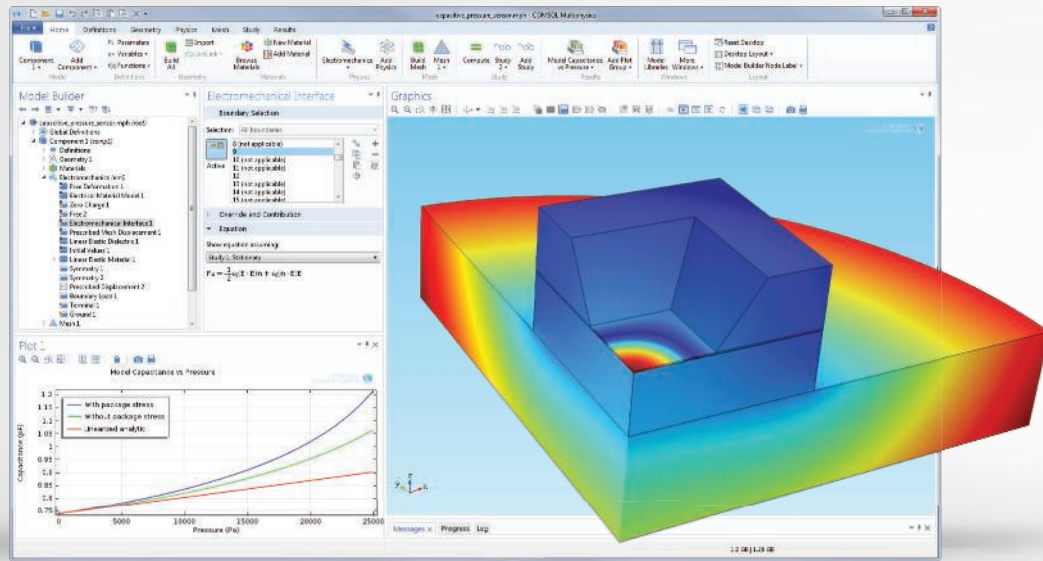
In this issue: Rapid Prototyping • Sensors, Test & Measurement • Oil & Gas Sector Report

## Designing Porton Man

Under the skin of the UK's new chemical warfare  
defence technology



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Cover photo: Charlie Milligan



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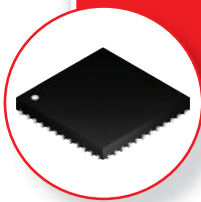
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# To BEEA or not to BEEA?



Paul Fanning, Editor (pfanning@findlay.co.uk)

It's that time of year when we at *Eureka* encourage our readers to put forward their people and products for the British Engineering Excellence Awards (see page 7 for full details of how to enter).

When one works to organise and judge awards, it is inevitable that one starts to see them as a project; a goal to be achieved.

The sheer logistical effort required to collate and process entries; the assembly of the judging panel; the judging day itself; the writing of scripts; the design and commission of the trophies; the briefing of presenters; the organisation of a venue; the design of brochures; menus; etc, etc, etc. All of these factors (and more) conspire to make an awards ceremony a daunting task from the organiser's point of view.

None of this is designed to elicit sympathy, merely to explain how it is sometimes possible for those of us close to something like the British Engineering Excellence Awards to forget how much the awards themselves mean to those who enter and win them.

That is not meant in any cynical sense. All of us involved with the BEEAs take them and the roles we play in facilitating them very seriously indeed. No, what I mean is that, in the hurly-burly of organisation, it is too easy for the real value they have to engineers and companies to be obscured.

Of course, all that changes on the day of the ceremony itself. Even as we continue to make sure everything goes to plan, it is impossible for us as organisers to ignore the raucous cheers from tables when their victory is announced, the beaming smiles of those who collect awards and the sense of pride emanating from everyone who has entered and reached the shortlist.

So every year, as we start the process and (perhaps) grumble about the amount of work involved, it is those uplifting memories of top-quality companies and engineers getting the recognition and limelight they deserve that inspire us.

But of course, the first step towards those moments and memories is to enter the awards. I therefore sincerely implore anyone reading this now who believes they or their colleagues deserve such recognition to enter the 2014 BEEAs.

I look forward to reading about your achievements.

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An exact adherence to the specified rotational speed profile is of essential importance for many fields of application of hydraulic motors. Here is a new generation of motors, for which a significantly improved constancy of rotational speed is achieved compared to conventional motors. [www.jbj.co.uk/hydraulicmotors.html](http://www.jbj.co.uk/hydraulicmotors.html)

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## 2014 British Engineering Excellence Awards **ENTER NOW**

**There is only just over a month left to enter the 2014 British Engineering Excellence Awards.**

The sixth British Engineering Excellence Awards (BEEAs) will be held on 9th October 2014 at 8 Northumberland, London, but the entry deadline is 30th June.

The Awards are open to all companies with an engineering design function and aim to demonstrate and promote the quality of engineering design within the UK.

"Over six years, we have grown the BEEAs from a new venture to what it is now – an established and eagerly anticipated fixture in the engineering design calendar," says Ed Tranter, Executive Director of organiser Findlay Media. "But I'm delighted to say that the awards' purpose this year and every year will be the same as when they started: to recognise, reward and celebrate the incredible innovation that takes place within British engineering."

The judging standards are rigorous and the winners will be justifiably proud with their achievement. The winners will be businesses that have recognised that creativity and design innovation are the critical elements of continually improving and reinvigorating themselves to stay ahead of the competition.

This is an opportunity for your company to raise its profile among the

UK's design engineering community and set yourselves apart from your competitors.

**There are three steps to victory:**

1. Visit [www.beeas.co.uk](http://www.beeas.co.uk)
2. Select your category
3. Complete the online entry form

**Categories for the Awards run the gamut of engineering design and include:**

- Consultancy of the Year
- Design Engineer of the Year
- Design Team of the Year
- Green Product of the Year
- New Product of the Year (Electronic)
- New Product of the Year (Mechanical)
- Materials Application of the Year
- Small Company of the Year
- Start Up of the Year
- Young Design Engineer of the Year

In addition, there will be awarded the British Engineering Excellence Grand Prix (which is selected from among the winning entries) and the discretionary Judges' Special Award. In order to ensure that companies of all sizes can compete fairly, the Judges will take into consideration such factors as team size, project budget, project design cycle time, the regulatory environment, the competitive nature of the target market, the materials and technology selected by the design team and the attention to environmental issues.

### Judging panel

The entries will be judged by an expert panel chaired by Andrew Burrows, Chief Technology Officer of i2o and former winner of the Design Engineer of the Year Award.

**Other judges will include:**

Philippa Oldham, Head of Transport and Manufacturing, Institution of Mechanical Engineers; Sebastien Cuvelier Musselian, senior engineering consultant, Team Consulting; Phil Mayo, Managing Director, Premier EDA Solutions and Ashley Evans, chief executive officer, Electronics Technology Network.

If you believe you have what it takes to win in any of these categories – or know of a product, company or individual that does – entry forms, detailed entry criteria and additional information on the Awards categories can be found at [www.beeas.co.uk](http://www.beeas.co.uk)

**Last year's winner  
Sebastien Cuvelier  
Musselian will act as  
a judge at this year's  
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## Clever control for prosthetic limbs

Prosthetic specialist Endolite has developed a foot and ankle system to improve the walking ability of amputees. Its latest iteration of the élan foot features two brushed DC motors from maxon motor that work in conjunction with gearheads,

encoders and two microprocessors to automatically alter the resistance around the artificial ankle joint. The aim is to replicate and mimic the human ankle as closely as possible to allow amputees to walk more easily, especially on inclines.

The microprocessors work in tandem with the hydraulic ankle, which sits on top of the carbon fibre foot springs. The ankle control ensures silent operation and sinuous movement that biomimetically matches the user's body and walking

style. It can be difficult for amputees, particularly lower limb amputees, to be able to walk uninhibited and with comfort as prosthetic limbs can't adapt to real-time changes such as slopes and obstacles.

Endolite is the products division of Blatchford, which has been involved in the design, manufacture and innovation of lower limb prosthetic solutions for over a century and whose prosthetics won it the inaugural Mechanical Design of the Year award at the 2009 British Engineering Excellence Awards.

Dr. David Moser, head of research at Endolite, said: "The maxon motors have operated flawlessly from the start, with great technical support from the maxon team during the design and development release phase."

The two RE10 brushed DC motors noiselessly operate the precision hydraulic valves and use precious metal brushes to give the advantage of low stiction at low speed, and low current draw. A maxon motor MENC encoder (Magneto-Hall-Effect) is used as it requires little space and is also low power, which is very important in a battery powered application.

[www.endolite.co.uk](http://www.endolite.co.uk)

[www.maxonmotor.co.uk](http://www.maxonmotor.co.uk)



## Engineering Design Show makes the 2014 PPA awards shortlist

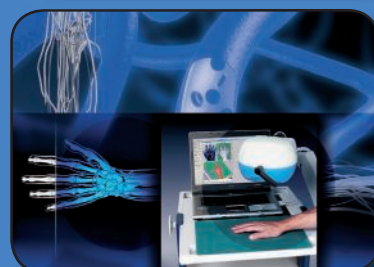
The Engineering Design Show has reached the shortlist of the PPA Awards 2014 in the Event of the Year (Business Media) category.

The show, which last year was named the PPA Independent Publisher Awards Event of the Year, was started by Findlay Media in 2012 and has gone on to thrive and grow, with 2014's event expected to attract 4,000 design engineering professionals to the Ricoh Arena, Coventry on 22nd-23rd October.

The winners of The PPA Awards 2014 will be announced on 10th July at a ceremony at The Grosvenor House Hotel in London's Mayfair.

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## Wind turbine mimics the beating of a bird's wings

The latest innovation to come out of Festo's Bionic Learning Network is a wind turbine that mimics the natural beating of a bird's wings.

Unlike birds, which flap their wings to propel them forward, the DualWingGenerator system is comprised of a vertical column supporting a bottom and top pair of carbon 'wings' that move in opposing directions.

The wings are fitted to separate sliders and then driven up and down as the air flows across them. The bottom wings move upwards when the top ones move downwards, and vice versa. This motion is then converted into

rotary movement inside the column using two timing belts and two free wheels.

The rotary force is then transferred to an electricity generator, which converts the kinetic energy into electricity.

The self-optimising system relies on advanced control technology to adapt to different wind conditions, adjusting itself at right angles to the wind direction.

In order to produce as much energy as possible, the device has to co-ordinate six key parameters to the respective wind speed: The flapping frequency of the wings; the amplitude of the wing beat;



the angle of incidence in the wing roots; the time for triggering the rotation; the setting speed of the wing rotation; and the stiffness of the preloaded springs.

Festo believes the system could be installed on buildings in the same way solar cells are fitted to generate clean energy.

[www.festo.com](http://www.festo.com)

## Three UK companies in line for MacRobert Award

Three UK companies are in the running for this year's Royal Academy of Engineering MacRobert Award.

OptaSense, the firm responsible for creating the 'Earth's Nervous System'; Cobalt Light Systems, an SME using cutting edge materials science to fight terrorism; and Rolls-Royce, the engineering giant behind the world's first vertical take-off system for a supersonic fighter jet, are all competing for the £50,000 cash prize.

The winner will be announced on 2 July at the Academy's Awards Dinner at

the Royal Opera House in London.

QinetiQ-owned OptaSense has created an innovative technology that can turn any existing fibre optic cable into a real-time microphone. The system is already being used to help soldiers deployed in hostile environments and improve the safety of hydraulic fracturing (fracking).

Oxfordshire-based Cobalt Light Systems, meanwhile, has pioneered a means of identifying the chemical composition of solids or liquids sealed within any non-metallic container

without opening it. As well as improving and simplifying airport security, the technology could be used for non-invasive cancer screening and detecting counterfeit goods.

The last finalist is Rolls-Royce, which has developed the world's first short take-off and vertical landing (STOVL) system capable of powering a supersonic aircraft, the Joint Strike Fighter. The aircraft represents the largest defence programme of all time.

John Robinson, chair of the MacRobert Award judging panel, said:

"Each of this year's finalists has demonstrated excellent innovation and technical expertise but, perhaps more importantly, the significance of how this is being applied for the benefit of society is exceptional.

"These three UK organisations, each of a different size and stage of business development, truly represent the breadth of the UK's engineering capability and its global importance. They are first-rate examples of the economic importance of the nation's engineering sector."

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## IE4 geared motor launched

Bauer Gear Motor has launched the world's first modular, stainless steel, IE4 super premium efficiency geared motor at Hannover Messe 2014. Building on the tried and tested Bauer permanent magnetic synchronous motor (PMSM) and aseptic drive technologies, the new stainless steel model combines the benefits of both and is ideal for use in hygiene critical applications where high footfall and frequent washdowns could damage specialist coatings.

Due to the special hygiene demands of industries such as pharmaceuticals and food & beverage, specialist components typically have to be specified which can withstand the regular cleaning regimes and guarantee clean operation without risk of contamination. However, because the return on R&D investment is slower for specialist components, the latest energy efficiency developments often filter through at a slower rate when compared to standard motor products. As such there are very few IE4 super premium efficiency geared motors suitable for these applications.

