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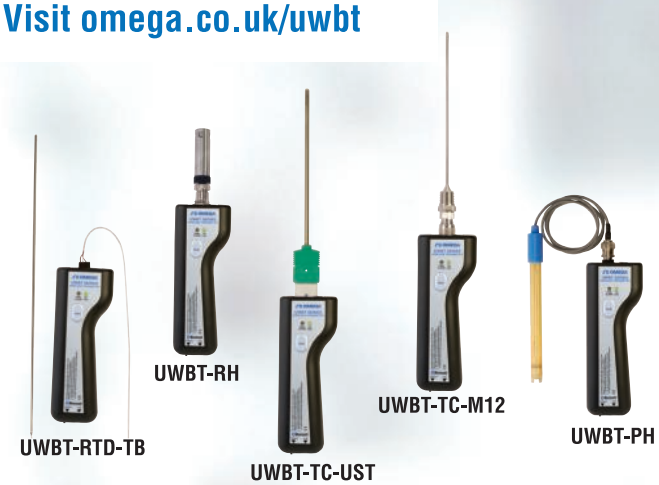

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Wave hello, or say goodbye

Tim Fryer, Editor (tfryer@findlay.co.uk)

Last month, I wrote a blog about the lack of co-operation between developers of wave energy harvesting technology, suggesting that in some cases, UK companies may put self-interest before the collective good.

The benchmark here is with Denmark and the development of wind turbines. The Danish suppliers co-operated, they shared results and learned from each other's mistakes, and now they are a dominant force in the maturing wind energy market. The UK, where much R&D was carried out, lost out when it came to the commercialisation end of the lifecycle.

However, maybe the tidal energy sector has learned the lesson. Martin Murphy is President elect of the Institute of Marine Engineering, Science and Technology (IMarEST), an organisation that counts offshore renewables within its remit. Murphy praised some of the collaborative work that was going on, particularly pointing a favourable finger at the Orkney European Marine Energy Centre. "What we are trying to do is create an industry," he claimed.

While this appears to be the case for tidal, why is it not for wave? Perhaps it is all about potential. Tidal has the massive advantage over any other renewable energy source of being predictable – a turbine designed to create 1MW will do just that at specific times of the day. The potential in terms of contribution to the UK electricity generation requirements (conservatively estimated at about 10%) and also as a business sector is therefore more calculable.

Conversely, many remain to be convinced that wave energy has a meaningful contribution to make, and as a sector has recently suffered a couple of major set backs. Perhaps it needs to prove the technological point before it reaps the benefits of co-ordination and collaboration. But if we have good wave energy technology (and there is a report on page 23 on some very promising British wave technology), it would be a shame to see it washed away.

NEWS

3D printer doubles as a scanner

The Blacksmith Genesis is claiming to be the first all-in-one 3D scanner and 3D printer.

A start-up company from the Nanyang Technological University, Singapore, created the desktop size printer that aims to make 3D printing more streamlined and user-friendly.

For scanning, the printer-scanner uses a revolving platform to do a 360° scan of objects. This digital model can then be edited in the 3D software if it is desired or directly printed.

The scanner uses a 5megapixel camera and

is intended to eliminate the need for creating complicated models in 3D CAD software from scratch.

The printer is then able to print out objects at a resolution of 50µm using a PLA (Polylactic acid) that is a non-toxic and biodegradable thermoplastic. It uses an FDM (Fused deposition modelling) process to capture fine detail and print complex shapes.

Live monitoring allows the printing process to be monitored through a smartphone and the built-in camera also acts as an automatic error detection feature.

Siemens showcases digital factory

The Siemens factory in Amberg, Germany believes it is paving the way for 'Industrie 4.0'.

The factory already has products that communicate directly with machines, with many of the processes optimised and controlled autonomously through its comprehensive IT infrastructure.

The factory employs production methods that will be become standard in many of the firms manufacturing facilities over the next few years. Products in the plant control their own assembly needs by directly communicating individual specific requirements to assembling machines. It hopes it could lead the way for industrialised mass-customisation of products.

Production is largely automated, with machines and computers responsible for 75% of the value chain. Products are touched only by human hands at the beginning of the process when basic components, for example a bare printed circuit board, are placed on the assembly line.

Offering some encouragement to employees the company insists that, 'humans remain indispensible for developing products and production processes, for planning production, and for handling unexpected incidents'. Time will tell how true these sentiments are for the manufacturing industry at large.

The factory produces the company's Simatic products, ironically these are integrated industrial automation systems. In total one is produced every second in the 230 working days of the year.

Events

MANUFACTURING & ENGINEERING NORTH EAST 2015
8-9 JULY, NEWCASTLE

ENGINEERING-ASSISTED ORAL & MAXILLOFACIAL SURGERY
20 MAY, LONDON
Engineering-assisted surgery and additive manufacturing technologies are being increasingly used in the medical sector to create orthodontic and maxillofacial implants that are rapidly produced, and individualised for each patient.

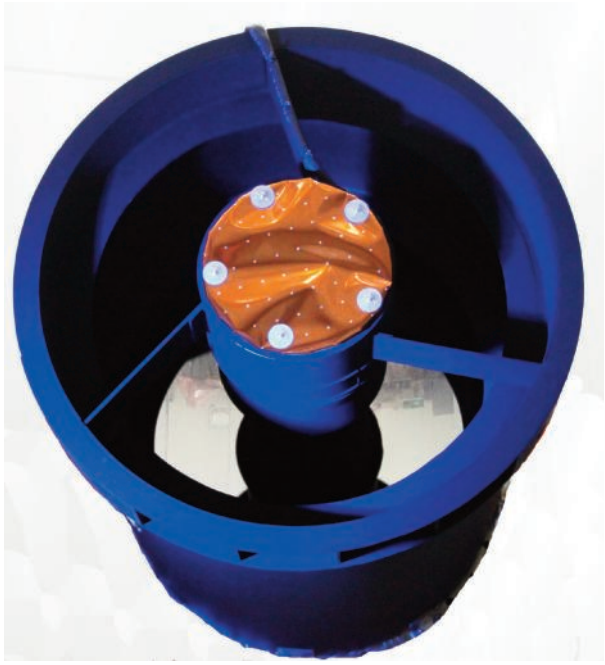
This conference will bring together experts from both engineering and medical sectors, to explore and assess the current applications and future potential of these technologies within the NHS.

Improved gesture recognition in cars

A collaboration between Vidantis and Gestigon is set to bring improved gesture recognition systems to vehicles. The partnership has seen a low-power vision processing IP platform paired with skeleton tracking and gesture recognition algorithms.

Image sensors already used in cars include depth-sensing technologies, which can be used for skeleton tracking inside and around the car. As the driver and passenger's pose or gesture, signals can be formed and used as control for a variety of multimedia platforms in the car, without causing the driver much distraction from the road ahead.

The scalable, efficient processor already powers millions of cars on the road, and can be used in the low-power implementations of the algorithms.



Venus space camera ready for integration

Elbit Systems has delivered the Venus Space Camera to the French Space Agency, Centre National d'Etudes Spatiales (CNES). The camera is the result of collaboration between CNES and the Israel Space Agency (ISA) to develop a satellite system for scientific studies of land resources, such as the environment, vegetation, agriculture and water resources.

The Electro-optics Elop was chosen to develop the camera, based on capabilities of high 12-band spectral resolution and 5m ground resolution. The camera has been examined to establish that it will withstand harsh space conditions and maintain its performance capabilities.

The camera will be integrated onboard the satellite in the coming months ready for the launch. It joins the Neptune and Jupiter space cameras.

Next gen Pi

Raspberry Pi 2 - the next generation of the hugely popular single board computer – has been launched by its distributors and features upgraded capabilities, faster processor cores and a doubling in memory capacity to 1GB.

Raspberry Pi 2 incorporates the Broadcom BCM2836 application processor, containing a powerful ARM Cortex-A7 quad-core CPU running at 800MHz. This new processor makes the Raspberry Pi 2 more than six times more powerful than the first generation Raspberry Pi Model B+. The board layout, multimedia subsystem and peripherals remain fully compatible with the Raspberry Pi Model B+, including the use of the extensive 40-pin GPIO connector, four USB ports and an efficient switching power supply.

OEMs will also be able to benefit from the new board's greater processing capacity as well as the Raspberry Pi platform's record of reliability and robustness. Those involved in educating the next generation of young programmers will also take notice of this highly capable new board.

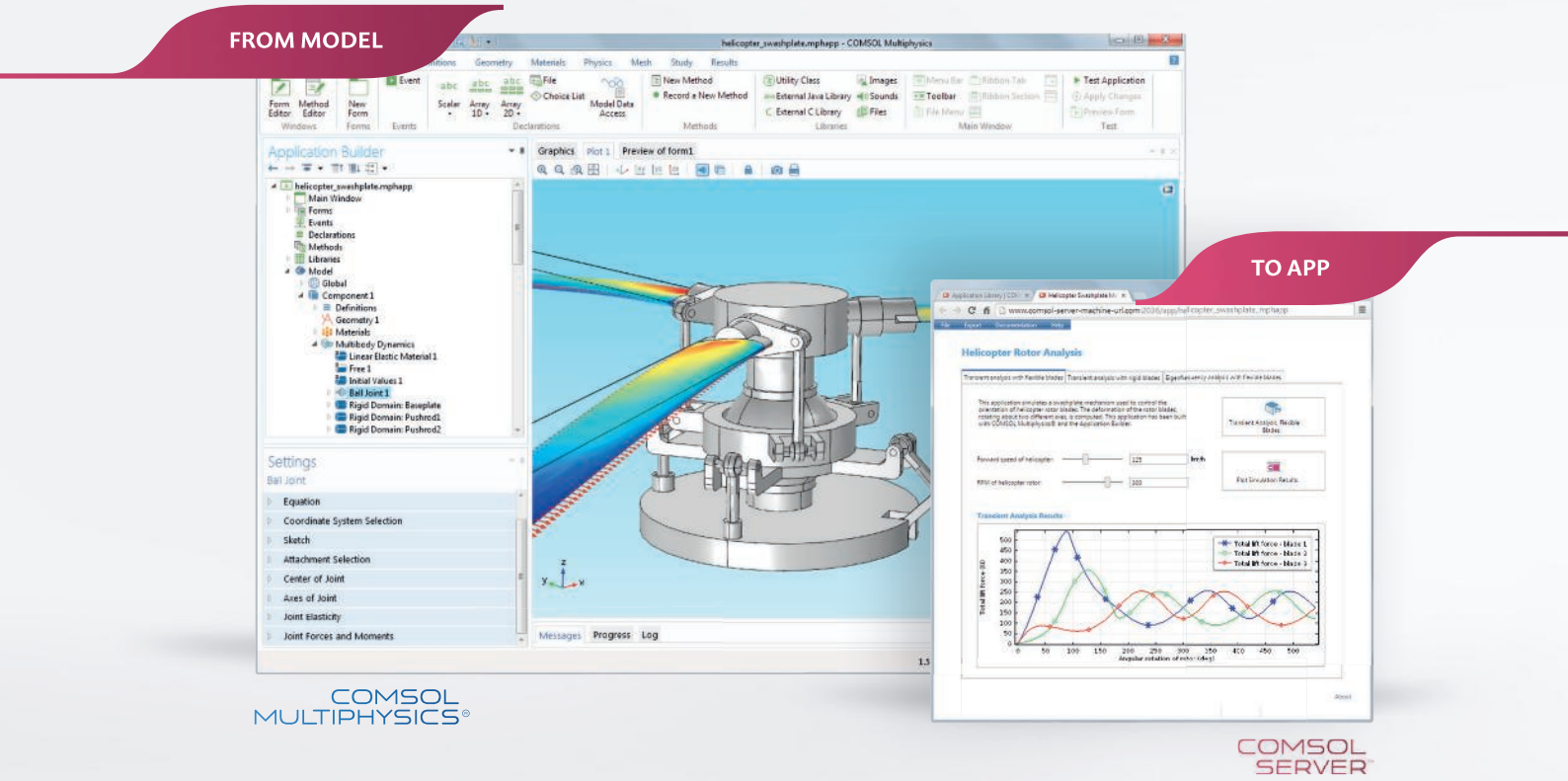
TECH BRIEF Robot offers social care

Researchers at the University of Hertfordshire have developed a prototype of a 'social robot' as part of its ACCOMPANY (Acceptable Robotics Companions for Ageing Years) project.

The robot uses the Care-O-bot 3 platform and works within a smart-home environment to support independent living for the elderly, working in partnership with their relatives or carers.

Over the past three years, the team has carried out a range of studies in the University's Robot House, such as detecting the activity and status of people in a smart-home environment and the robots' ability to remember and recall.

Evaluation by elderly people and their formal and informal carers was carried out across France, the Netherlands and the UK. Results demonstrated that a social robot can potentially help to prevent isolation and loneliness, offering stimulating activities whilst respecting autonomy and independence.



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NEWS

Rail industry urged to install track side solar

Installing solar panels alongside railway tracks could save Network Rail £30m and 895,000 tonnes of carbon per annum according to consultancy firm WSP. It calculates that if solar panels were to be installed on 50% of trackside land, the scheme could generate 2.44GW electricity, which is around 40% of the electricity Network Rail currently uses to power trains.

While installation costs are estimated to be as high as £2.9billion, annual savings could lead to the system pay back in just over 12 years. WSP's Barny Evans, said: "A scheme like this could generate revenue of £235m in its first year, a return on investment of over 8%. It benefits from having two guaranteed revenue streams – firstly through the Feed-In-Tariff for renewable electricity, but also by selling the electricity back to Network Rail at a reduced rate."

Bloodhound fame

SEMTA, the engineering skills organisation, has announced that Mark Chapman is to be its 2015 investee into its Hall of Fame. Chapman is Bloodhounds chief engineer. This award celebrates the most inspiring and innovative British engineers, from the eighteenth century to the present day, and looks to the future of British engineering by recognising the amazing achievements of contemporary engineers.

More structure

Altair has announced new OptiStruct solver capabilities that expand topology optimisation support for the use of additive manufacturing.

OptiStruct is an award-winning technology for topology, topography, size, and shape optimisation that is included in computer-aided engineering suite Altair HyperWorks.

TECH BRIEF

Auxiliary arm of joints and drive unit is driven by robotic technology

A video from igus shows how its robolink technology is being used to create an auxiliary arm for wheelchair users. The arm is made up of articulated, multi-axis joints and a drive unit, with a three-jaw angle gripper.

The modular design produces 5-degrees of freedom, with variable arm lengths for pick and place operations.

When equipped with a direct drive incorporated within the joint, the modules can be combined to create lightweight and cost-effective articulated arms with up to six degrees of freedom.

www.igus.co.uk

UK components vital to Rosetta success

The success of the Rosetta satellite mission late last year has been lauded as marvellous example of modern engineering success. But behind much of this success has been UK component manufacturers subtly applying innovative techniques to this historic mission.

Reliance Precision in Huddersfield manufactured the gears used on the satellite, which continue to play a vital role in rotating the two 15m solar arrays so they are perpetually facing the sun. They have been a crucial function given that Rosetta has no internal batteries and relies entirely on solar energy for electricity.

Andrew Wright, managing director at the firm said: "There is something very satisfying about knowing our components are not only performing perfectly after 10 years, but are doing so in deep space at a distance of around 500 million km from our works here in Huddersfield."

Wave energy boosted by cascade gear

A Swedish company says it has cracked the challenge of scaling up wave energy, with the help of technology from researchers at KTH Royal Institute of Technology.

CorPower Ocean's wave energy system uses a gearbox design that KTH researchers helped to develop. According to the company, the system generates five times more energy per tonne of device, at one third of the cost when compared to competing technologies. Energy output is also three to four times higher than traditional wave power systems.

Known as a point absorber, CorPower's converter consists of a buoy that absorbs energy from the waves, plus a drivetrain that converts the buoy's motion into electricity.

CEO, Patrik Möller, said: "Unlike other wave power systems, ours actively controls the timing between the buoy and the incoming wave, with the help of a unique drivetrain. We can ensure that it always works in time with the waves, which enhances the buoy's movement and uses it all the way between the wave crest and wave trough and back in an optimal way, no matter how long or high the waves are."

Solution to last month's Coffee Time Challenge

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The solution to last month's challenge – to come up with a clean and efficient method of personal transport comes in the form of an electric monocycle. While it may sound like something out of a sci-fi film, the slim line cousin of the Segway is being increasing spotted around UK cities.

It might look like the hands-free riding is going to be difficult, and while there is no doubt that they will appeal most to the younger generation and those with a keen sense of balance, a series of gyroscopes and sensors help riders keep balance.

By leaning forwards and backwards, changes to the rider's centre of gravity controls the speed and braking of the monocycles. And with a top speed of just 12mph, most falls shouldn't cause too much injury.

Many variants are now available including those with stabilisers, two parallel main wheels, handle bars as well as a seat, all aimed to help add more balance to those that need it. But they all share similar attributes in that they can cover around 15 miles on a single charge and fold up into something the size of a briefcase – much easier to take on the train and in to the office. And recharging takes just over an hour. Perfect for that morning commute to the office.

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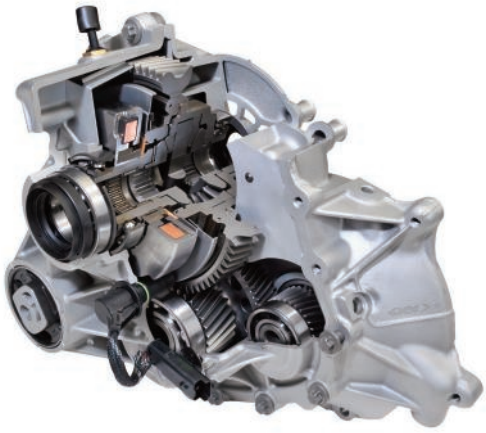
NEWS

Porsche awards GKN Driveline for eAxle



Porsche has awarded GKN Driveline the status of Technology Partner for its development of a high-performance eAxle for the 918 Spyder, a plug-in hybrid supercar. The eAxle module supports full-electric mode, all-wheel drive and provides a boost function.

The vehicle set a record lap time at Nurburgring and of achieved fuel efficiency of 3litres per 100km.

The eAxle that supplements the 918 Spyder's hybridised 4.6litre V8 is an evolution of the company's eAxle drive. The module has maximum power of 95kW and can deliver up to 1500Nm of torque to the front wheels via a fixed gear ratio.

A specially developed compact differential engages the torque seamlessly, giving optimum power distribution at all times. The differential also disengages the module to minimise drag losses and maximise efficiency.

At speeds above 265kph, a clutch isolates the electric motor to prevent it from over-spinning. To achieve the low centre of gravity and ground clearance, the output overhead was positioned using a lubrication concept to manage the oil flow.

The oil reservoir is positioned above the geartrain allowing it to be gravity-fed down onto the bearings and gears until it reaches the high-speed input at the bottom where it is then circulated back to the oil reservoir at the top. This minimises the amount of oil on the input shaft, keeping churning losses to a minimum. To ensure the critical areas remain lubricated even in disconnect mode, the motor is driven for brief, intermittent intervals to maintain a constant flow of oil.

The vehicle's tight packaging also means there is almost no air flow around the transmission; water cooling was needed to manage the heat generated by the module's high power density.

GKN Driveline's president of engineering, Peter Moelgg said: "Being selected as Porsche's Technology Partner on the 918 Spyder programme was the perfect opportunity for our global e-drive team to demonstrate how putting the right technology on board can improve both fuel efficiency and dynamic performance. Our eAxle technology continues to evolve and we expect many more high-performance vehicles to adopt similar driveline concepts in the coming years."

Drone market continues to soar

A report by IDTechEx has forecast dramatic growth in the use of UAVs for both consumer and defence applications over the next 10 years.

Most of the market value today lies in military applications, both for electric and the majority non-electric versions. However, it is small UAVs that are increasing in sales fastest, which are primarily non-military applications.

From 2026, civil uses will greatly exceed military in market value, says the report, with small UAVs achieving $2billion in sales in 2025 generating over $20billion in benefits in agriculture, border protection, parcel delivery, warehousing, coastguard, customs, search and rescue, medical emergency, mine detection, protection of rare species and movie production.

The report evaluates various enabling technologies including lithium batteries, motor advances, lithium-ion capacitors, silicon carbide and gallium nitride power semiconductors, as well as multi-mode energy harvesting. It also discusses the rapidly changing powertrains, the uses, participants and benefits.

Raising the BAR

If you have the best sailor in Olympic history, sailing the best boat available, then the long wait for a British victory in the America's Cup could be over. Easier said than done, of course, as Tim Fryer found out.

Sailing competitions are all about the best sailors? Not so says Andy Claughton, technical director of Ben Ainslie Racing (BAR). "One disappointing thing for naval architects about the America's Cup is that it is actually turned into a mechanical engineering contest," said Claughton. "We have to think about things like the electromechanical actuators for the wing flaps, we have to control the dagger boards coming up and down – it is all about power consumption and getting the systems as light as possible."

In fact Claughton is leading a team of 20 or so designers. Their initial focus is to develop the technologies that will be deployed on AC45 yacht (test boats which are 45ft long) over the course of the next two years, before being included in the 62ft (AC62) version, which is the boat that will actually challenge for the America's Cup.

The rules are complex and are set by the defending champion, in this case Oracle Racing from America. The defender can contrive rules, timings and locations to suit their own purposes – an accepted quirk of the competition.

"The rules are just about fixed now," observed Claughton. "What they have done is configure the rules so it is very hard for a challenger to come up with something from left-field that will beat them. The boats are going to look very similar but the devil will be in the detail of the control system, and the hydrodynamic design and the aerodynamic control of the wing and so on. To the layman's eye they will be quite similar but to the engineer's eye they will be quite different."

Testing restrictions add to the challenge

Among the details for the 2017 America's Cup is that AC62 boats are not allowed to have been in the water for more than 150 days prior to the start of the competition. Also, the World Series of Challenger events in 2015 and 2016 will use AC45-F boats. These are 'one class' boats that are all of the same design and therefore virtually identical. The good thing about this is that it becomes a true test of seamanship, but it means that the technologies and designs that Claughton and his team are working on cannot be tested in a racing capacity until 2017. In a bid to control costs, only one America's Cup class boat is allowed to be built.

"It is part of our strategy to look beyond what rules allow us to do, and try and work out exactly what the physics of the problem are," claimed Claughton. "Then we have to come back behind the fence of what the rules

The America's Cup is a trophy that the UK has never won and, as a maritime nation, there is a lot of people who want to set that right." Andy Claughton, Ben Ainslie Racing

will allow and work out how to best tackle the problem. We are doing a lot of our development work on the test-bed 45ft catamarans, so we have to design smaller scale versions of what we want to do on the big boat."

The boats themselves are spectacular, seemingly flying above the surface at up to 60mph. Claughton said: "They are fully foil supported, so the whole seven ton boat is actually supported on a hydrofoil that is no bigger than a regular surfboard - the structural problems are quite severe. There are little wings at the end of the rudders, where the rudder pitch is controlled so the helmsman can control the way the boat flies."

One of the features of the America's Cup boats is that all of the power used in moving the control systems, the control for the wing for example, has to be created by the crew – the grinders. They turn grinding handles that shifts hydraulic fluid which is used to move the actuators.

Claughton commented: "It's a fairly heart in the mouth operation for the helmsman because he will press a control button and hope that the crew has actually generated enough power to move the control surfaces. It's a really strange combination of human power and technology. And a lot of energy is expended in saving energy!"