PM synchronous motors offer considerably improved efficiency when compared to induction motors, even under partial load conditions. In real life application examples they have been shown to offer energy savings of over 40% when compared to a standard, asynchronous motor. Bauer is at the forefront of this technology and is committed to developing solutions for specialist industries where energy efficiency is a high priority.



Like its industry leading, IE4 Asepticdrive, the stainless steel modular geared motor from Bauer is designed with surfaces which slope by at least 3° to prevent the formation of dirt deposits and allow the run-off of cleaning agents and water. The stainless steel construction eliminates the risk of the hygiene rating becoming compromised in the event of an impact or over prolonged periods of use in heavy washdown environments, making it the perfect addition to Bauer's range of super premium efficiency motors for the pharmaceutical and food & beverage industries.

[www.bauergears.com](http://www.bauergears.com)

## Permanent magnet motor surpasses IE4



WEG has again raised the bar for energy efficiency with its new permanent-magnet motor in the W22 series. Already a pioneer in this area with the W22 Super Premium IE4 three-phase induction motors in late 2012, WEG is further consolidating its leadership with even more efficient permanent-magnet synchronous motors.

With losses roughly 20% lower than Super Premium models, it is among the first Ultra Premium motor on the market that fulfils the present criteria for the potential IE5 energy efficiency class. This makes the W22 one of the most efficient electric motors currently available.

Using innovative design, the W22 permanent-magnet motor combines unique high efficiency with compact size. Along with raising efficiency, WEG optimised motor performance to achieve lower noise and vibration emissions as well as especially low maintenance.

The new permanent-magnet motors in the W22 series are AC synchronous motors driven by CFW11 frequency inverters. The CFW11 frequency inverters have specific software for open-loop speed control of permanent-magnet motors. The software is based on a special drive strategy designed to maximise the torque per ampere. This approach makes the combination of a W22 permanent-magnet motor and a CFW11 frequency inverter a very efficient drive system that is able to deliver constant torque over the entire operating range.

With motors in efficiency classes IE2 to IE5, soft starters, servo technology and frequency inverters, WEG now offers the broadest portfolio of drive solutions to help manufacturers raise the efficiency of their systems, improve their processes and lower their operating costs.

Says Marek Lukaszczyk, European marketing manager at WEG. "We're delighted to far exceed the regulations with our new permanent-magnet motor and it's another example of how we're pushing boundaries and going one step further to help engineers maximise the energy efficiency of their processes."

[www.weg.net/uk](http://www.weg.net/uk)

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### Briefs

#### INTELLIGENT DRIVES FOR PUMPS AND CONVEYORS

Developed for strict hygiene requirements and featuring IP66/IP69K ingress protection, smooth-surface motors from Nord DriveSystems with an integrated frequency inverter are available for the 0.37 to 1.1 kW performance range. Common applications include conveyors, pumps, mixers, and agitators. Sensor data such as pressure or flow rate values can be directly communicated to the drives, enabling them to automatically adapt to current demand. If partial load operation is frequent, an automatic energy-saving function decreases the running costs by a significant share. In conveyor applications, light barriers can be used for contact-free or gapless accumulation.

[www.nord.com](http://www.nord.com)

#### NEW LEVEL FOR CHANNEL FLUID MEASUREMENT

Liquid volumes and flow rates can be continuously monitored using sensitive yet rugged new sensors which have recently been added to the range of piping systems specialist, George Fischer. The new Type 2270 Ultrasonic Blind Sensor and Type 2260 Ultrasonic Display Sensor have been designed to offer both ease of installation and use, as well as a long low maintenance life, and will find applications in the water, sewage treatment, chemical, manufacturing and processing industries.

They are also suitable for measuring flows in culverts and spillways where flood monitoring is a priority. The sensors can be used in such roles as for calculating the dosage of chemicals required to control the pH value of a flow, for the accurate filling of storage tanks and in specialist treatments.

[www.georgefischer.co.uk](http://www.georgefischer.co.uk)

## Laser profile sensor smaller than ever

A range of extremely compact, lightweight 2D/3D laser profile sensors (laser line scanners) is now available from precision sensor manufacturer Micro-Epsilon. The controller and electronics are integrated directly in the sensor, making the devices suitable for high precision profile and dimensional measurements in a variety of applications including automation, systems integration, machine building, robotics and automotive production.

The new scanCONTROL 2600 / 2900 COMPACT series of 2D/3D laser profile sensors from Micro-Epsilon offers a range of technical advantages, flexible installation options and versatile interfaces. As Chris Jones, managing director at Micro-Epsilon UK comments: "With their compact design and integral controller, the scanCONTROL 2600 / 2900 series sensors are ideal for a wide range of machine design and automation systems, particularly where space is restricted or where low sensor weight is critical. Unlike many laser profile sensors on the market that require an external controller, the scanCONTROL 2600



/ 2900 COMPACT series offers users the most compact design possible.

[www.micro-epsilon.co.uk](http://www.micro-epsilon.co.uk)

## Solution to last month's Coffee Time Challenge

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The solution to last month's Coffee Time Challenge, to re-design dynamo powered bike lights, comes from Kickstarter start-up company, Magnic Light iC.

The key to its bike lights are in its exploitation of the physical phenomenon of eddy currents. It's able to generate electricity by using magnets in the dynamo that generate eddy currents as the metallic rim spins.

An internal conductor in the dynamo induces an electrical current as the wheel rotates and changes its magnetic field. And since it is non-contacting, this method of power generation is friction-less and causes no noticeable additional resistance to the wheel. The energy produced is sufficient to power LEDs, is silent and also lightweight.

Though the output wavers with the spinning speed of the wheel, this has been addressed by an onboard microprocessor that is able to adapt with wheel speed and maintain peak efficiency. A built-in capacitor also allows the lights to stay illuminated when the bike comes to a standstill.

Though the voltage and current generated is relatively small, the Magnic Light iC is optimised for the LEDs used, allowing for more light to be generated per unit of power and about 160 lumens per watt.

The Magnic iC is soon to be fully commercialised and widely available, but if you can't wait, the lights are available from its website. [www.magniclight.com](http://www.magniclight.com)



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# Chemical agent

**The latest defence for the military against chemical and biological attack comes in the shape of an animatronic mannequin for testing protective equipment. Paul Fanning visited Dstl Porton Down to meet the latest incarnation of 'Porton Man'.**

**W**ith this year seeing the 100th anniversary of the outbreak of the First World War, it is sobering to remember that it was this conflict that saw the first ever use of chemical weapons. A century on, weaponised chemical agents still represent a threat to military and civilian personnel alike.

Devoted to the protection of the UK's population and armed forces from chemical, biological and nuclear threats, Porton Down in Wiltshire was founded in 1916 to respond to the threat of chemical warfare – a job it still does today under the aegis of Dstl (the Defence Science and Technology Laboratory), an executive agency of the MoD.

It would, therefore, seem counter-intuitive to find a BAFTA-winning company that cut its teeth in creating effects for film and TV in such an environment, but that is what i-Bodi (AKA Crawley Creatures) is.

The reason is the latest version of Porton Man, an animatronic mannequin designed to test and evaluate the chemical, biological, radiological and nuclear (CBRN) suits and other protective equipment used by infantry soldiers. Using state-of-the-art technology, Porton Man can walk, sit, march, run, kneel and even lift its arms as if to sight a weapon.

This latest mannequin replaces an original first introduced in the late 1990s. Colin Willis, group principal for chemical biological radiological defence at Dstl Porton Down explains the reasons behind this. "Terms like nerve gas and mustard gas are all misnomers as these are not gases at all," he says. "These are in fact colourless, oily liquids with boiling points higher than that of water. Skin contact with either the liquid or the vapour from that liquid can cause serious injury or death."

Clearly it's important to be able to develop protective equipment to block these agents. There is a pretty simple quantitative penetrative test on clothing that involves putting the fabric into a simple cell whereby the agent is put in one side and the degree to which it penetrates can be measured over a period of time.

However, says Willis: "That doesn't tell us how that material will perform when turned into a suit. For instance, it tells us nothing about the effect of movement, incident wind, seams and seals. In the 1990s, we embarked on a programme to test the whole suit as an ensemble. Out of that came our early Porton Man."

When it was introduced it was the first system of its kind in the world for demonstrating and testing CBRN fabrics. The data Dstl was able to

collect from Porton Man was invaluable and was used to develop the existing Mark 4A CBRN suit that is currently in use. However, having seen a range of upgrades and adaptations over the years (even at one point being dressed as a female), it started to become clear that the original Porton Man was, as Dr Jaime Cummins of Dstl's Chemical and Biological Physical Protection group puts it "an ageing capability".

With this in mind, Dstl put the proposal to develop a new mannequin out to tender. The winner was i-Bodi, whose historical and award-winning expertise in animatronics for TV and film has proved ideally suited to this type of application in the industrial and military sectors.

Even so, however, the challenge was not insignificant, which meant that the i-Bodi team had to approach it systematically. Says the company's director Jez Gibson-Harris: "The thing we did first was to get an idea of how the old system worked. So we were taken to the chamber where all the testing was done. It had a small, airlocked doorway and we had to jiggle it through. There was a cable that had to feed into the chamber. Two people had to handle this figure, it weighed 80kg and it had to be winched into position to dock it. Spanners then had to be used to get it together. Jaime and Colin were in full protective gear, including gloves and respirators. So to say the least, it was quite challenging to set the test up. And simplifying that was really our first challenge."

## Composite body

Weight reduction has been achieved by the use of light, but highly-durable carbon composite to create the mannequin's body. This, Gibson-Harris concedes, was an idea taken directly from Formula One technology. "We're based in Buckingham – right in the Formula One corridor, so we were able to find out about this material and find a company to machine the carbon composite body parts for us pretty easily," he says. This process got the body weight of the mannequin down to just 14kg.

In terms of the other problems, the mannequin is mounted on a wirelessly-controlled turntable, making it much easier to operate. In addition, it operates on a simple, no-tools locking and unlocking process and is easy to move in and out without any need for additional equipment other than its specially-designed trolley. i-Bodi also developed a system of drop-down feet for the turntable that allow it to be used on uneven surfaces.

i-Bodi's chief design engineer Mike Franklin says of the project: "The main issue was that it had to be useable – what [Dstl] wanted more than anything was a tool. The last thing you want is to have a tool that's harder to use than the old version. So getting rid of hand tools was vital.

"They used to have to wheel the frame in and then winch the mannequin into place and then link it up using socket sets and spanners. And all this had to be done in 30 minutes or so in CBRN suits in a potentially toxic environment."

According to Franklin, the original brief from Dstl was very

"THE MAIN ISSUE WAS THAT IT HAD TO BE USEABLE – WHAT DSTL WANTED MORE THAN ANYTHING WAS A TOOL"

MIKE FRANKLIN, I-BODI



comprehensive and the organisation had spent a great deal of time ensuring it took everything important into account. "They split it into 'must-haves' and 'nice-to-haves'," he says. "We could comply with virtually all their requirements."

The design was based around anthropometric data gathered from the 50th percentile of 2,500 servicemen from all branches of the service. From this, i-Bodi was able to create a CAD figure and the CAD work was sent off to be five-axis machined. Says Franklin: "From the frame and drive point of view, the important thing is the limb lengths. At the same time, the body can be sculpted from a mechanical design point of view. From there, we can start putting the joints in."

The movement of the mannequin is based on twinned pairs of drives and servomotors, which are used to create a complex range of motions. Franklin says: "The drive design was linked to the limb lengths. As soon as we got the anthropometric data, we were able to get things like the distance from his elbow to the centre of his hand and from his elbow to his shoulder, shoulder width, hip width – all the main points. From there, you can develop the drive mechanism to make sure you've got all the extremes of movement to be certain nothing crashes or breaks."

"It's a pretty adaptable design," he continues, "because you've got control of two axes on each limb, you can pretty much put that end point wherever you like. At the end of the day, it's a two-axis robot arm. The only difference is that it's been designed to be all sealed and chemical proof. If we could have gone out and bought the right kind of robot arm in the right materials off the shelf, we'd have done so."

One of the biggest problems for Franklin was finding equipment 'off the shelf' that he could use, as the alternative was to design it's own. Given that the alternative was to develop expensive bespoke solutions, however, it was on occasion necessary to find 'workarounds'.



Franklin gives an example: "One of the gearboxes is a right-angled drive, hollow-shaft gearbox, which is used to pass through the second axis from the first axis. The alternative was to design a whole unit from scratch, but it was too much for a one-off unit – maybe if we'd been making ten or 20, but not for a one-off."

The need to cope with a variety of agents also restricted i-Bodi in terms of the materials it could work with. "There were a lot of restrictions on what materials we could use," says Franklin, "because a lot of common materials either absorb or are destroyed by the agents. So, for instance, there were

a lot of O-Ring materials that weren't useable. However, these guys [Dstl] have a huge amount of data that they were able to share with us."

In addition to its greater ranges of movement and useability, Porton Man is also able to provide real-time data when undergoing test – something its predecessor was unable to do. Says Dr Cummins: "Using the original Porton Man, we could only get the performance data at the end of the trial. We don't actually know what's happening while the suit is under test. With the new mannequin, we can insert an active sensor into any of the 270 cavities and pick up data in real time during the test. Coupled with the increased range of movements, this means we can really start to understand the effects of different movement profiles on the efficacy of the equipment."

Looking ahead, the capacity to update and adapt the new Porton Man is something i-Bodi was careful to factor into its design. For instance, there is already talk of creating a female mannequin ("Women have different air gaps," as Dr Willis delicately puts it), while the ability to sell the concept to friendly nations with different anthropometric requirements is obviously a factor.

Franklin is in no doubt of the possibilities, saying: "If they want to update it to a heated, sweating model, we can do that. Equally, the actuators can accommodate slightly different sizes of mannequin, which means a female mannequin could be developed quite easily."

The final word, however, belongs to those who will have to wear the equipment developed in response to the data collected from Porton Man. Major Ralph Livingstone, who was military advisor to the project, says: "From the military perspective, it's the end result that counts and this gives us that. A few small, but significant changes can result in a suit that gives much more protection to the end user. It allows these scientists to get the job done as well as it can be. We're looking at the next generation of suit and that's why we need this now – to give us the knowledge to build it."

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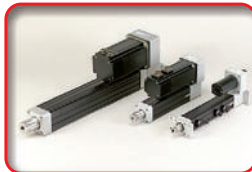
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**W**hen the figuratively high-octane drinks company Red Bull joined the literally high-octane world of Formula One 10 years ago, there was mixed opinion about its

chances of success. It bought the Jaguar Racing Team in 2004 from Ford, which after five seasons of poor results was pulling out of the sport. Many thought that if the pedigree and automotive might of Jaguar and Ford could not produce a competitive car, the chances for an Austrian energy drinks company, with no experience in motorsport turning the team around was nothing short of laughable.

However, as any fan will know, the Infiniti Red Bull Racing team has had the last laugh after dominating Formula One for the last four seasons, winning both the Constructors' and Drivers' Championships back to back.

For any successful Formula One team – like any successful operation – the secret lies in its people. In particular, though, it lies in their ability to exploit the technology and tools of the day to give a discernible advantage over competitors.

And in Formula One it is not just drivers that rise through the ranks. The mechanics, engineers and designers in the sport are also considered world-class. So what is the mindset of a Formula One world championship winning employee?

#### **"WIN RACES"**

"Our mission statement at Red Bull is simple; win races," says Al Peasland, technical partnership manager at Infiniti Red Bull Racing. "This focuses our team. When I or any one of our team goes to work we ask ourselves, 'are we doing something today that is going to contribute to us winning races?'"

Managing the technologies and tools used by the team is the responsibility of Peasland. It's no straightforward task as there are often many similar technologies on the market. However, part of Peasland's role is to look at which technologies can be exploited most effectively since, in the world of Formula One, the margins of success can be very fine indeed.

Peasland liaises with department heads at the Infiniti Red Bull factory in Milton Keynes to make sure that the company's current technical partners are delivering what the team needs to help win races, look for the potential for any partners to offer more, and listen to requirements of engineers so he can scout for new technologies.

  
INFINITI

# Backbone of a Bull

We talk to the man responsible for making sure the Formula One team Infiniti Red Bull Racing is able to give its engineers the best technology available. So, what is it like to work for a company that gives you wings? Justin Cunningham finds out.

"You only get a quick car on track if the rest of the business, and your business systems, are high performance, reliable and robust," he says. "The focus we put on the car and improving its performance and reliability is the same focus we put on the rest of the business."

At the moment, Infiniti Red Bull Racing has about 16 technical partners that range from the largest and most long standing in Siemens PLM, to partnerships with simulation software companies, metrology equipment specialists and even providers of gym equipment and car polish.

"We can't win races without leveraging world class technology," he says, "that is why we go out and choose the partners we do."

The key attribute and skill that has stood Peasland apart has been his expertise and knowledge of the Siemens PLM systems, including its NX design suite. This saw him carry out work on gearboxes for the Porsche Cayenne as well as become a trainer of the software to engineers.

## TEACHING ROLE

"Now, I'm no gearbox designer," he says, "but I could use the CAD tool really well, so Porsche recruited me to teach their engineers. And that led to me getting a job with Siemens as a CAD trainer as it wanted someone who could relate to engineers when delivering training. We could tailor the training courses to make them more efficient, so for F1 teams they obviously like that."

This stint as CAD consultant and trainer saw Peasland make the transition from design engineer to PLM administrator and manager, which has ultimately enabled him to take on the challenging world of Formula One as he joined Infiniti Red Bull Racing as its head of CAD/PLM.

"After seven years in engineering, I decided that

I hadn't tasted enough Champagne," he says, "so I thought a move to marketing might help to change that!"

His role as technical partnership manager now involves making sure that the team has the right strategic partnerships in place to help develop the car more quickly, and more effectively than its rivals.

## AVOIDING SCRAP

"The challenge for us in Formula One is to design and manufacture as many new parts as we can in the shortest time possible," he says. "We do not want to manufacture scrap, we need to make parts quickly and accurately, as the designer has specified. And we need to know they work so simulation software is vital to us."

"There is a direct correlation between the number of points scored and the number of design changes made to the car. The challenge is that the requirement goes up every year. Year on year, we push more design change through the business than previous years. And that is with the same amount of people, the same budget and the same amount of hours in the day. So we have to get more efficient and push our tools, and our partners, to help us do that. It is not just about performance, it is about efficiency, reliability and quality."

Communication through its business is vital and allowing collaboration throughout every aspect of the team is something that Peasland is proud to have helped to put in place, as the backbone of the Red Bull team relies on Siemens' Teamcenter PLM software, which links every aspect of the business from design to manufacture to logistics to parts management.

[www.infiniti-redbullracing.com](http://www.infiniti-redbullracing.com)

[www.plm.automation.siemens.com](http://www.plm.automation.siemens.com)

## CV

Al Peasland has been with Infiniti Red Bull Racing for seven years, initially joining the team as their Head of CAD/PLM. A Chartered Engineer, Al has an extensive engineering background, having started out as an Aerospace Design Engineer, then moving into Automotive Transmission Design. He has over 20 years' experience with 3D CAD and CAM tools and their respective data management systems. A short stint as a CAD consultant and trainer saw him make the transition from a design engineer into a PLM administrator and manager, which has ultimately enabled him to take on the challenging world of Formula One technical management.

*"The focus we put on the car, and improving its performance and reliability, is the same focus we put on the rest of the business"*

Al Peasland

Infiniti Red Bull Racing

# When you're 400 km from the nearest coast, safety comes first

Visiting an oilrig for the first time can be a daunting experience. After landing by helicopter, you see nothing but endless ocean in all directions. You're deafened by the sound of heavy machinery pounding through your daily routines. Strong winds threaten to pull you over the edge, and the smell of diesel is everywhere.

Helmets, earplugs, eye protection and steel-toed boots are all standard attire. Drilling operations, by their very nature, expose crews to the risk of serious injury. With so many mechanical and hydraulic processes in operation, falling objects and malfunctions are hazards for even the most experienced staff members.

When working in such demanding conditions,

safety is absolutely paramount. Cranes are swinging heavy objects across the deck; drills, pumps and shakers are in constant operation; and everything needs to be 100% reliable. At the same time, operations must be continuous. The pace needs to be high and every minute of downtime is costly.

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# Deeper and down

**How is technology helping the oil and gas industries adapt to the increasingly strenuous demands of deeper drilling? Paul Fanning finds out.**

The oil and gas industries have always made certain demands of the products used within them, the most pressing of which is the ability to deal with harsh, high-pressure, flammable, toxic and sometimes explosive environments.

However, these demands have become even more pressing in recent years as the need to seek oil and gas in ever more difficult and challenging conditions has grown. This demand for oil and gas exploration to go ever deeper and ever further afield has come about because supplies are shrinking and prices are rising, making the costs incurred in such exploration worthwhile for drilling companies.

More than 85% of global energy consumption is based on fossil fuel sources i.e. oil, gas and coal. It is also estimated that energy demand will be about 30% higher in 2040. However, to acquire these valuable resources, it is necessary to drill deeper and deeper. This makes it possible to recover oil and gas from depths of more than 2,500m.

For instance, by combining downhole drilling with directional drilling (dynamic position alignment of a bore in the earth), formerly inaccessible oil reserves can be retrieved. Drilling depths of approximately 5,000m and drill lengths of up to 11,000m can currently be reached by this method.

This has meant that products increasingly have to be able to withstand ever greater pressures. This applies from top to bottom. For instance, ABB has expanded its 266 range of pressure transmitters with 1000 bar gauge (266HSH) and 600 bar differential (266DSH) versions. These high-pressure transmitters



**Trelleborg offers a range of offshore products, including thermal insulation material Vikotherm R2, which offers increased thermal conductivity and heat capacity, a unique hose system and berthing, docking and mooring solutions that ensure safety in LNG operations, and SealWelding technology that can slash downtime.**

are suitable for applications such as high pressure injection and other similar applications around the wellhead, such as high pressure gas compression systems.

The type of holes now being drilled also require special equipment to verify the integrity of the well and the diameter of the bore, as well as the location of the oil and the rock properties.

## Temperature and pressure

In particular, the temperatures and pressures at these depths, combined with the strong vibrations that occur during the drilling procedure, present unique challenges to the use of electronic drives. The conditions several kilometres below the surface of the earth are anything but technology-friendly.

The EC-4pole 32 HD brushless motor was developed by maxon when a customer required a higher-powered motor than the award-winning EC 22 HD. The new motor offers the same features and performance as the EC 22 but with greater strength. Its larger diameter makes the motor suitable for accommodating a four-pole rotor, allowing for much higher torques.

This new high-performance motor is available in two versions for operation in air (power rating of 220W) or oil (power rating of 480W). They are both designed for ambient temperatures of more than 200°C and atmospheric pressures of up to 1700 bar. The 32mm motors are also able to withstand vibrations of up to 25 G<sub>RMS</sub> as well as impacts of up to 100 G, for example Apollo 16 on re-entry reached only 7G. The motors are highly efficient (up to 89% in air, more than 80% in oil) and, with their detent-free running

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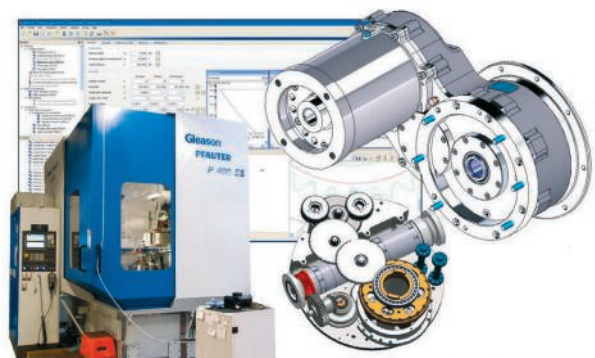
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properties, have excellent control characteristics and are suitable for high-precision positioning tasks even at low speeds.

For the use of the motor in conjunction with a gearhead, maxon motors offers the GP 32 HD, a powerful and robust planetary gearhead that is available in ratios of up to 913:1.

The EC-4pole 32 HD and the GP 32 HD are ideal for use in environments with extreme temperatures and/or subject to high vibration. It is ideal for ultra-high vacuum applications as there is no glue or plastics involved. As well as downhole tool technology, these motors can also be used in aerospace applications such as gas turbine starters, generators of jet engines, for regulating combustion engines or for exploration robots.

As the oil and gas industry exploits more unconventional sources and deploys more complex techniques, from hydraulic fracturing to floating LNG (liquid natural gas), the challenge of gaining high-quality, real-time intelligence to inform and accelerate decision making at every stage of the extraction process increases, driving the search for new tools and techniques deeper into the science lab.

### Growing gap

Several recent reports have highlighted the growing gap between capital investment into oil and gas production and actual recovery rates. For producers around the world this disparity clearly cannot be sustained. The oil and gas industry urgently needs new tools that can provide high-quality real time intelligence to inform and accelerate decision making at every stage of the extraction process to improve exploration and maximise production.

This is where Distributed Acoustic Sensing (DAS) comes in. DAS uses a fibre optic cable to detect acoustic vibrations so that engineers can 'visualise' and record what is going on down hole at every point of the well in real-time. This

gives well engineers greater clarity than ever before and allows them to focus time and effort on value-adding activity and, ultimately, increasing recovery.

One of the techniques that stands to benefit most from DAS technology is hydraulic fracturing – an method of extraction that still suffers from significant limitations in terms of monitoring and analysis of the drilling operation. DAS produce a tool to provide a new dimension of knowledge during the fracturing process. A cost-effective solution that allows the fracturing engineer to have vital information regarding the efficiency of the process – reducing uncertainty and allowing an optimised fracturing job to be delivered.

Helios DAS from Fotech converts an optical fibre, up to 40km long, into tens of thousands of individual and real-time vibration sensors. Real-time detection of the vibrations caused by acoustic disturbance at each point along the fibre enables engineers to 'visualise' and record what's going on down hole, in real-time, with greater clarity than ever before. As such, Helios DAS provides data and interpretative tools that have not been possible until now to improve the efficiency of oil and gas exploration, production and delivery.