BAR will be based in a purpose built HQ in Portsmouth harbour that is due for completion in May 2015. It will house the design team that Claughton has assembled and they have a very specific deadline. It is a different mindset from that of Formula One, who demand a new car that is up and running for the start of the season. "But actually," said Claughton, "if they don't go so well in Melbourne you know you have got a race two or three weeks later and there is time for an upgrade. We can't. On 24th June 2017 an upgrade in four weeks is completely useless to us. So it is quite a different mindset."

The parallel with Formula One is relevant as BAR is working with Red Bull Advanced Technologies as consultants for performance predictions based on simulation. The logic is that there are similarities between the two forms of racing. The fastest car down a straight will not necessarily win a Grand Prix as the crucial areas concern deceleration and acceleration around corners. Equally the America's Cup now has a constrained track – there are more twists and turns, and a boat will rarely be going in the same direction for more than a couple of minutes.

BAR is therefore looking to use the simulation techniques developed in Formula One to find out how to get the best out of the boat, and that is new territory. Claughton said: "We are just in the process of working out what is the best way of getting our data to them. They are relying on us to give them a very accurate picture of how the boat performs. They are not doing any work that says how this boat will behave. We are telling them how the boat behaves and they are helping us create methodologies that will simulate the performance bit. So it is just about finding the right approach for the sailing simulator."

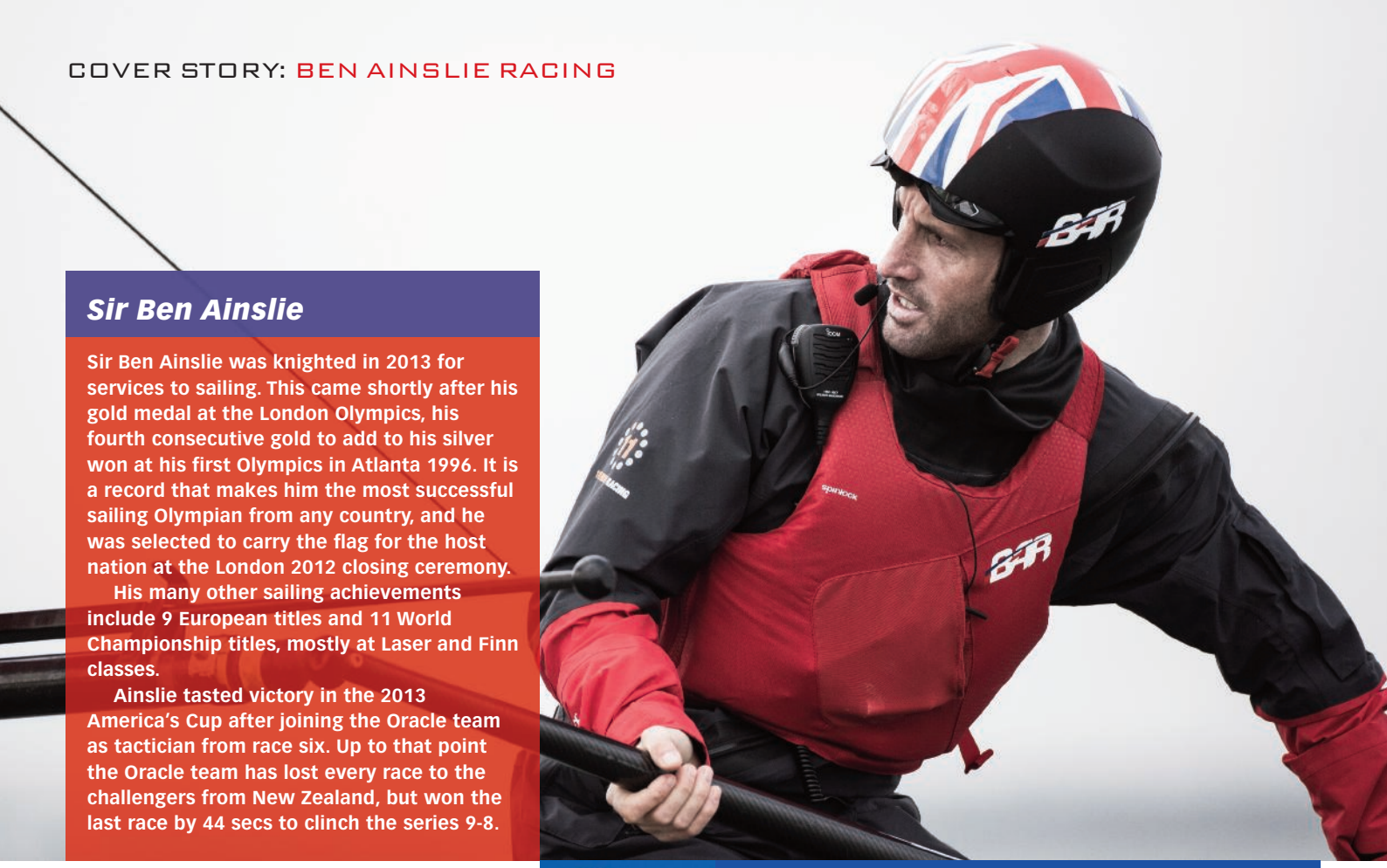
Software environment takes shape

The actual design platform is Siemens NX, which was selected partly by default. Claughton had identified who he wanted to work on his design team and the platform of choice for those individuals was Siemens NX. Siemens PLM is now a partner of the team, who also use the company's Team Centre software.

Claughton explained why the BAR designers have gone down this route: "I think two reasons are apparent to me. The NX CAD is very good with surfaces and we have quite complex surfaces in terms of aerodynamic shapes. It is very important that these surfaces are well behaved when you get right to the edges of them and that is what NX does. It is very reliable with shapes. If you do an offset inside or outside it to make a mould, it will do it. It won't crash.

"And the other thing is that we live in an environment where we are very quick to parameterise a problem, because we want to create geometries for Computational Fluid Dynamics (CFD). Also if you have got the problem correctly parameterised you can do all the work in the 2D CAD, which is the lingua franca for the construction side of things. You can start the 2D drawing process much earlier in the piece."

Jan Larsson, senior marketing director EMEA for Siemens PLM, added: "It needs to be fully integrated with all the traditional core modelling tools,



Sir Ben Ainslie

Sir Ben Ainslie was knighted in 2013 for services to sailing. This came shortly after his gold medal at the London Olympics, his fourth consecutive gold to add to his silver won at his first Olympics in Atlanta 1996. It is a record that makes him the most successful sailing Olympian from any country, and he was selected to carry the flag for the host nation at the London 2012 closing ceremony.

His many other sailing achievements include 9 European titles and 11 World Championship titles, mostly at Laser and Finn classes.

Ainslie tasted victory in the 2013 America's Cup after joining the Oracle team as tactician from race six. Up to that point the Oracle team has lost every race to the challengers from New Zealand, but won the last race by 44 secs to clinch the series 9-8.

but also be able to drive the models parametrically as well. So they can do very rough designs initially when they have all the ideas kicking around, but then they can drive the final design by tweaking the parameters they have attached to the models, saving them a lot of design time downstream."

With a large design team working on the same project it is important that the process is managed correctly. "That is why they have Team Centre in place," said Larsson. "All the revision control is managed by Team Centre. The project is split down. Normally engineers will be working on different parts of the boat, so you don't have people trying to change the shape of the hull at the same time. You are in a fully managed environment when you do this. It minimises the risk of people making changes they shouldn't and eliminates the risk of people working on outdated information." Training and support has been provided by Magenta PLM, Siemens PLM's channel partner.

The America's Cup

Starting in 1851 with a 'round the Isle of Wight' race, the America's Cup is claimed to be the world's oldest sporting trophy. It was won by America from its inception through to 1983, when an Australian team triumphed. Since then American, Swiss and New Zealand teams have won. Britain has never won the Cup.

The next race will take place in 2017 in Bermuda, a venue determined by the holders. The event, as tradition dictates, is held between the defender and a challenger. In recent events the challenger has been determined by a challenger series.

Current holder is Oracle Racing, who race out of the Golden Gate Yacht Club and who retained the trophy in 2013 in San Francisco, having first won it three years earlier in Valencia.

Control systems pass first test

The initial AC45 test boat was in the water in October last year and its initial objectives was to try out the control systems and hydrofoils. The second boat will move on to modelling the cockpits, the helm steering position, building a new wing with some different control systems and much more.

Assessing the first tests Claughton said: "We were not really looking for a performance advantage as such. These are test beds, they are just prototypes. Part of the experimentation with the first AC45 test boat was to explore some systems for adjusting the hydrofoils in terms of angle of attack and the angle of cant. We wanted to measure how much power it took to move the various control surfaces because in the AC62 we are limited to human power only, so it is really turning into a massive mechanical engineering problem. You are trying to find very efficient ways of moving these heavily loaded components because you know that you have to save the energy of the grinders. It is no fun being a grinder on one of these boats!"

However, it clearly is a lot of fun being part of the BAR team at the moment, and they are open to engage with people who can provide useful technology, although given the time sensitivity there does need to be a disciplined approach to only progressing technologies that are likely to deliver performance for the AC62.

Claughton concluded: "Who knows where the race winning widget or technique might come from? So our door is always open. We want to win the America's Cup. We want to win it well. We want to win it using British technology."

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What makes the creature crawl?

As we start the hunt for industry's finest for this year's British Engineering Excellence Awards, Tim Fryer talked to Mike Franklin, Designer of the Year in 2014, to find out what makes a winner.

Not everybody gets to make a dinosaur when they go to work but that is what can face the staff of Crawley Creatures – a special effects company specialising in static and animatronic models. Primeval, Lost World, the Flintstones, Return of the Jedi, Walking with Dinosaurs and Walking with Beasts are among the company's most recognisable projects, with the last two winning BAFTAs.

Mike Franklin is head of mechanical design at Crawley Creatures and was bought into the company to do a project for DRDC – the Canadian defence research agency – who wanted a mannequin for testing chemical and biological protection equipment. "I came here for this three month project," explained Franklin, "and haven't been allowed to leave since."

Franklin started out as a tool maker specialising in plastic injection moulding and high pressure die casting, before going on to make tools for shoe manufacturing equipment at Griggs. However, when manufacturing was shifted to China, Franklin, and thousands of others, were made redundant. It was at this time when it helps to have a hobby, and Franklin's hobby was making things, most specifically robots. "I was doing Robot Wars and I knew a few of the people at the BBC Special Effects Department by this time so I thought, I'll go into the non-adult world of special effects," said Franklin "I managed to wheedle my way into the BBC Special Effects Department, which closed a year and a half later, moved to another special effects company for a year and then came here."

That first project, the Canadian mannequin, was intended to test clothing designed to protect against mustard gas attack. While it presented challenges in terms of sensor and materials technology, it also had to be lifelike in its movement. "That's where the special effects side of the business comes in," said Franklin. "Purely from an engineering point of view, if somebody asks you to make something move from A to B that's fine. But now make it do those things and look like a human and be lifelike. That's the other side of the business - looking at studying videos of people running and walking, looking at how limbs move, and also the artistic point of getting sculptors in to sculpt body shapes and get the body to not only look like a human but be the right sizes for their anthropometric data."

"It's a bit chicken and egg. If it was dinosaur head and the customer said we want the jaw to open, we want the head to sweep left to right, rotate, we want eyes that look around and blink, you've got to have some sort of grasp of how much room you are going to have in there because that makes a big difference as to how you are going to articulate it.

But every project is different and usually the models are not required to have any longevity, as Franklin demonstrated by sticking a finger through a hole in a disintegrating liopleurodon's head. If a model was destined for a museum rather than a film set it is designed using more durable materials.

Designing from scratch for every project takes considerable creativity and versatility. And, as Franklin says, even the starting point is not always clear: "It's a bit chicken and egg. If it was dinosaur head and the customer said we want the jaw to open, we want the head to sweep left to right, rotate, we want eyes that look around and blink, you've got to have some sort of grasp of how much room you are going to have in there because that makes a big difference as to how you are going to articulate it. So if it's big enough you can fit servo motors and drives inside the head. If it is really tiny you have got to look at remote actuators and cables and push rods and some very tiny pneumatics probably to articulate. We've got some little tiny chicks - they've got the actuators virtually all built in."