An even more extreme example of the type of technology required to go deeper and further afield is in the use of Remote Operating Vehicles (ROVs) in the oil and gas industry. ROVs are essential for the exploitation and development of

deep-water oil and gas reserves, far beyond the reach of divers and the ability to control them successfully is vital.

Planning when to use an ROV is tough as a number of reasons can affect the timing. Weather, distance and availability all have to be factored in. When users get the opportunity to use an ROV they cannot afford faults or delays, so the system has to be extremely reliable and tough.

It was for this reason that Saab Seaeye approached Amplicon with the requirement for a stable and repeatable control system for its new Cougar-XTi range of underwater ROVs. The Saab

Seaeye Cougar-XTi ROV (left) is rated to 3,000m depth, and is used to address the industry's need for a 3,000m observation ROV capable of providing a 'self help' and light work.

The Amplicon industrial computing team worked closely with Saab Seaeye engineers to come up with the best solution for their requirement. The Amplicon Ventrix 2030 rackmount computer, one of Amplicon's most reliable systems was selected for its repeatability and long lifecycle. Its robustness, SBC configuration, and road-mapped components met the stringent hardware requirements set by the customer.

Amplicon was also able to supply additional hardware that was required for the project, including a MAG35-01-1 Panel meter unit to be used for constant data updates. These low-cost digital panel meters have the functionality to integrate easily into any system.

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*The EC-4 pole 32 HD brushless motor from maxon motor is designed to withstand the pressures, temperatures and vibrations caused by drilling at extreme depth.*



## Pipe flanges for fluid systems

jbj Techniques manufactures and markets an innovative range of pipe flanges for fluid systems, designed for pressures up to 450 bar; flow rates up to 20,000 lpm; and pipe sizes between 20 and 220 mm (outside diameter).

Known as the "QM" flange (quick maintenance flange) they are specifically aimed at the steel, oil, gas and food industries where ease of maintenance features are economically particularly attractive, when downtime must be kept to a minimum.

The ease of maintenance feature involves the ability to remove the seal, which is supported within a special retaining element, and replace it without fully disconnecting or moving the mating flange or runs of pipework as is typically the case with the standard DIN and CETOP flanges found in heavy pipework systems.

[www.jbj.co.uk](http://www.jbj.co.uk)

## Electro-Magnetic Clutches

Centa Transmissions has launched a range of electro-magnetic clutches (EMC) that will make life easy for designers and manufacturers in the oil and gas sector, where the remote clutching of ancillary drives or equipment is required in all weathers and environments.

These new EMCs have been designed around a parametric format that allows the whole range to benefit from the flexibility and practicality of an almost infinite number of applications. And with seven different sizes from 400 to 10,600, clutches can be fitted directly to the engine SAE flange, or via a



torsionally flexible coupling onto the flywheel. They can also be assembled as stand-alone units for auxiliary drives from the non-flywheel end. Given the correct application factors, all items of drive can be accommodated, from high inertia fan drives to hydraulic pumps and its versatile design allows generators or hybrid motors to be added to the clutched or drive end. Additionally, all PTO requirements can be accommodated with this one compact unit.

[www.centa-uk.co.uk/emc](http://www.centa-uk.co.uk/emc)



## Machined springs

Abssac's machined springs have been used in an application for a constant force compression spring to connect two pipeline 'pigs' together (A pipeline pig is a machine that enters into the actual pipeline from an offshore oil rig supplying oil or gas to the mainland).

As the pig moves along with the flow of oil or gas, the pig records data, such as the condition and reliability of the pipe wall. Originally, a traditional wire wound spring was used for this connection, but the long term compression forces caused performance deterioration. The readings from the PIGS were becoming more and more unreliable as pulsing shockwaves in the pipeline hit the pigs along their journey. The spring also needed guaranteed flat end surfaces and the piano wire material was corroding in the hostile atmosphere. Reliability of the wound spring was poor.

The customer gave Abssac the overall dimensions, as these parameters were finite. Next the desired axial spring rate was supplied. Using finite element analysis, Abssac could tune the geometry of the machined spring to guarantee the desired spring rate, but also look at the resonant

frequency of the spring system to try and counteract the pulsing shockwaves.

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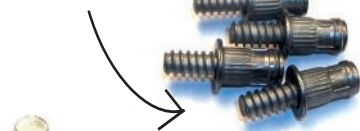
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The function of the bearings is to provide a flexible support between the mono column and main rig allowing for movement of the column caused by waves and tidal current relative to the main rig. The bearings, which have a bore diameter of 1m, are designed to transfer these loads from the column to the main rig.

Chris Head, application engineer at Schaeffler UK commented: "It was clear to us that the customer would require a unique design of bearing that offered both a very high level of reliability and zero maintenance. We therefore proposed Schaeffler's range of ELGES spherical plain bearings, but



customised with extra sealing features and low friction sliding layers. These would ensure maximum reliability and zero maintenance."

[www.schaeffler.co.uk](http://www.schaeffler.co.uk)

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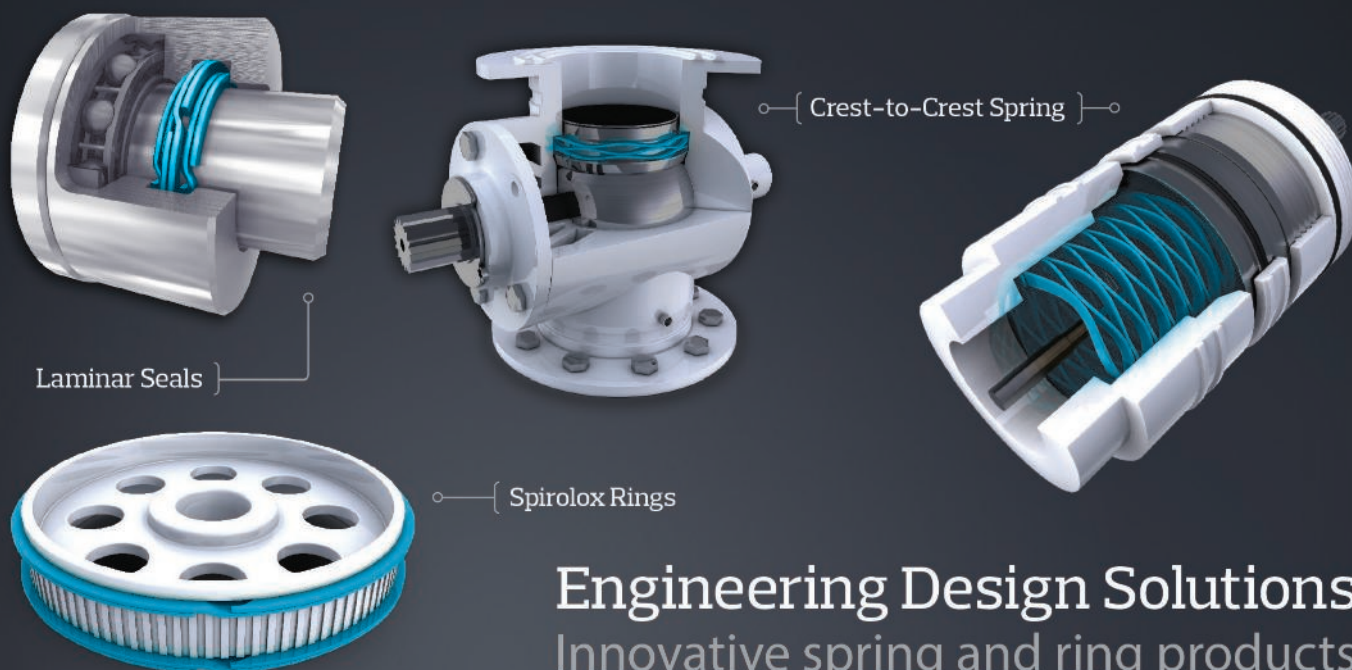
at new and refurbished offshore installations, are proving increasingly popular because of their efficiency and dependability, as well as their small footprint.

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"Integrating a robot into your process can be a challenge, so you need the help and advice from an expert to help to find the right solution" – Paul Barrett, Kaman

# The great robot debate

**Following a reader survey of over 220 UK SME manufacturers to find out where they stand on the issue of robotic automation, Eureka recently held a round table event to further debate the topic. As expected, there was a very interesting mix of views and some strong opinions expressed.**

**Neil Mead reports**

**W**ith the recent robotic automation survey throwing up some interesting results, a meeting of representatives from 15 leading small- and medium-sized UK manufacturers was always going to prompt some interesting debate on the subject. Held at ABB Robotics UK's head office in Milton Keynes, those present were not only able to discuss the pros and cons of investing in robots, but also take a tour of the ABB facility and get the chance to discuss technical issues with the ABB engineers present. An ideal opportunity then to voice their opinions, but also to hear others and possibly be won over by the advantages that robotic automation can present, when used in the right applications.

"BARA's main objective is to encourage UK

manufacturers to use robots and automation technology to improve their productivity, efficiency and, most importantly, their competitiveness," said Mike Wilson, Chairman of the British Automation and Robot Association (BARA), as he set the scene and kicked-off the discussion. "There has been growth in the use of robots in UK manufacturing over the last few years, but one characteristic of this is that the automotive industry has been by far the biggest user.

"If we look at some numbers from the International Federation of Robotics (IFR), which measures robot density, they show that the UK's density per 10,000 workers outside of automotive is actually relatively low and we don't use as much automation as our main European competitors."

## **What comes first, the order or investment?**

The robotic automation survey shows that 59 percent of respondents review their automation needs 'as and when necessary', which suggests that many will wait to automate until they get an order. This strategy risks incurring additional delays through time spent specifying, installing and commissioning, and learning to use the technology. It may also hinder the best choice of automation technology for the application. So the first question posed was whether it's best to invest or wait to automate?

Julian Bond, representing Parafix, a specialist in industrial adhesive tape conversion commented: "At Parafix, when a customer asks us to make a product, we work with them to incorporate the automation that's required to manufacture it at the design stage. It's a kind of halfway house solution that's worked for us."

"Something to consider is cycle time cost, and robots give me a lights-out option that means I can use the hours we don't currently run so return on investment is quite fast," commented Alan Collins from Norbar Torque Tools. "And, of course, there's a saving in labour cost to consider as well," he stated.

This then raised the question around the table of whether you introduce a robot to solve a problem in a current application, or do you change your process to incorporate a robot in order to improve productivity? The general feeling around the table was that having an order first is often what's required to justify the



"We took a leap of faith and bought three robots at once. We just decided to make the investment and it was probably the best thing we have ever done" – John Kenny, JK Engineering

investment to the company accountants.

Collins continued: "My MD has said if a robot offers a sub-three year payback, it's a 'no-brainer'. Of course, it's always easier to justify the investment when the job is there than to spend first and hope the work will come."

Chris Mulvihill of EMS Fire & safety commented on his company's experience: "We've recently started to use robotics to test a third-party customer's product. For us this was an opportunity to get some automation in. Therefore, the order did drive the investment in this case."

A common view around the table was that, once you have made the step into investing in some automation, it's a matter of making sure

you are fully utilising it and looking into whether you can improve your production processes further. Commenting on this, John Wingfield of Flambeau Europlast said: "For us in the plastic processing business, machine cycle time is driven by an operator opening a door getting a part out and then putting another one in which can vary. A robot will repeat this process at a predetermined rate, improving cycle time and repeatability."

"We have a similar problem," said Simon Coyne of forgings company, Coupe Foundry in Sheffield. "We are under pressure to increase sales, but we are at maximum capacity and trying to reduce cycle times so we can take on more work."

It was generally agreed that, if you have a reasonably high number of cycles, then using a robot to complete a repetitive task improves your cycle times and repeatability, and therefore increases your productivity. Robots don't make mistakes, if they are set up properly, and will just work all day and night, so in the right application they make perfect sense.

Paul Barrett of aerospace supplier Kaman said: "Everyone thinks that the aerospace industry is a leader when it comes to the use of technology in manufacturing when in fact it isn't. It's actually far from it, and we have been slow to introduce automation into our applications and we are seeing resistance from all the major manufacturers we supply."

"But one of biggest issues we face in

aerospace manufacturing is quality, and robots would give us the accuracy and repeatability to ensure quality, but it's getting the justification for investment for what is, essentially, a low-volume product that is the problem."

#### Barriers to investment

The survey shows a mix of real and perceived problems when it comes to investment in robotic automation. Major factors include cost, both purchase and cost of operation, insufficient

in-house technical know-how, lack of experience in robotic technology, access to funding, and they are sometimes deemed to be unsuitable for low volume batch and bespoke products. So the question is, if you have low volumes, are people the answer or

should you find a way to automate the process?

John Kenny, owner of motorsport engineering company JK Engineering has experience in this exact problem. "We only make low volumes, so when we invested in robots, we took people off the lines and up-skilled them from machine operators to programmers by training them in

CAD/CAM. We also found that, having originally invested in robots to run at night and weekends, our production throughput on our machines went up by 60 percent during the day, because people were never at the machines all the time before as they were minding two or three at a time. Plus, if a machine stopped while they were on a break, it would just sit there idle until the operator returned. Now we have around 90 percent of our machines running all the time and we use robots to put jobs in and take them out.

"So we've taken seven machine minders and turned them into programmers, so they feel they have gone up in the world and the factory runs all weekend without anyone there. We have, therefore, successfully made robots work for us in a low volume production environment and it has certainly improved the quality of the product as well."

Julian Bond, Parafix, said: "When producing high accuracy components, using robots is the

only way to ensure the quality we need. So that's one of the drivers we have for automation, otherwise we may end up producing 50 percent waste. "But, of course, the automation has to be used properly and approached in the correct way, taking advice from suppliers to make sure that the integration and controls systems are suitable and correctly installed, such as in a turn-key cell. A lot of the front-end controls are not that complicated, so they can be operated quite easily."

Chris Mulvihill, EMS, commented: "You really need to build a case for why you want to introduce robotic automation and have a clear strategy of how you want your processes to add value to your business. Automation won't work for everyone, the decision is not an emotional one, there has to be a business need that drives the process."

"The investment comes in the hardware, software, as well as training of the operators, which means you can go from having a low skilled manual workforce to a more highly skilled one that drives and facilitates the automation."

"Automation technology is also enabling a new generation of young engineers who've

grown up with it to take on jobs and make products that a few years ago would have required many years of engineering experience. They also tend to be more enthusiastic and willing to embrace the technology, although once

most people realise it improves their working life they become more pro automation and robots."

"The technology is enabling the UK to re-shore more manufacturing by reducing labour costs and improving quality," concluded Mulvihill.

#### Automation advantages

So, after a lively debate, the general consensus from those around the table was that robots can offer SME manufacturers many advantages. Those that may have needed convincing at the start certainly heard plenty of positive arguments for why they should consider introducing them into their own production processes.

In summary, if UK manufacturers want to improve their efficiency, repeatability and quality; up-skill their workforce, safeguard jobs and compete in a global market, the benefits of robotic automation are hard to argue against.

**"Robots can also offer an answer to a shortage of skilled labour. So, if you have a requirement for repeatability and accuracy, and well-educated and skilled people are not available, then investment in robots and automation can solve the problem."**

Chris Mulvihill, EMS Fire & safety

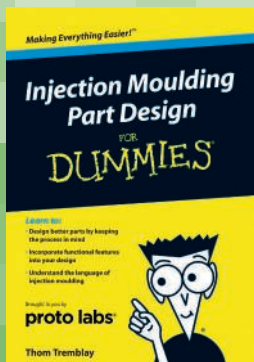
**"It's about getting the culture built into the business so that the practice of using automation can be included in any new processes."**

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# FDM-printed UAV takes flight

**Engineers from the AMRC's new Design & Prototyping Group (DPG) have developed a prototype Unmanned Aerial Vehicle (UAV). Paul Fanning reports.**

The recent increase in the use of both additive layer manufacturing and UAVs has led to the availability of a number of 3D printed UAVs for a range of applications.

Small wingspan, fixed wing aircraft are used for applications ranging from hobby flying to reconnaissance and humanitarian aid. Key drivers in the development of these vehicles are manufacturing lead time and cost, with additional focus on ease of assembly. With this in mind, the Advanced Manufacturing Research Centre's (AMRC) Design & Prototyping Group (DPG) undertook an internal project to design and build a low cost UAV airframe in ABS using its Stratasys Fortus 900mc FDM machine.

For printing relatively large components such as a UAV airframe, FDM technology was chosen over stereo lithography and selective laser sintering for its lower initial investment, material cost and simplified process.

Ordinarily, an FDM-built aircraft would require significant amounts of support material around its component parts to prevent the airframe structures from deforming during the build process. Using support material adds a direct material cost, and significantly increases build

time, in some cases by an order of magnitude. This is a result of the machine having to change between build and support structure heads after each printed layer.

A more efficient self-supporting design is, however, constrained to a maximum angle in the machine's vertical orientation (layer height). This requirement places onerous geometrical constraints upon the designer, particularly for a small aircraft operating at low Reynolds numbers, where performance depends largely upon a complex combination of specific and accurately orientated geometrical forms.

The manufacturing aspects of the project were led by additive manufacture development engineer Mark Cocking: "By understanding the capability of the FDM process and associated

software," he says, "we were able to manipulate the design to contain a number of unique features as well as preventing build deformation. All parts required for the airframe can be combined onto a single build within the DPG's Fortus 900 machine, taking less than 24 hours with ABS-M30 material. Before design for additive manufacture optimisation, this airframe would take over 120 hours to produce."

With these constraints in mind, a number of conceptual CAD models were created for evaluation. A range of configurations, sweep angles, chord lengths, taper ratios and aerofoil sections were considered. Development engineer John Mann was responsible for detail design and CAD modelling of the aircraft:

*In order to prove the design, the UAV was flight tested as a radio-controlled slope soaring glider*

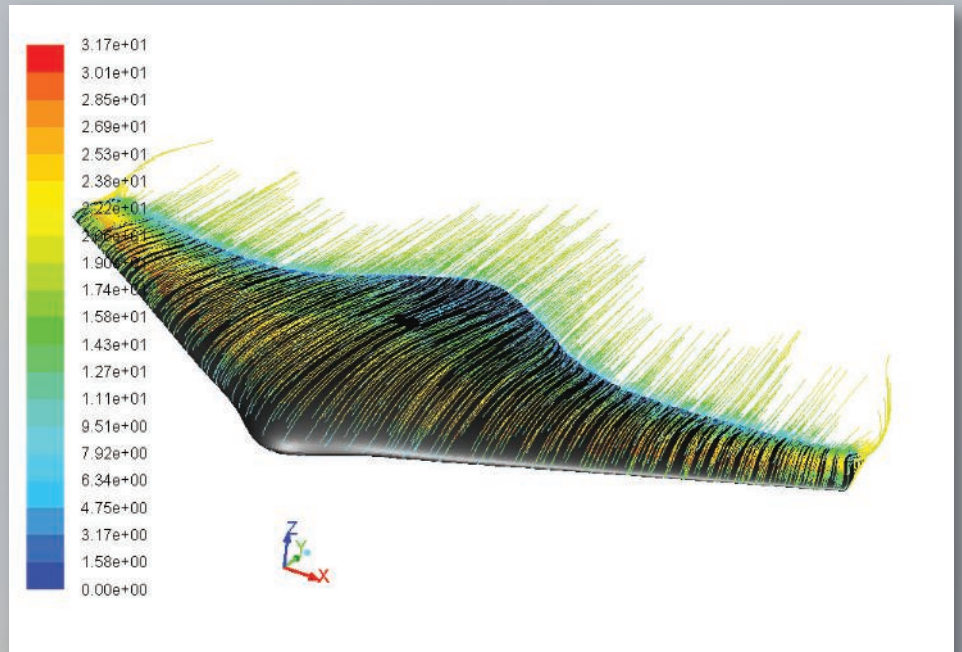


"The whole airframe was designed specifically for additive manufacture," he says. "The optimum configuration for the diverse requirements of aerodynamic performance and FDM manufacture appeared to be the blended-wing-body. This type of design has a number of advantages: Primarily for this project, it lends itself to FDM technology due to the smooth leading and trailing edges over each half-span."

This configuration allowed all geometry to remain below the critical angles beyond which support material would be required. In addition, the aerodynamic advantages over conventional fuselage and wing designs, and its potential as a testing platform for a range of new technologies were considerations during the down selection process.

Computational Fluid Dynamics (CFD) was used to optimise the chosen design and to assess the lift, drag, pitching moment and other characteristics over a range of angles of incidence. Sam Bull, development engineer, conducted these analyses: "The final configuration comprised two aerofoil sections blending from a thick, reflexed section in the body to a thinner, conventional section on the outer wing. The trailing edge was extended aft near the centre, where the reflexed aerofoil aids the longitudinal stability of the tailless design."

The FDM process also allowed the design to incorporate swept wings with straight leading edges, suited to the low Mach number flight regime in which the UAV would operate.



contributes to the rapid manufacturing time for the airframe. The airframe has a wingspan of 1.5m, and weighs under 2kg.

The internal structure of the wings is a semi-monocoque, which serves a number of purposes:

- The unsupported thin walled structures have to withstand becoming distorted as the build

additional fixings, while adding rigidity and strength to counteract launch and flight loads.

The control surfaces (trailing edge elevons) were designed to snap fit onto two hinges that protruded from the outer wing section. Elevon control is by means of a direct acting servo in each wing. The servos are fixed onto mounting spigots housed within the aft section of the body. The wing tips are capped by flat end fences that clip into the ends of the aerofoil sections, closing them to span wise airflow and helping to reduce induced drag. The wing end fences also provide a degree of yaw stability and serve as a retaining structure for the elevons.

In order to prove the design, the UAV was flight tested as a radio controlled slope soaring glider. Here it showed good stability, while low aerodynamic noise at speed indicated an efficient wing design.

Senior design engineer Dr. Garth Nicholson oversaw the project: "Following successful flight testing," he says. "The airframe is currently being optimised further to incorporate blended winglets and twin ducted fan propulsion, to facilitate the target flight envelope. Planned developments include full onboard data logging of flight parameters, autonomous operation by GPS, and control by surface morphing technology. Concepts for novel ducted fan designs are also being investigated".

[www.amrc.co.uk](http://www.amrc.co.uk)



The airframe comprises just nine parts, all of which are built using FDM: two wings, two elevons, two spars, two wing end fences and a central spine. None of these components requires support material during build. The aircraft was designed to split into two halves about the central spine. This configuration allowed a larger wingspan to be built within the FDM machines build envelope, and made transportation easier. A pair of short spars (front and rear) clip into sockets formed within each wing half, giving a rapid set-up time for flight. The low part count

height increases during manufacture.

- Aerodynamic loads around the aerofoil in flight act to distort the skin and create bending moments, especially in manoeuvres. The wing structure has to withstand these loads.

- Due to the requirement to minimise fixings and reduce part count, the structure has to incorporate a solution for ease of assembly of the two wing halves. In this case, two locating spars are used to snap the wings together without any

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# A step forward for thermoplastic bearings

**The use of lightweight plastics in bearings has been crucial to the development of a prosthetic foot and ankle. Paul Fanning reports.**



In the development of prosthetics, there can be few more important considerations than light weight and toughness. Since these factors ensure the usability and durability of the end product, they make the difference between a prototype and a hard-wearing and effective aid to the end user. These strictures apply to all components within the prosthetic and not least to the bearings.

Fitbionic of Boulder, Colorado is a developer and manufacturer of next-generation prosthetic technology and has recently launched its first product, an innovative prosthetic foot that features high load-carrying bearings made of Torlon polyamide-imide (PAI) from Solvay Specialty Polymers.

The ultra-high performance thermoplastic delivers long-term strength and stiffness along with exceptional wear and fatigue resistance in this highly demanding load-bearing application.

The Fitbionic prosthetic foot, developed specifically for lower-activity and diabetic amputees who comprise more than 80% of the

*Fitbionic's prosthetic foot employs high-load carrying bearings made from Torlon PAI*

U.S. amputee population, utilises 'Active Stability' technology to help wearers feel more stable and potentially prevent injuries while walking. Effortless ground conformance and reduced pressures on the wearer's tissues combine with propulsive energy to deliver the most human-like walking foot commercially available, according to Jerome Rifkin, chief technology officer and founder of Fitbionic.

The prosthetic foot assembly includes a lubricious, nickel-plated aluminium axle that rides on and between two bearings made of Torlon PAI, thus providing multi-axial motion. The 19 x 13 x 13 mm bearings are machined from Torlon PAI plate stock. Fitbionic may potentially switch to injection moulding Torlon PAI bearings to handle larger production volumes since the material offers the flexibility to convert the application.

"Patients put these components through

demanding situations and varying loads for years of hard wear," says Rifkin. "Torlon PAI is strong and tough enough to withstand those forces reliably and consistently."

The thermoplastic exhibits metal-like performance and is routinely specified for precision components used in repetitive-use, load-bearing operations. The material's exceptional wear resistance withstands the forces of walking that are projected on the bearing's 13mm wide surface without any material loss or non-uniform wear.

As a thermoplastic, Torlon PAI provides high strength and stiffness up to 275°C (525°F). It has outstanding resistance to wear, creep, and chemicals and is ideally suited for severe service environments. Rifkin says: "Torlon PAI exhibits exceptional bearing properties (fatigue resistance and compressive strength), resulting in long-lasting performance. It also yields a stable tribological interface by virtue of its strong mating and compatibility to a receptacle made of PEEK."

Fitbionic offers the new prosthetic foot for body weights up to 113kg. The company currently sells the prosthetic device to prosthetists throughout the U.S.

**[www.fitbionic.com](http://www.fitbionic.com)**

**[www.solvay.com](http://www.solvay.com)**

# Giving linear a **lift**

**Linear-based lifting columns have a wide range of applications across industries such as medicine, ergonomics and even packaging. Paul Fanning reports.**

Linear lifting columns are able to offer a wide range of key design benefits in a variety of ergonomically-focused applications. These include medical equipment, such as patient beds, to industrial uses including the use of trolleys for automated and high volume production lines.

Indeed, wherever there is a need for an adjustable lifting mechanism, there is a need for lifting columns. The advantages of lifting columns are numerous, in particular their combination of adjustability, small footprint, low noise and rapid movement can deliver superior performance and operation against many other technologies.