The chick, pictured opposite with Franklin, was created for a Swiss milk advert, but was later used in another commercial alongside a harrier hawk – which took exception to the chicks and attacked them. Sometimes the models can be too lifelike!

However, talented designer as Franklin is, there are other aspects to his career which made him stand out when the judges were looking at the finalists for Designer of the Year.

One of these aspects is the need, in such a small company, to be

Mike Franklin - CV

Franklin started his engineering career making ‘everything from cannon to turbines’ as a teenager. He combined a lorry turbocharger and parts from a central heating system to build a gas turbine which ‘sounded like Heathrow on a bad day and ate up my dad’s lawn’.
He did an apprenticeship in tool making and a further decade making tools for the Griggs shoe manufacturing operations. He switched to the world of special effects with the BBC and later joined Crawley Creatures where he is now head of mechanical design.
In 2014 he won the Designer of the Year award at the British Engineering Excellence Awards.

Photograph: Alastair Levy

multi-disciplinary and lead a team that can grow considerably when big projects come in. "It was probably something of an advantage for me in that the initial grounding at my apprenticeship covered all bases," commented Franklin. "I was already interested in everything in any case, even from my hobby I'm doing electronics and I'm doing mechanical systems, hydraulics and pneumatics. I'm probably no expert in any of the fields but I do know enough of them to be able to pull in the relevant knowledge."

Not that design engineers in special effects are necessarily 'disciplined' in the same way that ordinary engineers are. Franklin explains: "If you ask them to make you something they will make it, but they couldn't make two exactly the same. There are some extremely brilliant mechanical engineers that come and put mechanisms in animals - I've got great admiration for some of them but they never design anything on paper. They're sort of craft engineers, they'll cut a bit of tin and bend it and do fantastic things with it. They are very skilled in what they do."

Another string to Franklin's bow is his proven willingness to inspire the next generation, having worked on 'Techno Games', a spin off from Robot Wars, and BBC Learning. Both were aimed at getting schools involved in technology. Franklin also went to China with the British Council to help set up a robotics project with Chinese schoolteachers.

"Any chance I get to get someone into engineering I generally take." Franklin

However, in this country Franklin believes that the current education system is missing a vital ingredient.

He commented: "I think we need to invest more in engineering [in education]. The trouble is schools now are very focussed on design technology, without anything that goes below it. There are people out there who don't want to just design, there are kids out there who enjoy making things. Kids just love making things that move and go bang. They are very risk averse now schools – I don't know if that is right or wrong. They were very unsure about building robots to fight – was it too dangerous? Well if it's not dangerous it's not fun. Unfortunately a lot of teachers don't share my enthusiasm for slightly dangerous things."

Information about how to enter this year's British Engineering Excellence Awards is on the website: www.beeas.co.uk.

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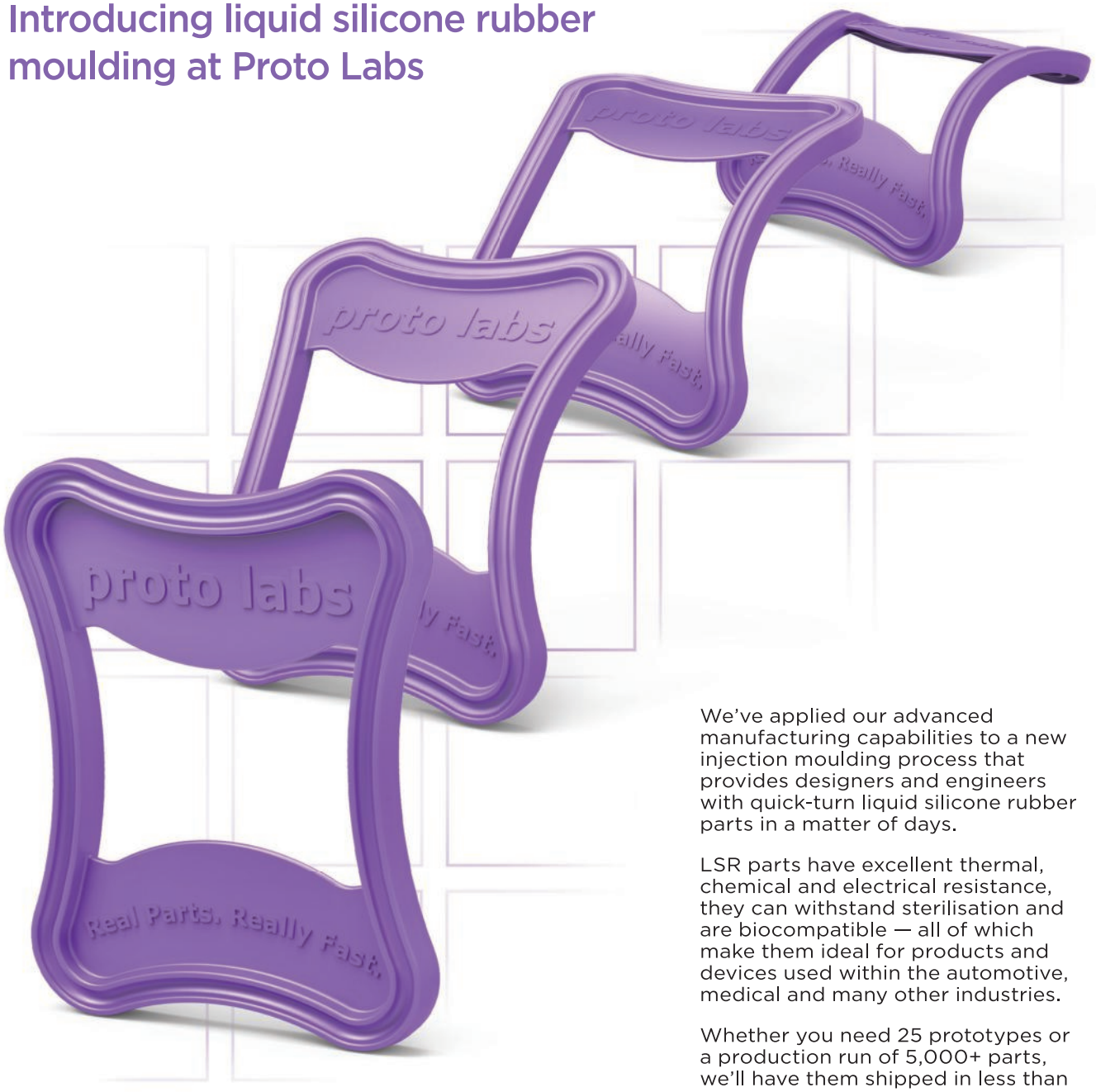

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Cowboy *rides* **the wave**

Not many companies describe themselves as cowboys in a cowboy industry. But, as Will Bateman admitted to Tim Fryer, that is where his company Ccell finds itself. It does not mean that the wave energy sector cannot foster innovation, and Bateman believes he has made a breakthrough

Over recent months the renewable wave sector has seen its two biggest players sink below the waves. Pelamis went into administration and has failed to find a buyer, while Aquamarine has downsized considerably and its future remains uncertain. Hopefully both of these companies, or at least their staff and technology, will live to fight another day, but in the meantime it leaves a void.

Will Bateman, whose company's technology is very much still in the early stages of development, gave his view on the state of the market: "Solar has been done, costs are coming down but it is really tinkering around the edges. Wind energy is still in the learning curve, but has in general settled on the three blade turbines and all they are doing now is making their devices bigger. If you look at those two sectors there are now big multinational OEMs involved in making them on a massive scale. Wave energy as a whole is the cowboy industry of the 21st century, certainly of the renewable energy sector. It is the wild west."

In other words the market is left to smaller companies looking to make themselves a name. Playing the role of sheriff in this analogy are such organisations as the Scottish Association for Marine Sciences, the National Renweable Energy Centre, WaveHub and the European Marine Energy Centre in Orkney. But these organisations provide the sector with support rather than structure, leaving the door open for small companies to come in and make a splash.

Although following a cautious development schedule, Bateman believes his company is set to do just that. The main reason for that is that he believes, in terms of the fundamental technology required to harness wave energy, that everyone else has got it wrong.

Wave energy harvesting

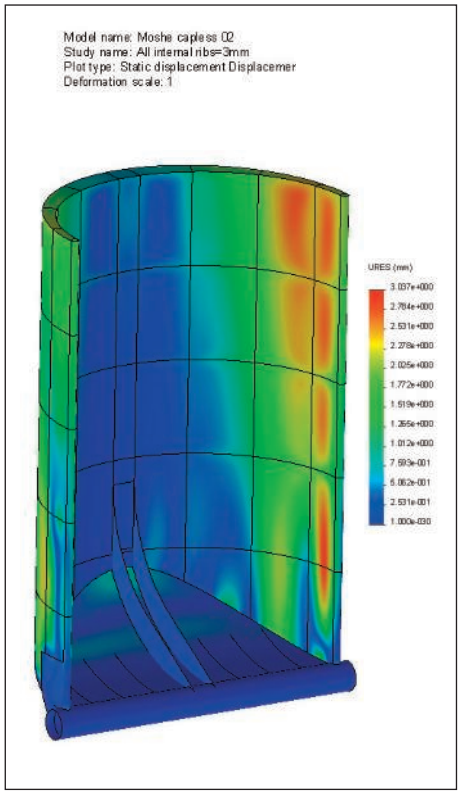
There are several different ways of trying to capture wave movement and convert it to electricity (for example, see Eureka February 2015 for a report on Wello's 'Penguin'), but a common approach, and the method used by Aquamarine, is to have a flat paddle that is pushed forward and backwards by the waves, effectively then converting this into a linear flow that can be used to power a generator.

The logic behind this is that the particles in water move approximately in an elliptical way, allowing the symmetrical paddle to be pushed back and forth. However, Bateman questioned this for a number of reasons. Firstly the amount of turbulence created around the edges of the paddle was making movement less efficient due to counterflows acting against the paddle. Secondly was the notion that as the paddle swept in one direction it created waves and Bateman believed that it was therefore using up energy in doing so. If all the wave energy was being captured then it would theoretically leave a flat calm behind it.

Most significantly is that the flow in energy of waves goes in one direction. Local waves are produced by the wind, but swell waves come in from the Atlantic and are long period waves. These are not affected by local waves, they are consistent, they go in the same direction (or are defracted round land masses), and they are generally the ones that renewable energy generators are interested in.

"So why then are we building a symmetric system," asked Bateman, "when it is an asymmetric problem? I thought if I am going to make an asymmetric solution then naturally I am going to make a curve. A curved paddle will displace the same amount of water as a flat paddle, but the circumference will be longer, meaning the wave heights are smaller, and the energy in the waves is proportional to the wave amplitude squared. That was my Eureka moment."

Bateman continued: "So what we did was take that to UCL and ask them to test it and from there



it has snowballed. At first a student rigged up a flat panel and a curved panel with identical dampers from a car boot, and the curved one moved 40% more. So I got a patent on the curved paddle."

The proving and prototyping phase has turned into a lengthy one and started with more thorough tests at UCL using different shapes. Bateman said: "The results were categoric. We were probably able to generate two to three more times power from a curved paddle rather than flat.

"The last year has been spent proving the physics. The commercial side of me says we have got something that works - go and get it in the water. The rational side says until we know exactly the physics behind it, why it is better than everything else – and we believe this to be the most efficient device on the planet – until we can do that our ability to innovate is only as strong as our current knowledge is."

Not all progress has been smooth. Tests last year in a giant water tank in Plymouth involved covering the device in a grid of pressure sensors, designed to test the water pressure on the paddle. Bateman said: "In Plymouth we weren't actually successful with the pressure tests. We got some indicative results but there was too much noise in the signals. There was a lot we underestimated, the sensors themselves weren't accurate enough,

"One of the big problems we have is that no one shares any data. I know the government is frustrated by this. So while some companies do brandish around some claims, I have never seen hard facts. It makes it hard to determine if we are good, bad or fantastic." Bateman

we were getting too much noise on the connections... but it was the first big test we've done. We had modelled the pressures with our CFD but we wanted to actually capture that physically. You learn more from your failures than you do from your successes they say, so we learnt vast amounts in Plymouth last year!" The CFD modelling is done in the opensource package OpenFOAM, which includes a turbulence feature.

Tests take to the water

The next iterations of the design are being put to test just off the coast of Cumbria which are on a larger scale – approximately 4m high. One of the important aspects here was to establish that the design could be made easily and partnering a ship repair company, MPM, it has passed this test. Small companies like Ccell need to build up expertise around them. Bateman said: "What we are trying to do is to find people who have an interest in doing some research or developing new capabilities that matches with something we need. Hopefully there is a meeting of minds and we can go off and do something clever with them."

MPM's devices have been constructed in steel, which the company is comfortable working with, while previous lab versions had been made in aluminium. An anticipated tie up with the National Composites Centre in Bristol shows the direction Bateman is looking at following. He commented: "Composites come with a whole host of benefits - corrosion proof, super light, strong and it also allows double curvature. The flip side is that making a prototype in composite typically means making a mould. We are looking at 3D printing smaller models."

Along with material and mechanical design it is also vital to create the most efficient way of converting the energy and also controlling the panel so that it is always in the right position to be efficient, and this is an area that Bateman again expects to rely on the help of others in his unofficial consortium, notably in this case the Universities of Bath and Exeter. "We will only be as successful as the people we involve and bring in around us," he added.

The next phase of the project should raise the technology readiness levels from around five to nearer seven or eight and by 2017 it is anticipated that five devices will have been deployed in the water at least one of them for over a year.

It is an exciting market yet one that awaits the breakthrough, with several small companies like Ccell leading the charge to identify a winning technology. Bateman concluded: "If anyone gets their device to work then they go from being worth thousands of pounds to billions because there is so much coastline."

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Tests in the wave tank at Plymouth, demostrated the need for improved sensor strategy

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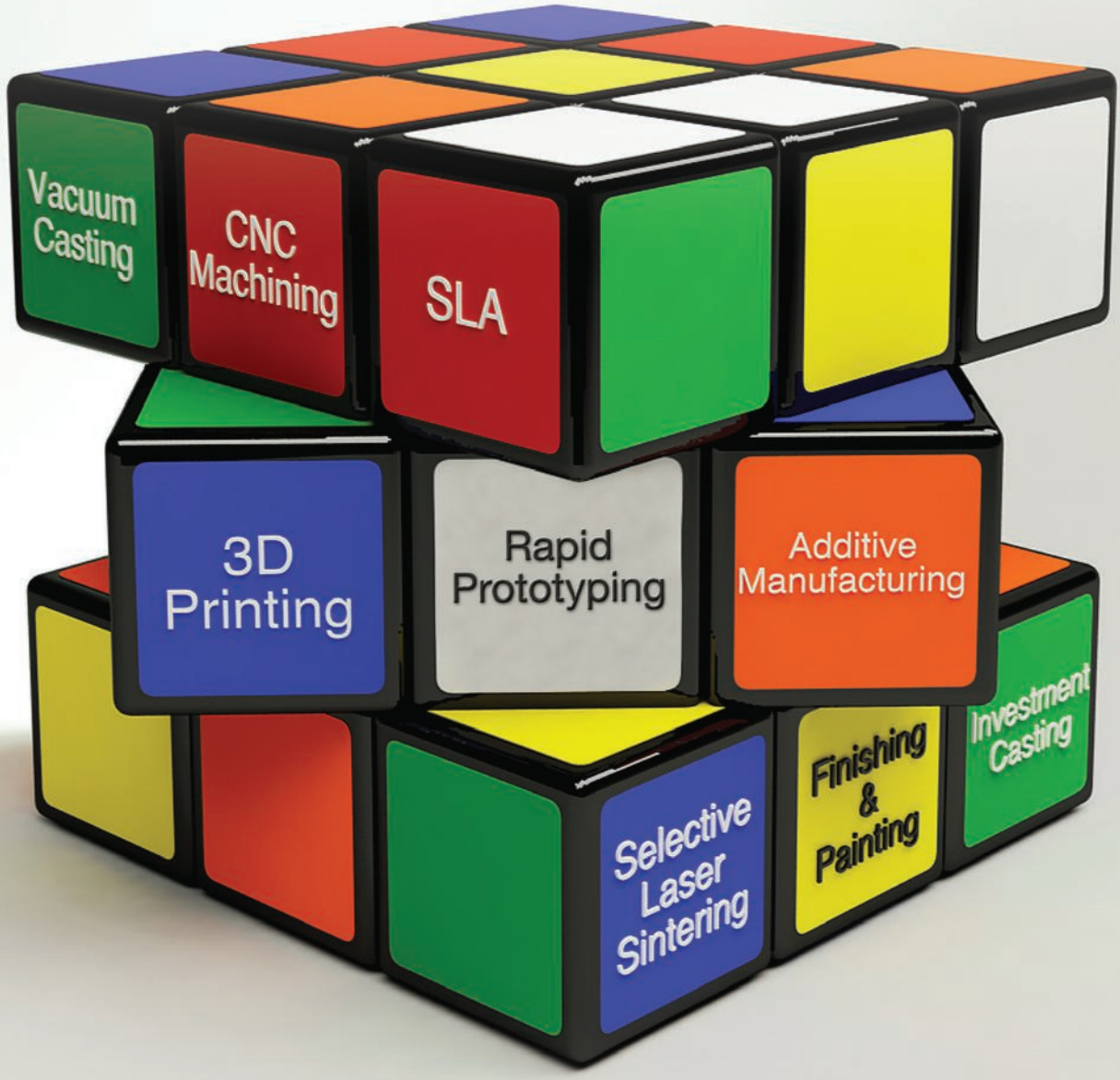

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THE QUIET **REVOLUTION**

The 3D printer has emerged as the saviour for all those experiencing prototyping problems – right? Not necessarily according to John Tumelty, who argues that other options are sometimes better suited.

Design engineers wanting to create prototype parts have to face a variety of challenges. For those working for OEMs, be they large or small companies, the problem is always the same: getting the necessary parts made, with the desirable mechanical qualities, without interrupting production. The product design department and the production department are often at loggerheads: the latter intent on hitting a weekly schedule, the former desperate to squeeze in a few prototypes to help validate their latest design. It's an awkward situation and one usually where production, as the revenue generator, gets precedence.

The design engineer working independently or for a small bureau also has his or her challenges when faced with creating usable prototypes. Most will not typically have access to manufacturing facilities and will, therefore, outsource. However, subcontract manufacturers don't always hit delivery dates, and getting a small number of prototypes made is often extremely expensive. In the past, manufacturing economics has always dictated that high volume equals a better price per part.

When designers today think about prototyping they are usually drawn to increasingly popular 3D printing (additive manufacturing, as it sometimes called), believing it to be a panacea for turning design concepts into reality: download the CAD file, load the material, push the button and walk away. Job done, right? Well, not quite.

3D printing is an extremely versatile tool, but it is better suited to pre-prototype analysis. Here it can provide highly beneficial insight into initial shape, scale and fit. The process is also invaluable for producing parts that are simply not possible using other technologies.

"designers get real precision components in real materials" Tumelty

While 3D printing has its place in the art-to-part process, for components more suited to the intended end-use application, design engineers want prototypes in design-intent materials that are manufactured using production-intent processes. This is because substitute materials have little if any validity under real operating conditions. Designers want to test parts for form, fit and function, as only this combination can deliver the confidence a product development team needs before moving from prototype into volume production.

It's comes as no surprise then, to find that more and more design engineers are seeking better solutions to the rapid prototyping dilemma. As a result, there now exist third party manufacturers specialising solely in this area, offering an ultra-fast resource for custom injection moulded and CNC machined parts delivered in as little as one business day.

Such services are designed to be accessible to everyone, even those with no prior experience of the manufacturing processes involved. Online quotation services simplify the process for the user. These online tools represent time- and cost-saving systems that are already benefiting design engineers around the world. Using such a service means that designers get real, precision components in real materials. What's more, they will be made using the same processes and technologies deployed in volume production.

The types of parts that can be made using these advanced rapid prototyping methods are

many: from smartphone accessories, cable system components and bearings, through to equipment for sports, leisure and outdoor pursuits. There really are no limits.

So, how is it possible to make injection moulded parts, for example, in such a short timeframe? Firstly, the supplier has to have a proven and lean process, from receipt of the CAD model through to parts delivery. Secondly, the issue of the mould tooling has to be addressed. Clearly it is unrealistic, both from a cost and time perspective, to produce fully hardened, tool steel moulds. The alternative, therefore, is to use advanced aluminium alloys.

Aluminium is far easier and quicker to machine, and allows the elimination of costly and time-consuming custom engineering tasks that are normally associated with tooling development. Such moulds can be produced rapidly using a negative of the 3D CAD model to digitally design the two halves. Within a day the mould can be in the polishing process, where extremely high levels of finish can be achieved to ensure the production of high quality components. The mould is then ready for loading to the press, thus facilitating the delivery of parts to the design engineer in ultra-quick time.

Any designers concerned about the longevity of an aluminium mould might be surprised to learn that they are normally suitable for many thousands of parts. In fact, there's little reason they cannot last a lifetime, albeit with the intervention of appropriate maintenance when required. Volumes such as these push this rapid manufacturing service way beyond prototyping. After all, in the grand scheme of things, relatively few products are produced in millions. With this in mind, there's no reason why an aluminium mould cannot service a product's lifetime production run, making it an extremely cost effective option.

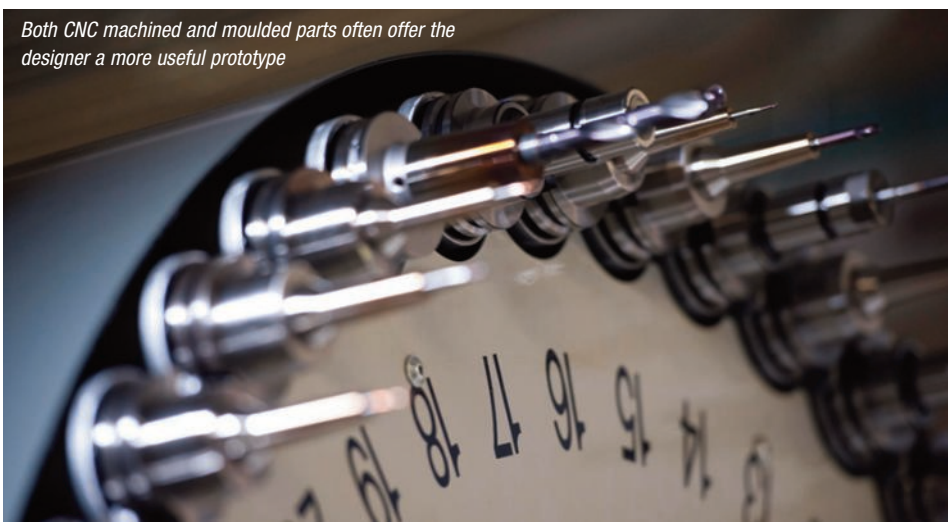
Injection moulding with aluminium alloy moulds is no different to conventional injection moulding, in that thousands of engineering grade resins are available that produce strong moulded parts with excellent finishes. As an industry standard process, it's an excellent predictor of manufacturability when moving to volume production, and allows full, functional testing on actual moulded parts. Moreover, because of the speed of such services, many customers are able to develop hard tools in parallel, thus reducing that all-important time to market. Any issues arising from testing can be quickly fed into the hard tooling process. This concurrent engineering strategy is invaluable in expediting many solutions.

The story is similar for rapid prototyping using CNC machining. The machines deployed are the same as regular machine tools operating in subcontract facilities all over the world. However, the process is finely honed to deliver low volume unique parts in very quick time without any compromise in quality.