Swedish company Thomson recently introduced its LC range of linear lifting columns, which are finding increasing use in a range of domestic, medical, and workplace applications, products and systems.

Kyle Thompson, the company's product line manager explains the principles, saying: "A lifting column is a package with a lifting mechanism and bearing supports built into one. So you have a lifting mechanism with the actuator inside it and telescopic aluminium extrusions. Between those extrusions you have engineered polymer bushings that provide load support. So essentially, you have both your lift mechanism and your moment load support for side-to-side movement."

## Key benefit

However, the telescopic action of the lifting columns is their key benefit, as they allow the adjustable lifting of a range of loads. Clearly, this relies on the lifting columns being able to offer a considerable extension to retraction ratio – in other words, the ability to extend and retract smoothly and rapidly from very low to very high extension and vice versa. In the case of the Thomson's LC series, this is achieved by the use of a mechanically-actuated 25mm diameter lead

screw within the tube that is supplemented by another, 12mm diameter lead screw to provide additional lift.

Within the actuator itself are internal limit switches wired within the motor. These are wired in such a way to ensure that when the actuator hits the end of a stroke it will automatically turn itself off and will not allow any further movement or cause any damage to the motor or the end of the unit.

In addition, at the bottom of the tube there is a wrap spring brake, which is able to hold the



*The LC Series of Lifting Columns includes three sizes*





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load when the power is off. Thus, should the power go down for any reason, the workstation, dentist's chair, medical table bed or other critical load bearing system, will hold its position.

Thomson Lifting Columns are available in three model variations (LC1600, LC2000 and LC 3000, whose model numbers all relate to their loading capacity in Newtons), which provide different performance in extension to retraction ratio, load capacity, speed and cost to best match application needs.

The LC1600 features Thomson's Whispertrak drive technology, resulting in an extremely quiet and smooth operation. Naturally, the lifting columns can also be customised to meet specific customer requirements.

Depending on the application, multiple lifting columns may be required, which can be synchronised using a Thomson control unit to ensure they work perfectly in unison.

One such application is in medical tables such as those used in hospitals for examination, where the ability to get onto and off of the table

easily is important – particularly as those doing so may be physically incapacitated.

In such applications, there is of course no guarantee that the overall load will be balanced, which is why Thomson offers a demonstration desk lift that they can load with two 5 gallon water bottles at one end to demonstrate the ability to deal with offset loads.

#### **Industry Application**

As well as the LC Series, Thomson offers the DMD and DMA lifting columns, which are self-supporting, height adjustable units designed for a variety of industrial applications such as work tables, conveyors, loaders/unloaders, and many others.

This height adjustment capability especially serves work environments that need to meet specific ergonomic requirements for a wide range of operator positions.

Rugged and robust, these columns provide high load torque capability in an extruded anodised aluminium, self-supporting frame.

Incorporated into the design are Thomson's Electrak actuator units in both acme and ball screw versions.

Mid and end of stroke protections include an overload clutch along a T-slot groove design throughout the entire column profile to prevent damage during operation.

One application of Thomson's linear lifting columns has been in the Meyra Champ adjustable height wheelchair, where the ability to lift the user safely, smoothly and reliably is clearly vital in order to ensure safety, comfort and stability. Here, the lifting column allows the wheelchair user to sit comfortably at eye level with companions with ease.

In industry, lifting columns have been used to create adjustable trolleys or materials handling equipment, meaning that employees of greatly differing heights are able to lift and handle items without bending or reaching in such a way that could potentially threaten their wellbeing (and perhaps lead to claims against their employers).

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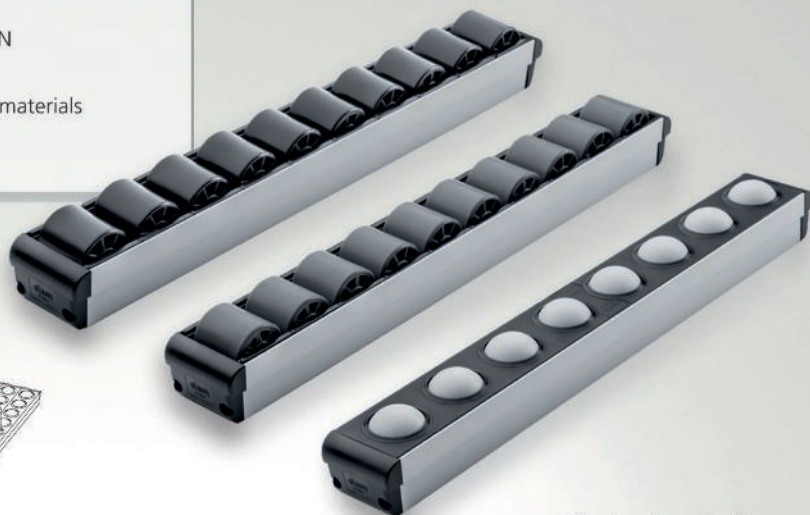
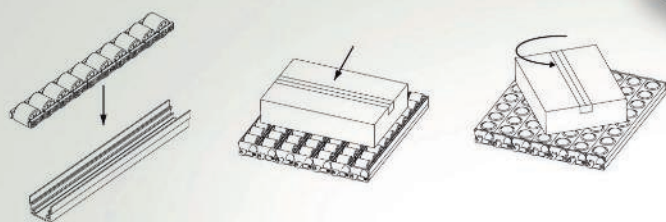


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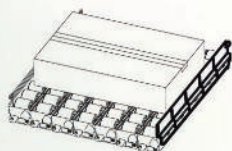


\*Trademark application

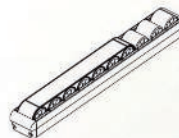
Available accessories in the range:



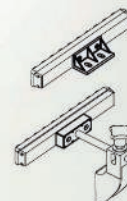
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## Tube Clamp Connectors

**Tube clamp connectors** are clamping components made of aluminium which offer the facility for simply and rapidly constructing jigs, fixtures and operating systems using standard round and square section tubes.

The vast range of clamp connectors in split monoblock or multi-part form offer almost unlimited possibilities.

**Split monoblock clamp connectors** give very robust and sturdy tubular constructions with relatively tight tolerances.

**Multi-part clamp connectors** (consisting of two or more separate parts) are not tied to tight tolerances as they can also be used with square tubes thus allowing incorporation into existing systems.

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## ele:roll Modular Roller Tracks



Modular roller tracks for idle handling can be used to create sliding, containing, feeding and discharging benches for storage, picking and packaging systems.

Modules consist of 10 rollers or 8 balls per module, any number of roller or ball modules can be inserted into the profile to create custom lengths of track on site. RLT-AL aluminium profile is available in lengths up to 2970mm and the use of RLT-HJ joining headers allows multiple pieces to be clipped together.

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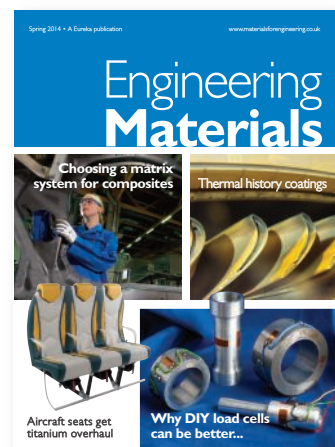
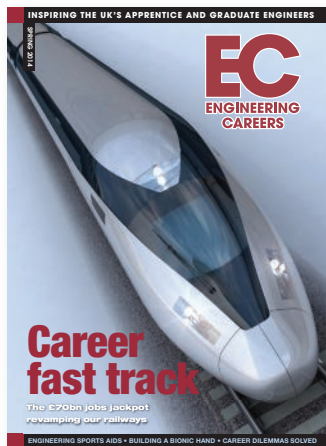


## Castors and Wheels

The range addresses applications such as manually manoeuvred trolleys, barrows or equipment in storage, service or production or waste handling environments, industrial trolleys or transfer equipment, including production, machining, transport, distribution and storage.



# Inspired by innovation



# Passionate about engineering

# Still missing out?

With so much investment and importance being given to developing the UK's innovation base, why are so many SMEs still hesitant to apply for R&D tax credits?

Justin Cunningham finds out.

**H**istorically, the taxman is down there with estate agents, traffic wardens and lawyers in terms of unpopular professions. And while HM Revenue and Customs (HMRC) has a reputation for taking, and not giving, things are perhaps not quite as bad as the Beatles once made out some years ago.

In particular, when it comes to research and development work HMRC wants to be generous in the form of giving companies tax credits on work carried out. But, while many have heard of the scheme, uptake continues to be poor among SMEs as many fear the paperwork and bureaucratic process will far outweigh any potential financial benefit.

"It is unusual for a tax collector to enter in to a dialogue with companies to say, 'we want to give you some money back', so first of all

don't get spooked by it," says Motorsport Industry Association (MIA) chief executive Chris Aylett, who has been promoting the scheme throughout the motorsport industry. "The difficulty for HMRC has actually been engaging with engineers, as they don't believe it. But, it's taking great steps to make things easier. It wants more companies to take advantage."

There is cynicism as many wonder how many hoops you'll be made to jump through. The wider story, however, is that national spend on research and development is used as a measurement of economic wellbeing and competitiveness. And on the world stage the UK is lagging worryingly behind.

If a country spends 2% of GDP on R&D then it is likely to grow and prosper. Less than that and it is in danger of declining. In 2000 the average spend in Europe was 1.7% and member countries were keen to raise the figure to ensure that Europe remained a key place in the world for investment in

technology, innovation and development.

The UK target is 3% but is currently only at 1.8% compared to Germany's 2.8% and France's 2.3%. So the scheme being managed by HMRC wants to encourage innovation and R&D activities by making it an area of tax relief. One of the key assumptions about the scheme – that seems to be well proven – is that any money claimed back is reinvested in more R&D, and hence the Government incentive. The average size of a claim for an SME is around a third of total R&D spend. For many that is an extra design engineer, project, piece of equipment, or more cost effective quote.

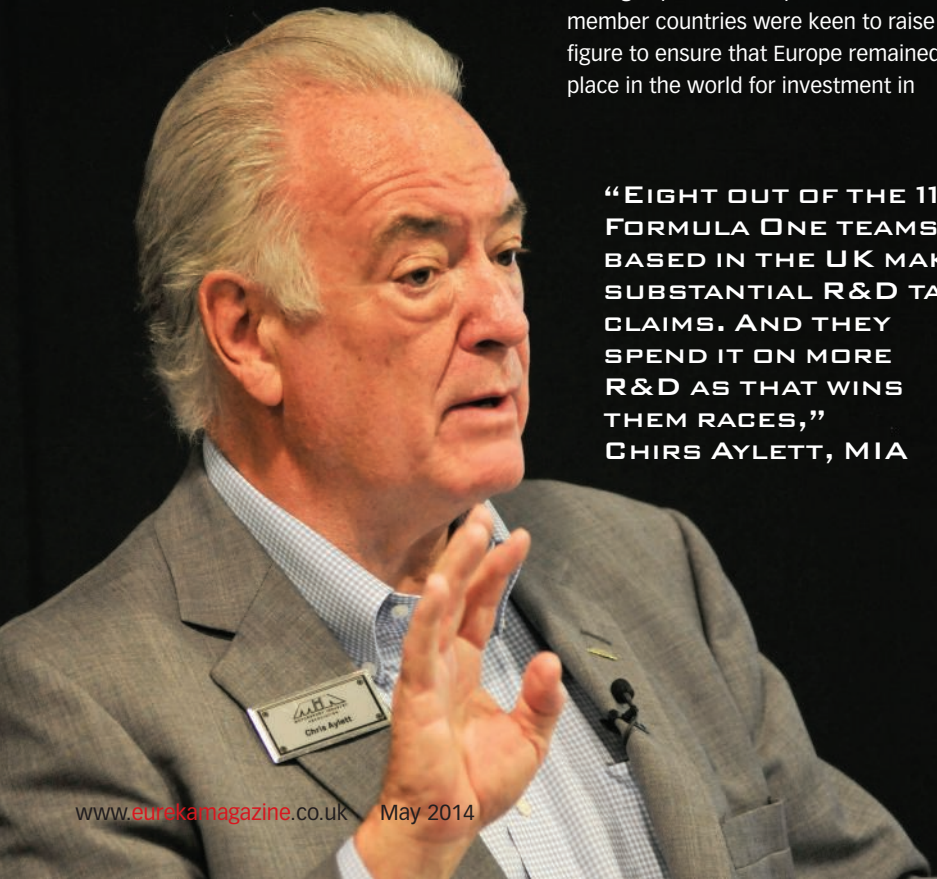
Commenting on the motorsport industry Aylett says: "Eight out of the 11 Formula One teams based in the UK make substantial R&D tax claims. And they spend it on more R&D as that wins them races.

"The simple premise is: you will spend R&D tax credits on more R&D. It is not governed that way, but HMRC is confident you won't run away and buy a Bentley. It believes you will reinvest it in R&D and so the UK increases its community of intelligence."

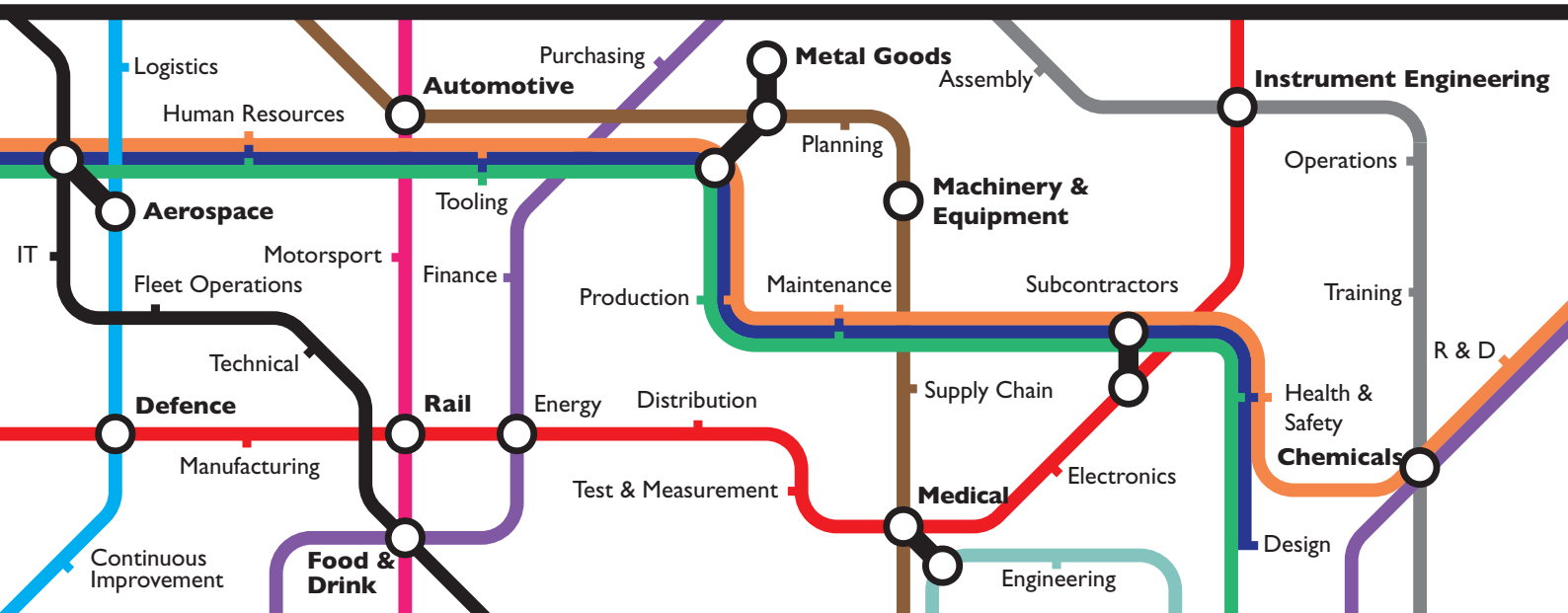
And with the scheme being earmarked to be in place until at least 2032, it is money that companies can put aside, against the bottom line, to help fund the following year's innovation, research and development work.

"You've answered that problem of how to fund next year's innovation," says Dave Pepper, director of The MPA Group, an accounting firm specialising in R&D tax credits. "It is about competitive advantage through innovation. You can get this set of funds, year on year, from the tax office provided you carry on doing the same sort of innovation and development. We have seen a trend of almost exponential growth in R&D spend for companies that have really got their

**"EIGHT OUT OF THE 11 FORMULA ONE TEAMS BASED IN THE UK MAKE SUBSTANTIAL R&D TAX CLAIMS. AND THEY SPEND IT ON MORE R&D AS THAT WINS THEM RACES,"**  
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heads around the scheme.”

For many, it's a change in mindset to how risk is assessed against innovation. Being able to claim money against development of a new technology or solution, even if it doesn't work, allows engineers to stretch the envelope of how far an activity can be pushed.

“Despite this, the take-up rates have been pretty poor since it began,” says Pepper. “Many organisations still do not believe they're eligible, when in fact they are. Many people think R&D is someone in a white coat and a clipboard. But this is about innovation and development, which is a much broader set of activities.”

Another problem can be that accountants and financial directors often do not really understand what innovation and development really is, and what qualifies under the scheme. The criteria can be vague, uncertain and changing, and it doesn't help that some engineers have been known to exhibit an element of intellectual snobbery on occasion, talking in a overly complicated way to those outside the profession.

#### Down to the engineer

“Engineers, like many other ‘knowledge professionals’, need to be clearer when talking to financial people about what it is they are up to,” say Pepper. “The process of making a claim requires a level of confidence and knowledge about the scheme, so if accountants don't understand the work being

done, they might not get the maximum amount you're entitled to.”

What companies need to ensure from the outset is that processes and project management is well documented. R&D tax credit claims are not a job purely for accountants. Engineers play a vital role in both implementing the process and recording the innovation.

“This is not an accounting job for the end of the year,” says Aylett. “It is a project management job that needs to be done at the beginning as it can affect the costing of the whole thing. If you leave it to an accountant or auditor to decipher at the year end, then you've made a mistake. You need to sit down at the beginning of a project with tax credits in mind. But it is SMEs that don't seem to do this quite so well.”

And in the early stage of putting a project together, it's a good idea to liaise with internal accountants as well as external auditors to make sure that all the necessary information is being captured.

One company that has experience, and success, in claiming R&D tax credits is Torotrak. Finance director Rex Vevers says: “You need to document and manage a project carefully to allow a claim to be made. In our experience it is not complicated, it's really an administrative process. If you set up a project properly and have good systems and records in place it is very straightforward.”

For Torotrak, R&D tax credits are a useful

#### At a glance: R&D Tax Credits

- Despite improvements, many UK limited companies do not claim R&D tax credits.
- The R&D tax credit scheme is the largest single funding mechanism for UK SMEs, representing over 85% of all money.
- You can claim for R&D related activity performed during your company's last two accounting periods.
- You don't have to be profitable to claim R&D tax credits.
- R&D is defined in the legislation as dealing with ‘scientific advances and technological uncertainty’.

additional source of funding allowing them to claim back cash against the cost of people, consumables, sub-contractors, some overheads, as well as prototypes and testing. And if you have taxable profits, even more costs are eligible to be claimed against.

John Fuller, IP director at Torotrak concurs: “You need that rigorous project planning and execution. That's useful in outlining objectives but also in defining the research and development elements, which is vital at the end of the financial year to be able to make a claim.”

Engineers need to understand that helping the finance department in documenting relevant R&D in a project should go hand in hand with the innovation. While this may seem another box ticking exercise for the engineer that takes away from actual problem solving, the fact of the matter is engineers need to operate more holistically than ever and integrate their activities with other departments in a business. Companies that have done this successfully are reaping the benefits, massively. And not just from an R&D tax credit point of view, but as an organisation as a whole.

[www.hmrc.gov.uk](http://www.hmrc.gov.uk)

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# Is complete road safety possible?

**Developments and advances in sensor technology will allow cars to be safer in the future by overriding the drivers' actions. Justin Cunningham takes a closer look how.**

*Eye tracking will allow the car to 'see' if your eyes are on the road or elsewhere*

Swedish car manufacturer Volvo is setting the bar extremely high for 2020. Not only does it, like the rest of the EU's automotive OEMs, have to comply with the very strict exhaust emission targets, it has also set itself the target of being perhaps the safest car in the world. Its goal is that no occupants will be killed or seriously injured in a new Volvo from 2020 onward.

Volvo, along with fellow Swedish firm Saab, pioneered much of the early safety engineering work in the automotive industry and has a reputation for solidity and reliability. However, while passive safety systems such as side impact protection, airbags, and seatbelts aim to keep occupants safe once there has been a crash, it wants to move safety systems being much more active, where the car is able correct driver error and take action to avoid a crash altogether. While this sounds a bit sci-fi, put in perspective it's not as big a leap as you might think.

While many are not in favour of their car making decisions for them (and being better drivers), the fact of the matter is that 90% of road accidents are down to human error. And, many already rely on driver aids such as electronic stability control or traction control where the car is correcting what the driver is actually telling it to do.

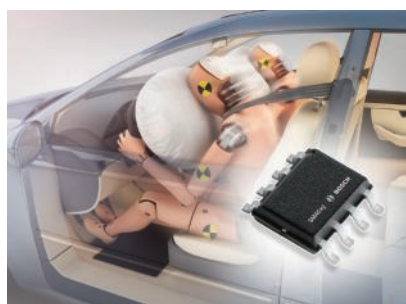
Volvo has been doing a number of trials and research projects recently to evaluate systems

that improve car safety. One example is the development of a sensor that can recognise and detect if a driver is tired or distracted. The system uses a sensor mounted on the dashboard that monitors the direction a driver is looking, how open their eyes are, as well as their head position and angle. The technology is already installed in test vehicles and Volvo is also conducting research together with partners to identify effective methods for detecting tiredness and distraction. In tandem with the sensors to detect the drivers focus, it is incorporating other systems such as lane keeping aids, collision warning with full automatic braking and adaptive cruise control with queue assist.

It means, Volvo is able to use this information to adjust a vehicle according to a given situation. For example, a car will not stray out of a lane or get too close to the car in front when the driver is not paying attention due to checking a phone, changing a radio station, or simply looking out the window. And more dramatically it would be able to detect if a driver fell asleep at the wheel, and then be able to keep the car from weaving out of

a lane, stop it from hitting any cars in front and wake the driver. This could all happen in a fraction of a second, but could be the difference between a scare at the wheel, and a potentially devastating crash.

"It will enable the driver to rely a bit more on their car, and know that it will help them when needed," says Per Landfors, an engineer at Volvo



Cars and project leader for driver support functions. "Since the car is able to detect if a driver is not paying attention, safety systems can be adapted more effectively. For example, the car's support systems can be activated later on if the driver is

focused, and earlier if the driver's attention is directed elsewhere."

The sensor uses small LEDs to illuminate the driver with infrared light, which is then monitored. The infrared light is just outside the wavelengths that the human eye can see, which means that the person behind the wheel doesn't notice any difference. By monitoring eye movements, the car would also be able to adjust both interior and exterior lighting to follow the direction in which the driver is looking.



*If the driver is distracted, the car will be able to intervene and take avoiding action to stop a collision or keep a safe distance from the vehicle in front. Magnets (below) might soon be used to enable cars to position themselves accurately on the road without the need for a driver at all*

Measuring how alert a driver is, known more formally as Driver State Estimation, is a field that may be key to self-driving cars in the future and one in which sensors will play an important role. Any cars acting in such a way will need to be able to determine whether the driver is capable of taking control when the conditions for driving autonomously are no longer present.

Moves toward autonomous vehicles have also featured in another research project by Volvo that saw magnets inserted in to the roadway to help cars determine an accurate position on the road. The project has been financed in strategic co-operation with the Swedish Transport Administration and could act as a key enabler in the implementation of self-driving vehicles.

Reliable and highly accurate positioning is one of the crucial issues in the development of self-driving cars and established positioning technologies such as GPS and cameras have limitations in certain conditions. However, integrated magnets would remain unaffected by physical obstacles and poor weather conditions. The research programme was designed to evaluate issues such as detection range, reliability, durability, cost and the impact on road maintenance.

Jonas Ekmark, preventive safety leader at the Volvo Car Group says: "The magnets create an invisible 'railway' that literally paves the way for a positioning inaccuracy of less than 100mm. We

have tested the technology at a variety of speeds and the results so far are promising.

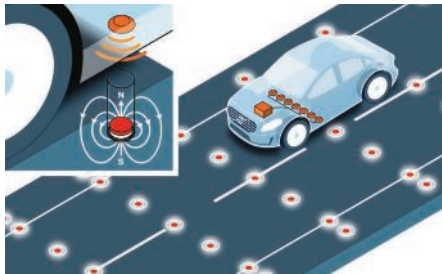
"Our aim is for the car to be able to handle the driving all by itself as accurate, reliable positioning is a necessary prerequisite for a self-driving car."

Volvo is playing a leading role in a large-scale autonomous driving pilot project in which 100 self-driving Volvo cars will use public roads in everyday driving conditions around the Swedish city of Gothenburg.

"It is fully possible to implement autonomous vehicles without changes to the present infrastructure," says Ekmark. "However, this technology adds interesting possibilities, such as complementing road markings with magnets."

In parallel with the potential of autonomous driving, road-integrated magnets also open up a number of other possibilities when integrated with safety systems, such as preventive run-off. In addition magnets could facilitate accuracy of winter road maintenance, which in turn could prevent damage to snow-covered objects, such as barriers and signs, near the road edge. There is also a possibility of more efficient utilisation of road space

The team has created a 100m test track at the company's Swedish testing facility where a pattern of round ferrite magnets approximately 40 x 15mm were located 200mm below the road surface. The car was equipped with several magnetic field sensors and trials continue .



"Our experience is that ferrite magnets are an efficient, reliable and relatively cheap solution, both when it comes to the infrastructure and on-board sensor technology," says Ekmark. "The next step is to conduct tests in real-life traffic."

Sensor development is also happening at tier1 component supplier Bosch, which is rising to the challenge of smarter and more accurate vehicle sensors. Its latest generation of acceleration and inertial sensors are allowing the further development of both active and passive safety systems, such as airbags and driver assistance systems. Its SMA6xy acceleration sensor platform simplifies the release approval process by giving sensors a common housing design.