Rapid prototyping using CNC machining is a subtractive method that delivers components from billets of engineering-grade plastic or metal, giving parts with full functionality and desired cosmetic appearance. Three-axis CNC milling is used for up to six orthogonal sides of the part, to machine as many features as possible in one set-up. Typically, multiple tool sets, including end mills and ballnose cutters, will be available based on a particular material or material type – plastics, soft metal or hard metal. Final parts are nearly indistinguishable from moulded parts, making for high quality prototypes.

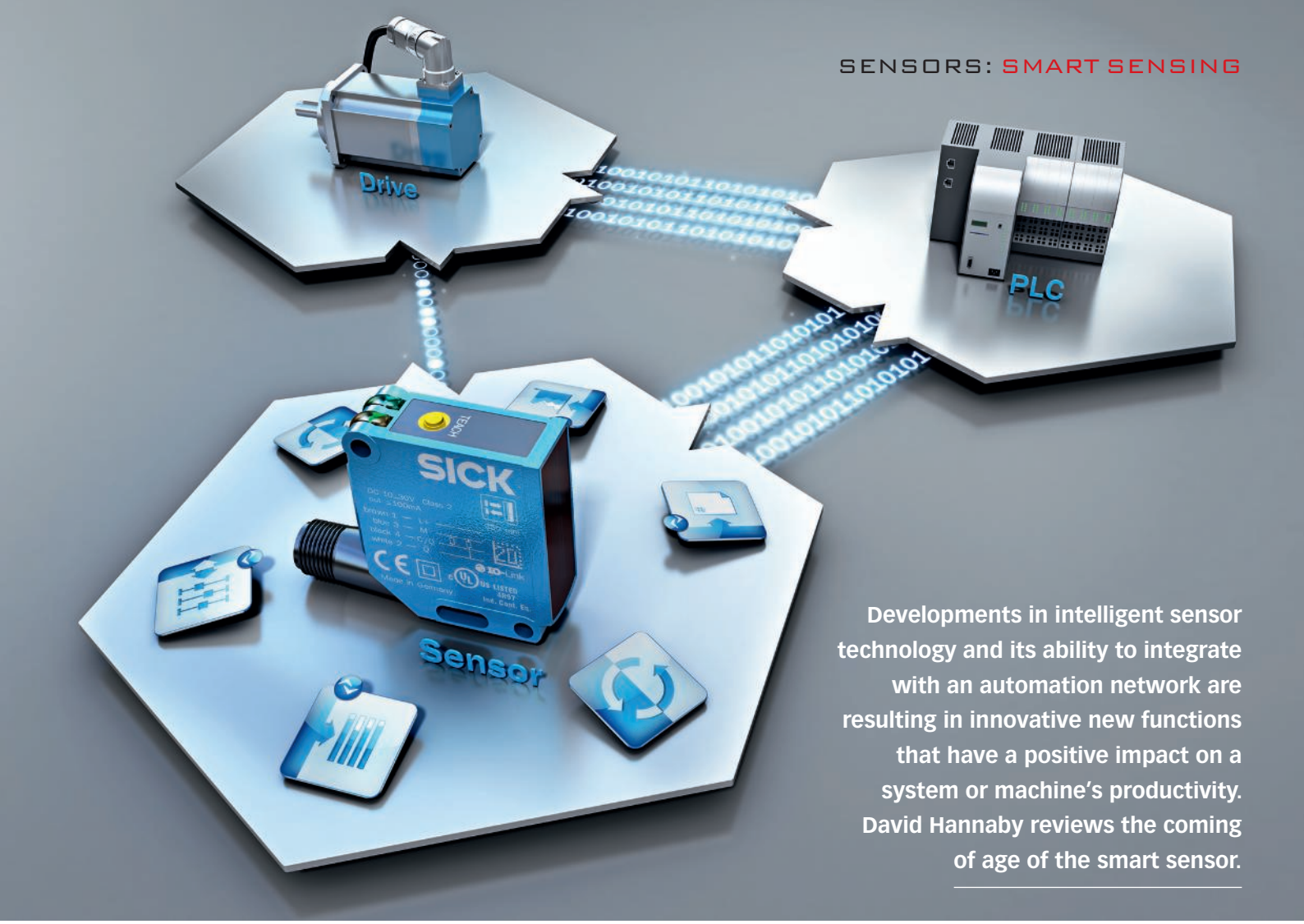
Some design engineers opt to use rapid CNC machining services at the outset for initial prototypes and assessment, before turning to moulding services for the production of final material prototype parts that allow the testing of factors such as strength, stress, functionality, performance and ergonomics. If the product uses metal parts these machined versions can be used to substitute for eventual cast or pressed production parts.

The popular press and the general public are fascinated with the idea of 3D printing. But, for design engineers in-the-know, the real revolution in prototyping is happening quietly, with a lot less fanfare. For those who have already discovered online services, getting sophisticated prototype parts in short lead-times has never been so simple, straightforward and cost effective.



Both CNC machined and moulded parts often offer the designer a more useful prototype

John Tumelty is managing director of Proto Labs
www.protolabs.co.uk



Developments in intelligent sensor technology and its ability to integrate with an automation network are resulting in innovative new functions that have a positive impact on a system or machine's productivity. David Hannaby reviews the coming of age of the smart sensor.

Sensor intelligence comes of age

Design engineers strive to boost the productivity of the systems and machines they create. By adding greater functionality into a standard sensor, it can be made more intelligent and provided with enhanced two-way communication channels to increase the flow of useful data.

Smart sensors help to manage fast processes or to speed up processes, increasing efficiency and productivity. They reduce the load on a PLC, replacing extensive PLC programming by setting and monitoring a few sensor parameters. Smart sensors also provide flexibility by remote parameter setting and parameter change through the PLC / HMI.

They do this without the need for special cabling and can be easily integrated into the PLC system via IO-Link. A wide selection of gateway cards is available from the major PLC manufacturers to integrate smart sensors into automation networks. By avoiding the need for bespoke cable systems, users can combine standard and smart sensors to create a network utilising high end sensors in critical areas of a plant or machine where they are needed.

Smart sensor functions include condition monitoring for predictive maintenance, flexible remote parameter setting, visualisation for application analysis and quick device replacement with automatic parameter upload/download.

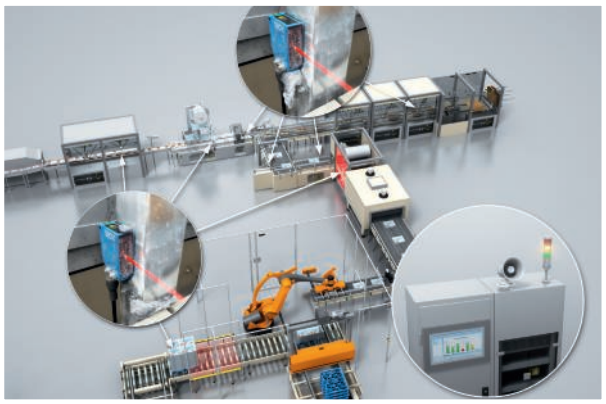
In addition, smart sensors can be equipped with add-on Advanced Functions such as a high-speed counter, a timer, debouncing and false tripping suppression, a speed and acceleration monitor, or a time stamp for security and traceability.

Smart moves away fromthe PLC

With these functions – core and advanced – we can see that logical loops have been moved from the PLC into the sensor. Real time events can be detected and analysed near to where the action is happening, without waiting for the raw data to be uploaded to the PLC, processed and information extracted before being acted on.

This facility speeds up the management of fast processes, reduces data processing capability limitations on optimum process speeds and enables higher productivity and efficiency.

There are further benefits to the deployment of smart sensors. The computing load on a PLC can be reduced by replacing the central programming with local processing functions. The flexibility and time saving offered by remote parameter setting of the sensor device from the



"The smart sensor can transform the cost of condition monitoring"
Hannaby

(Above) Condition monitoring with smart sensors
(Right) Easy and quick replacement of smart sensors

central PLC or HMI makes sense in terms of reduced downtime during process changes. Some costs can even be reduced on an application by application basis, for example an encoder could be economically replaced by a smart sensor such as speed measurement.

Applying intelligence

A guide to the power of smart sensors can best be achieved looking at the advantages of these powerful aids to more efficient and productive operation.

A common scenario in a plant is that the sensors at the heart of a mechanical process are subjected to extreme stress from a harsh industrial environment; vibration, high temperatures, contamination and mechanical shocks are common. As a result, the sensors that provide vital intelligence about the operation may fail and imperil the process.

The operatives have to pinpoint the failed sensor (it might be one of many, or in an inaccessible location), replace it and then configure the replacement using teach-in buttons. The find and replace procedure frequently results in hours of downtime which may be very costly.

On the other hand, a typical smart sensor can display its exact location on an HMI, allowing speedy location and replacement. No manual configuration is needed, as the automation system will recognise a new device and automatically download the application-specific, correct settings.

Personnel do not have to be specifically trained for teaching-in the process; all they have to do is remount and re-connect. Fitting a smart sensor with this capability is also advantageous for OEM machinery suppliers, who also operate a maintenance and spare parts supply service.

The replacement events are precisely recorded and the process is restarted once the new sensor is centrally checked as correct.

Flexible central sensor resetting

To maximise throughput and minimise manufacturing costs, many lines are run on three, eight hour shifts, with different products which may have a variety of shapes and configurations. While 'dumb' sensors can cope with this, they usually have to be manually reset with each change, a process that takes unproductive downtime and is subject to setting errors; the more complex and varied the changes, the more risk of errors and the more need for skilled personnel.

With smart sensors, all settings are centrally held and can be downloaded to the sensors from the PLC. Each product change has a suite of settings to take account of size, weight, colour, shape, material and a myriad other variations. In fact, the increased flexibility of the system allows a production line to be used for a much wider range of product types than would otherwise be possible, and even facilitate shorter runs and smaller batches than would have been possible or economical previously.

Smart monitoring and maintenance

By providing diagnostic data routinely and on interrogation, the smart sensor can transform the cost of condition monitoring and preventative maintenance on a busy production line. It allows production management to assess and tailor maintenance schedules on a plant-wide basis using real time updates of data from areas under most stress. Critical pinch points can be identified and their requirements balanced against plant segments where necessary but less urgent work can be deferred, all backed by full data.

Smart sensor based condition monitoring can give unprecedented control of a preventative maintenance programme while permitting informed schedule flexibility.

Real time parts inventory

Allied to preventative maintenance, centralised control also enables centralised inventory and documentation of all sensors, settings and maintenance work. This capability facilitates detailed record keeping for parts lifetime and replacement costs monitoring, for process traceability that allows production history to be accurately recorded.

Each of these core functions can be monitored and controlled through the sensor visualisation software which is uploaded to the PLC via a USB link. The visualisation software can also be used for simple configuration and setting adjustment of advanced functions.

To benefit from smart sensing, an IO-Link compatible with a wide range of fieldbus protocols is essential. While sensor manufacturers are rapidly building enhanced capability from the sensor end, major PLC manufacturers are also tackling the opportunity for more functionality, as are a number of third party suppliers.

The contribution from smart sensors to modern automated manufacturing is being realised more and more widely. Manufacturers like SICK are introducing 'smart' variants into their ranges at a rapid rate, realising the potential, not only to simply detect any object, often at high-speeds but also to eliminate production headaches.