In addition its SMI7xy inertial sensor platform is designed specifically for use in active and passive safety systems and in driver assistance systems. In addition to the normal x- and y-channels, these sensors are available with a z-channel for measuring acceleration in the vertical axis. This allows it to detect and react if a vehicle is about to rollover. The flexibility of the sensors gives airbag system developers greater design freedom than in the past.

The sensors can register high accelerations of up to 35g and are ideal for use in electronic stability control programmes and other demanding vehicle dynamics applications such as hill hold control, adaptive cruise control, and active front steering. They also protect against microcuts, the extremely brief interruptions in power supply following an impact.

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*Courtesy of Vestas Wind Systems A/S*

# Automotive and wind energy drive composite growth

**The composites industry is responding to demand from the automotive and wind energy markets for lighter and stronger materials. Justin Cunningham reports.**

The news from Europe's biggest composite trade show, JEC Europe, held annually in Paris was that business is on the up. It follows a significant drop off in growth in the last few years following the financial collapse of 2007/8. The event had previously seen growth in the composites sector fall from 5% to 2%, but following green shoots of recovery last year, the market is expected to bounce back to over 4% growth this year.

It is good news for the composites industry, and it follows a great deal of investment in the development of the material for other applications. While composite materials were once only for aerospace and high-end motorsport, composite developers have been busy engineering the material and tailoring it toward application elsewhere. Indeed, part of the growth expected can be attributed to the increasing interest and corresponding demand from two potentially massive emerging market sectors, which are looking to composite materials for gains in performance.

The first and most obvious market is the

automotive sector, which is facing near-overwhelming pressure to produce more efficient vehicles. While many vehicle designers have wanted to use composite materials to enable better power to weight ratios (and hence lower emissions), manufacture of composite parts has been a notoriously low-volume process and put the material out of the running. However, getting the cycle time needed for the high-volume manufacturing of the automotive industry has been an increasing focus for many material suppliers and developers.

Indeed, glass fibre producer Owens Corning used JEC Europe to highlight two separate glass fibre technologies; its Hydrostrand 256 chopped strand fibre that now works with both PA6 and PA66, and also its 272 chopped strand fibre that is compatible with PBT. The key is that these fibres are compatible with thermoplastics and avoid the



use of an autoclave oven, which has been a historical bottleneck for those using thermoset composites.

"For our 256 strands, 70% of its application will be in the automotive industry," says Mario Sandri, vice president and managing director of Owens Corning glass fibre business. "We want to enable customers to get better compounds and better processability. Similarly with 272, it is increasing our

penetration in to the automotive market as it yields a better process.

"We are also launching a long fibre called SE48/49 which goes into polypropylene. This allows the manufacturing line of our customers to run up to 20% faster. What that means is, as the market grows and their capacity reduces, instead of buying new machines they can use this material and have 20% more capacity right away."

The second market with the potential for



© BMW GROUP

*Material developers have had to modify processability to cope with the need for high-volume manufacture*

significant growth is in wind energy. As the length of turbine blades increases, so too is the demand for lighter and stronger materials.

"For the wind sector we are launching a family of products called Windstrand 2000, 3000 and 4000," says Sandri. "Here, the main thing is to have higher mechanical properties that allow both higher strength in the installation of the blade – to allow them to go longer – and also higher fatigue resistance, which means more durability."

A similar sector-specific response has been seen by carbon fibre and composites specialist, Hexcel. Although it has a history of servicing the aerospace industry, the company is now looking for growth in other markets.

Hexcel has a history of using thermoset resins and has been keen to develop out-of-autoclave, as well as fast cure, thermoset resin systems to extend its use in to higher volume and mass produced composite markets.

At JEC it highlighted its HexPly M77 'Snap Cure' prepreg. HexPly M77 is a rapid curing epoxy prepreg that it hopes will enable greater use in the automotive industry for components to be press-cured in a 2-minute cycle at 150°C and 80bar pressure.

The low tack of the M77 enables the prepreg to be cut into precise shapes by a laser cutter and individual plies can be oriented, assembled and consolidated into flat preformed parts using automated robotic assembly systems. Once in the mould, an optimised gel time allows the resin to flow into the contours to produce precise



geometries. Its high Tg of 125°C also enables cured parts to be de-moulded while hot for an even faster production cycle. The Hexcel M77

has a six week outlife at room temperature, and is available in various forms including unidirectional or woven reinforcements and heavy tow-fibres.

Hexcel has also been developing its HexPly M79 Low Temperature Cure Prepreg for wind blades. This material was developed to meet industry requirements for a faster and lower temperature curing prepreg for thicker laminates. A number of cure cycle options are possible including a very low temperature cure at 70°C for 8-10hours or a more rapid cure cycle of just 4-6 hours at 80°C. With previous systems it could take 10 hours to cure a laminates at 80°C. HexPly M79 also has a very long out life at room temperature of at least six weeks.

When HexPly M79 carbon fibre unidirectional (UD) prepreg is used in conjunction with Hexcel's grid technology, a void content of less than 1% in the cured laminate is achievable, almost regardless of the part thickness. On Hexcel's stand at JEC, it displayed what we believe to be the thickest carbon prepreg laminate ever made. The lay-up was made up of 695 plies of HexPly M79 600 gsm carbon UD tape with Hexcel's grid technology. It was cured in 6 hours at 80°C.

In order to commercialise these new technologies many material companies are seeking partnerships to develop specific composite materials. An example is the ongoing work being carried out by 3B Fibreglass, DSM,

Siemens Wind Power and The University of Denmark (DTU).

Siemens Wind Power has been evaluating composite systems for its next generation of wind turbine blades and formed the partnerships. Together the team has been able to offer an improved resin infusion and processing capability with excellent fibre and resin interaction to significantly improve the superior static and fatigue strength of the resulting composite.

The system is based on DSM's Beyone 201-A-01, a resin that is styrene-free, cobalt-free and is 40% bio-based with performance that can compete with traditional epoxy systems. These enhanced performances are obtained when used in combination with 3B's SE3030 glass fibres.

The 3B SE3030 glass fibre size is tuned for the new styrene-free resins and results in excellent wet out and laminate quality, improved inter-fibre properties with transverse tensile strength rated at over 50MPa.

The new composite system provides many benefits including a major reduction in blade manufacturing cost, an increased process output thanks to significantly shorter cycle times and a sustainable material solution.

Laurence Ponchaut, communications officer at 3B, says: "Our 3B SE3030 has been optimised for the new styrene free resins and together the material is able to deliver the enhanced performance that has been demanded. It's all thanks to that open technical exchange and brainstorming between the resin experts from DSM and the sizing developers from 3B."

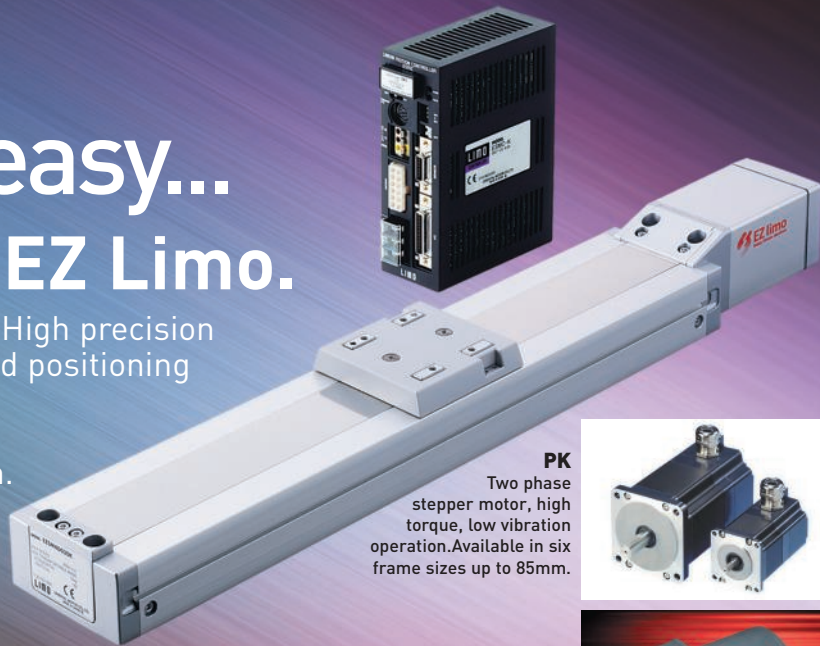
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# Avoiding digital damage

**Does the doorstep need a rethink? And if so, what form might it take in the future?**

None of us has probably ever given much thought to the humble doorstep. It's usually just a simple wedge that holds the door open. Alternatively, we might just use a heavy object or ornament to hold the door in place.

However, there are pressing reasons why we should take this issue seriously. It is a frightening fact that a closing door creates 40 tonnes of pressure – 20 times more than a Crocodile's jaw! This is clearly a worry for anyone, but in particular it represents a threat to children, who are less circumspect about where they put their digits.

A normal, wedge-shaped doorstep may hold a door in place from one direction, but it can easily be knocked out of place by a child or even a pet, meaning the door is free to swing towards at least one edge. And, of course, if it's not a wedge-style doorstep, this possibility exists anyway.

Equally, if the floor surface is shiny, certain types of doorstep may just slide on it rather than do their job.

A door guard or finger guard can be used, of course, but that protects one edge of the door only. And, if anything, protecting fingers from the hinge side of a door is even more important than the handle side because of the huge pressure generated there when a door closes.

What is required, then, is a door stopper that will prevent finger injury from the hinge side and the handle side of a door – and that is this month's challenge.

Of course, there are many possible answers. One could use two wedge-shaped doorstops either side of the door, for instance, thus preventing its movement. However, this is a slightly inelegant solution, as it can look rather unprepossessing and is awkward and irritating to undo when one wants to close a door.

As always, we have a solution in mind. It is simple, low-tech, but nonetheless elegant. It has also been the recipient of a number of plaudits, awards and is patented.



The solution will, as ever, appear in the next issue. But none of that is to say that you can't do better. We look forward to finding out.

The answer to last month's Coffee Time Challenge to redesign dynamo powered bike lights can be found in our Technology Briefs section on page 14.

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Titan Enterprises reports on the successful application of its flow meters for research by Formula 1® racing teams at their test facilities around the world. Managing Director of Titan Enterprises – Trevor Forster commented "Flow meters have recently become a hot topic in Formula 1® with one team casting doubt on the approved fuel flow meter (not from Titan) that has to be fitted to every car". He added "Because of this negative press we felt it right to share some of the successful implementations of Titan flow metering technology". A few seasons ago another F1® team did not trust the fuel flow figures being returned from their engine suppliers fuel management systems. Titan designed a very lightweight oval gear flow meter to be installed safely in the fuel tank of the racing car. Designed to be immune to immersion in fuel and the very noisy electrical environment of an F1® racing car the flow meter has provided accurate flow measurement over an extended period of time.



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## Self-Clinching Standoffs

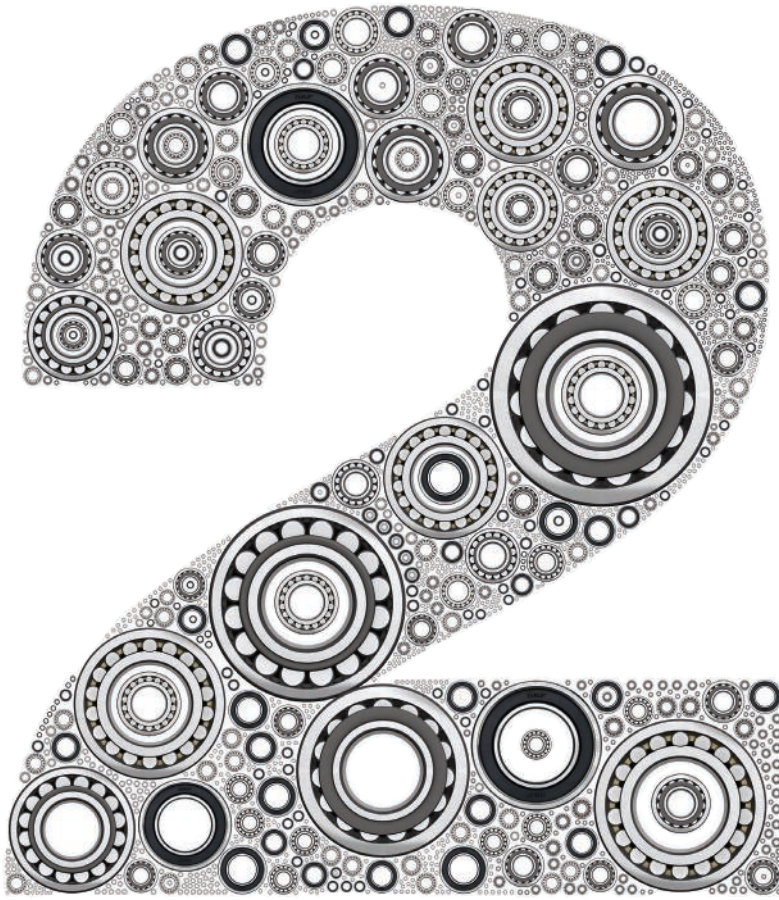
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