David Hannaby is product manager for presence detection at SICK UK
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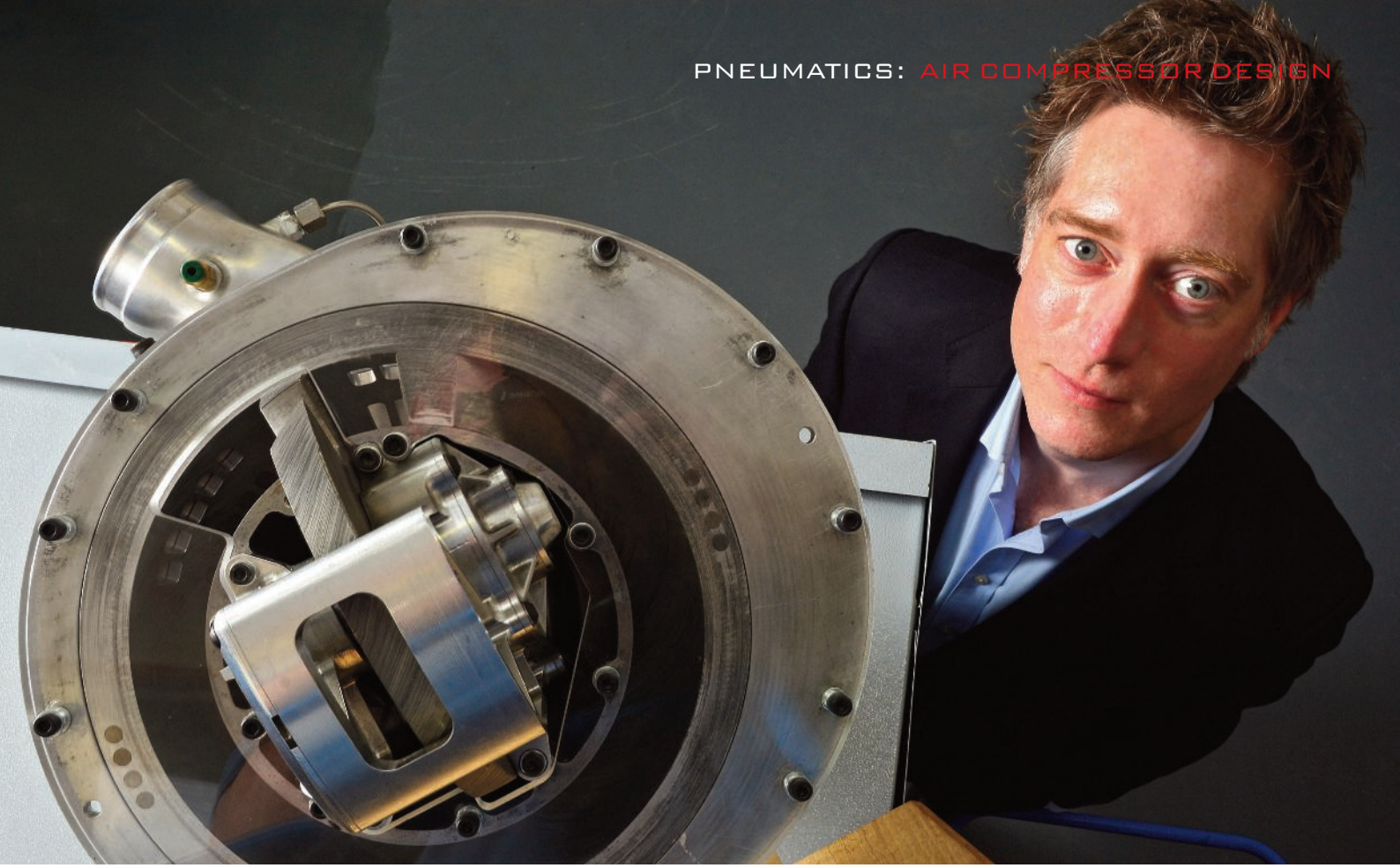

Blade cuts compressor costs

The hiss of compressed air can be heard in almost every industrial environment, but is this resource so familiar that we have not challenged its efficiency? Tim Fryer looks at a solution that claims to be game changing

Not much has happened of note in the world of air compressors for some considerable time. For the best part of a century the screw compressor has been king, with no new technologies emerging to take its crown.

This is important. According to the Carbon Trust, 10% of electricity supplied to industry is consumed by compressed air systems, so a new technology that offered a step change in efficiency levels could have a major impact.

"Everywhere where there is a piston cylinder, from compressors to engines to expanders, we essentially have a need for a more efficient mechanism," observed Steve Lindsey(pictured above) , who is CEO of Lontra. He is also the inventor of the blade compressor technology which he believes offers such a step change in efficiency.

"What we have essentially got here is a replacement for a piston cylinder," said Lindsey. "That can be everything from a bicycle pump to an air compressor to a cathedral diesel engine."

It is an idea that came to Lindsey over a decade ago and he has spent the intervening years building up Lontra and the design team. Lindsey commented: "I think they are inspired by the machine because looking at it is there isn't actually a great deal to it. It is one of those ideas that once you show people how it works they say, 'That must have been done before', or 'That's so simple'."

"The potential there is to really transform industry in the same way the screw compressor did."
Lindsey

The premise is that a good compressor needs to do four things: take in air efficiently, let it out efficiently, not leak too much and compress the air. "What was interesting was that if you look at most of the compressors that came before they are not very good at least one, if not two of those," claimed Lindsey. Screw compressors have issues with leakage, for example, and the Roots blower, the device of choice for aerating in the water treatment industry, doesn't actually compress the air.

Lontra's Blade Compressor, which is its core technology, is a departure from the traditional piston-based systems. Instead of having a linear piston that draws air in on the outward stroke and compresses it on the inward, the Blade Compressor effectively wraps a cylinder in a circle, with a constantly circulating 'piston head'. A permanently open inlet means that air is drawn in for the first 180 degrees of the device's rotation. The chamber is bisected by a perpendicular

blade, which means the trapped air that was behind the piston is now in front of it, and it is compressed for the remaining 180 degrees of the rotation and released through a series of holes in the end of the chamber.

The unique thing about this is that while the piston is compressing the air in front of it, it is drawing in the next volume of air behind it, so it is a continuous cycle. While the operation may be difficult to describe in words, its simplicity is evident when seen - there is a short video on vimeo (https://vimeo.com/90876721).

For initial design Lindsey called in the services of a draftsperson, but when Lontra came into being he started using PTC's Creo. "It is an expensive package but it is very, very good for the things that we do," said Lindsey. "A lot of our customers use the same grade of CAD package and so we can transfer documents very easily to them." Design transfer and joint development with customers is important as Lontra are not making products themselves but are selling the

A six month test showed efficiency gains of 21%

technology under licence. For this reason, and with different implementations of the designs being worked on simultaneously, the company has equipped all of its designers with Windchill, PTC's product Lifecycle management package, to ensure there is control over the design.

The key here to efficient operation is in the fluid dynamics, but the design team has not used an off–the-shelf CFD package for this. Lindsey said: "They built their own analysis package to model the compressor from scratch, which takes in everything from gas dynamics to heat transfer to wave motion. It has been fantastically powerful - whereas you hear some people who have built 1000 prototypes before they had a product that

Attention has been paid to the manufacturability of the design

worked, it means that we can virtually prototype and speed up the development process massively."

This modelling environment is based on a lot of theoretical work that has been done over the years, for example, by Gordon Professor Blair at Queen's University Belfast and also some work from the old Gas Research Council. "There was some fantastic work on the core of gas dynamics done many years ago," continued Lindsey. "What we have done is taken all of those and built them into a mathematical model specific to our compressor, so this allows us to put in specific geometry and it will spit out what size ports we should really need, what the leakage will be, what the efficiency will be and then we can optimise from there. So the IP that we are selling is not just patents, it is more of the background IP and modelling, which I think is pretty unique and it is an approach that hasn't necessarily been taken in this depth in a lot of industries before."

An early demonstration of this came with the model – the first prototype of its size - that was sent for testing to Severn Trent Water. Waste water treatment is a massive user of compressed air – according to Lindsey 1% of all the electricity used in the UK powers air compressors for sewage treatment. It is natural bacteria that actually breaks down the sewage in a process called 'activated sludge', but they need an enormous amount of air and, as that typically needs to be pumped to the bottom of a 5 – 8m tank, it needs to be compressed.

Severn Trent Water did a six month trial with a Lontra air compressor rated at 1800m^3 per hour – relatively modest by water industry standards – at a site in Worcester. The company measured the essential performance of the unit (efficiency based on power in to air out) and compared it to an existing Roots blower unit that was twice as big. The trial was conducted over the course of six months and showed an efficiency gain of 21.2%. "Industries normally chase improvements in efficiency of 1 or 2%!" added Lindsey. "And that was our first prototype of that size that showed those gains, while other compressors have been developed and gradually improved over 80 years. The next devices we have got on test are already well in excess of that original efficiency gain."

As 10% of industry's electricity is used compressing air, some basic arithmetic indicates that if such efficiency gains could be made across all industrial sectors, this technology could trim 2% off the UK's total electricity bill. And while the waste water industry has been the first target, other immediate applications are likely to include car superchargers and factories.

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Making machine contact

Many products need to be actively controlled and therefore need an interface - and that interface is important. It is the user's first point of contact with the product. Tim Fryer reports on interface technology and selection considerations

Many products use energy in some way – to alter heat, to provide light, some form of vibration or most commonly to move in one way or another. Any product that falls into this category needs some form of control, whether that is as simple as an on-off switch or one of the latest touchscreens.

Traditionally such things were not strictly the domain of the mechanical design engineer, and as such, like the power supply, often came under the category of 'after thought'. However, the HMI (human machine interface) determines how effectively a human communicates with the machine, both on an emotional and practical level. While this is accepted with consumer products, it is equally true of industrial equipment, as we address here.

Karl Rossek, product marketing manager of automation, Omron, observed: "Traditionally, the HMI was selected almost as an afterthought, simply to replace pushbuttons and lamps. Quite often today, this is still the case! However, many forward-thinking machine builders will look at the ergonomics of the HMI in the early stages of development in order to ensure that it is intuitive and enables easy operation of the machine."

"On an upgrade program," said Stuart Greenwood, product marketing manager for industrial control and automation, Eaton UK, "where potentially additional features are being added to access data for example, it is often one of the first considerations. When the PLC is being integrated with the HMI, it affects the whole architecture of the machine, and of course that decision has to be made very early on."

"Several HMIs have the ability to be mimicked on Smartphones - but you wouldn't want someone remotely starting a machine from the other side of the world!" Rossek

HMI development

The earliest form of HMI was the simple switch, replaced by membrane switches and subsequently resistive touchscreens, usually alongside some membrane switches as back-up. Ian Smith, sales manager for Danielson, described the evolution: "As the resistive touch screens became much more reliable and prices came down, people moved away from incorporating membrane switch panels with the touch screens, and they tended to be all resistive. They tended to be what we call 'closed front systems'. So you had a resistive touch screen with a graphic overlay on the front of it that was then built into a housing and could be sealed."

Greenwood added: "There are some harsh environments where a touchscreen just is not practical therefore we wouldn't recommend it. But lately we've found that the cost of touchscreens has come down to a point where they could almost be used in all applications."

There are two types of touchscreens – resistive and projective capacitive

"As often happens with any new technology, HMIs have not been immediately accepted by those working in certain applications" Greenwood

(PCAP). Resistive screens work by the mechanical pressing of a top layer (typically a polyester film with a thin coating of indium tin oxide) onto a layer beneath, and the changes in voltage, and hence resistance, identify the spot that has been pressed. One problem with this is that there are durability issues with the front layer. The other problem is that people are now used to their touchscreens operating like their smartphones or tablet computers. This necessitates the ability to slide a finger over the screen and 'multi-touch' to give a far greater degree of control.

Smith commented: "With the PCAP, if you've got a picture on there of something happening, a valve for example, then you can open up and expand it or contract it and move pages, scroll, and this sort of thing. So, it's much more versatile in terms of operation. Also it hasn't got a plastic front surface - it either has a glass or poly-carbonate front surface which is quite thick, so they are considerably more durable."

Resistive touchscreens are still widely used at the moment for applications that don't require the same depth of control, principally because they have become so much cheaper in recent years.

Integrating the HMI

Pulling an HMI into a design is not necessarily any more involved than a 'drag and drop' operation, requiring no further programming skills. Equally it could be that further integration, or to implement a higher level of functionality, could require a level of control re-engineering and software/code writing required which not all mechanical/design engineers are trained in.

And working with the HMI supplier can allow designers to enhance their products. "The HMI is often regarded as the window into a machine," claimed Rossek. "A poorly executed set of operator screens can give the impression of a poor quality machine, even if it is mechanically the best! Many machine builders add value to their machines via the HMI, in the form of production statistics, preventative maintenance, using video and other rich-media to assist fault recovery, etc."

Greenwood added: "Eaton offers a lean automation solution which uses an HMI/PLC with integrated smart cabling and intelligent remote components. Starting from the display, the SmartWire-DT (lean panel wiring system) connects pushbutton actuators, indicator lights, switchgear right up to the sensors. We can bring the world of hydraulics and the world of electric together."

"Perhaps more important is the HMIs ability to assist fault-finding/troubleshooting and speedy recovery of the machine in the event of a fault," observed Rossek. "A poorly designed and unintuitive set of operator screens can actually hinder production and increase downtime."

However, while the availability of the technology will inevitably 'push' the design of new equipment, there is also a considerable 'pull' factor emerging. Smith explained: "What we're seeing in the market is, from the companies that we supply resistive touch screens to who actually build the HMI, they are now being driven by their customers. It's really the end customers that are now wanting the new touch technology, and that again comes down, I think, to the fact that they have operators within these various plants who are of a younger age, who use their I-Phones and want to actually continue that touch screen experience across the range of products that we use in our factory."

"We are able to change the firmware so that we can make the screen more sensitive to touch by finger or by glove." Smith

Touchscreens are now being demanded by users looking for more intuitive machine control

But where will it all go? Some machine builders might prefer an industrial PC rather than a dedicated HMI, particularly if a PC is also required on the system for other things - what's the point of having a PC screen and an HMI next to one another?. Rossek said: "In these cases, just HMI software might be required, that can run in a standard PC environment. However, industrial PCs are typically much more expensive than HMIs, with standalone HMI software often costing as much as a physical HMI itself, so is generally an expensive option."

Or will the people's attachment to their smartphones and laptops go to the level of removing the need for an HMI on individual products and equipment altogether? Unlikely, according to Greenwood: "We've found that users are requesting the ability to use their everyday devices. However, the machine builder needs to use controls with multi-protocol capability to ensure they are future-proof. Smartphone and tablet operating systems change very quickly as technology progresses, and so using them could lead to issues with backwards compatibility."

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Getting a **grip**

Development of fully functioning prosthetic hand would not have been possible without some pioneering work with the motors and actuators. Tim Fryer reports

Prostheses had been recorded way back in ancient Egyptian times, but it is only very recently that technology has advanced enough to turn them from being visually acceptable, into something that is genuinely useful for amputees.

RSL Sleeper has developed the bebionic3, which they claim to be 'the world's most lifelike, affordable, functional and easy to use myoelectric hand commercially available today'. Myolectric means it takes the electrical impulses from the arm muscles and translates them into movements in the robotic hand.

The first hands of this type were designed for the US military and were restricted to large and medium hands due to the motor technology at the time. Ted Varley, technical director of RSL Sleeper, said: "Small hands would have been too weak to be functional five years ago." And this left a substantial gap in the market. While a prosthetic hand will obviously never be able to fully replicate the real thing, there were still big leaps to be made in terms of functionally, and there was not a size-appropriate option for smaller people.

Varley, who joined the company five years ago at the inception of the project, described the objectives: "The bebionic was designed as a multi-articulated hand for general patients using standard myo architecture. Hands prior to this had a very strong pinch but low contact area. The ilimb, which came slightly before bebionic, proved that people would accept a hand with a lower grip force, but with a compliant grip to give more control. But prosthesis can always be improved, the human hand is an amazing thing. Weight, power and sensory feedback would be a great improvement."

Bebionic3 – RSL Sleeper's 'small prosthetic hand' for amputees.

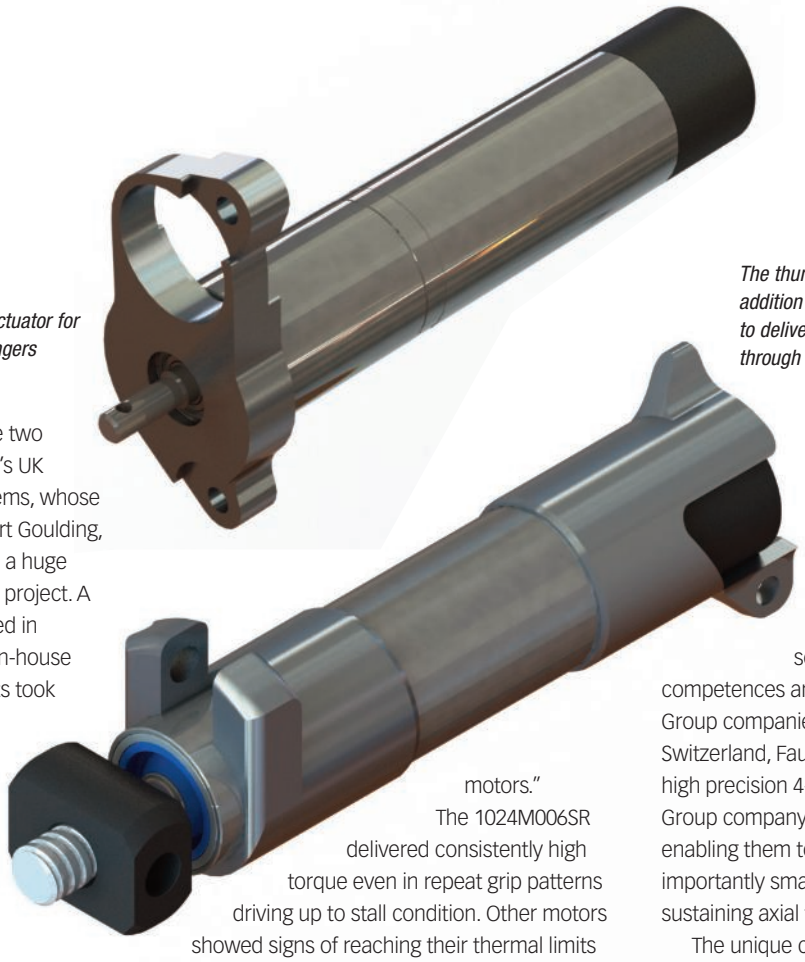
Moreover, it had to have mass market capability - it had to be cost comparable with an existing myo with simple controls in order to get lots of people using them.

Version one was introduced in 2010 and was improved on for the second version, which was faster and had the opportunity for medium sized hands. The recent introduction, bebionic3, looks better and is much stronger, making extensive use of aluminium and stainless steel. More particularly this is the 'small hand', meaning that amputees of any stature now have a bebionic option.

"Prosthesis can always be improved - the human hand is an amazing thing." Varley

The main problem in developing the small hand was in packaging – trying to match the performance of the medium hand in an extremely small space. Varley said: "We were benchmarking with a much larger motor, so we had a number of parameters to work to. I spent a great deal of time in Switzerland going though the motor and actuator design."

Switzerland is the home of Dr Fritz Faulhaber's precision micro drives facility. The high performance motor manufacturer, with headquarters in Germany, offered a potential solution to RSL Steeper's miniaturisation problems with high power motors and versatility in



The actuator for the fingers

The thumb actuator required the addition of a 4-point contact bearing to deliver the necessary power through the thumb

customisation. The link between the two companies was made by Faulhaber's UK distributor Electro Mechanical Systems, whose sales and marketing director, Stewart Goulding, commented: "Together we invested a huge amount of design resource into this project. A dedicated project team was assigned in Switzerland and a large amount of in-house testing of materials and components took place as well as regular meetings together with RSL in both the UK and at the Swiss plant."

The motor type used is a brand new series 1024M006SR, which is the strongest motor in the frame size – 10mm diameter and 24mm long. It features high stall torque of 4.6mNm. A new end cap was designed providing easier assembly with the Faulhaber range of optical and magnetic encoders. A new cover and material was used with more accurate brush positioning for increased performance even at higher temperature range, and new commutator and brushes were integrated with more accurate segment geometry for a cleaner commutation signal.

Goulding said: "A totally new coil construction was developed with 60% more copper than its predecessor and in combination with a new Neodymium rare earth magnet, exceptionally high performance was guaranteed. Improved tolerance on the shaft for better alignment and higher efficiency, improved the alignment of the bearings and their positioning reduces contamination from the brushes resulting in even higher system efficiency and longer lifetime. The advances in this motor design resulted in a huge step change and best in class performance when tested in the application and compared with other motors."

The 1024M006SR delivered consistently high torque even in repeat grip patterns driving up to stall condition. Other motors showed signs of reaching their thermal limits and not delivering consistent performance under the same operating conditions. One of the key factors of this motor is the flat speed/torque curve resulting in a strong consistent torque across the speed range. The addition of a robust planetary gearhead and 3-channel magnetic encoder with all flying leads including the motor power supply exiting from the same point together with special loom and tiny JST connectors made this combination much easier to package compared to others, according to Varley. The 3-channel 32 line encoder gave them all the positional and speed feedback data required but added just 8.5mm to the overall length.

"The biggest challenges were reaching the high power density from such a small motor."
Goulding

This was only half the story though as the requirement for a thumb actuator was altogether more challenging. There was insufficient space in the hand to mount the thumb actuator so this needed to be integrated within the thumb itself. Based on the same motor technology, RSL was looking for a complete in-line linear actuator in the smallest dimension but capable of delivering high force at the tip of the thumb.

Faulhaber was able to develop a complete actuator solution calling on the competences and synergies of other Faulhaber Group companies. Project managed by a team in Switzerland, Faulhaber were able to integrate a high precision 4-point contact bearing from their Group company Micro Precision Systems, enabling them to develop the most powerful and importantly smallest linear actuator capable of sustaining axial forces up to 300N.

The unique characteristic of the high precision 4-point (shorter than conventional bearings) contact bearing and high axial force capability meant that a considerably shorter overall actuator length could be achieved. In combination with a precision lead-screw, Faulhaber tested five combinations of nut material and lubrication before reaching the optimal performance from the actuator using a PEEK (Polyether ether ketone) material. A precision made customised enclosure with integrated pivot points completed the system.

The motors and actuators are typical of Varley's strategy – while everything down to the bolts are custom made, the actual technology behind them tend to be more established.

Varley commented: "We are looking at a number of developments, like application of ceramics and compact actuator systems. But what we are really doing is taking today's technology and bringing it together. If we were to develop the tech as well the project would have too much risk."

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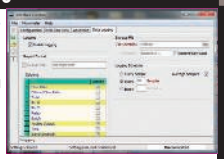
Data Recording Enables Monitoring, Reporting & Management of Process Flow

Titan Enterprises has released a new data recording version of its Atrato ultrasonic flowmeter software interface.



Easy to set-up and use the Atrato flow recorder enables data recording via an external computer. With features that provide monitoring, reporting and management of flow data - the Atrato flow recorder delivers a continuous picture of your process and a reliable alternative to restrictive and costly manual metering. The new software interface will be supplied with all new orders and can also be used with any Atrato flowmeter manufactured after June 2013.

The market leading Atrato ultrasonic flowmeter is a true inline non-invasive flow meter without the contorted flow path and disadvantages of alternative designs. It can handle flows from laminar to turbulent and is therefore largely immune from viscosity. It also offers excellent turndown, linearity and repeatability. Available in 60°C and 110°C temperature versions and a 30 bar higher pressure model - Atrato flowmeters use patented 'time-of-flight' ultrasonic technology that enables it to operate over very wide flow ranges (200:1) with excellent accuracy (better than ±1.0% of reading).

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New Sales Director appointed

Camlock Systems

Camlock Systems, a leading designer, manufacturer and supplier of industrial locks and locking systems, is pleased to announce the promotion of Tim Parsons to the position of Sales Director.

Since joining Camlock Systems, Tim has excelled in his roles. Over the coming months, he will hand over his previous customer base to his colleagues David Crook in the North and Richard Briggs in the South of England. Tim will operate from the company's head office in Eastbourne.

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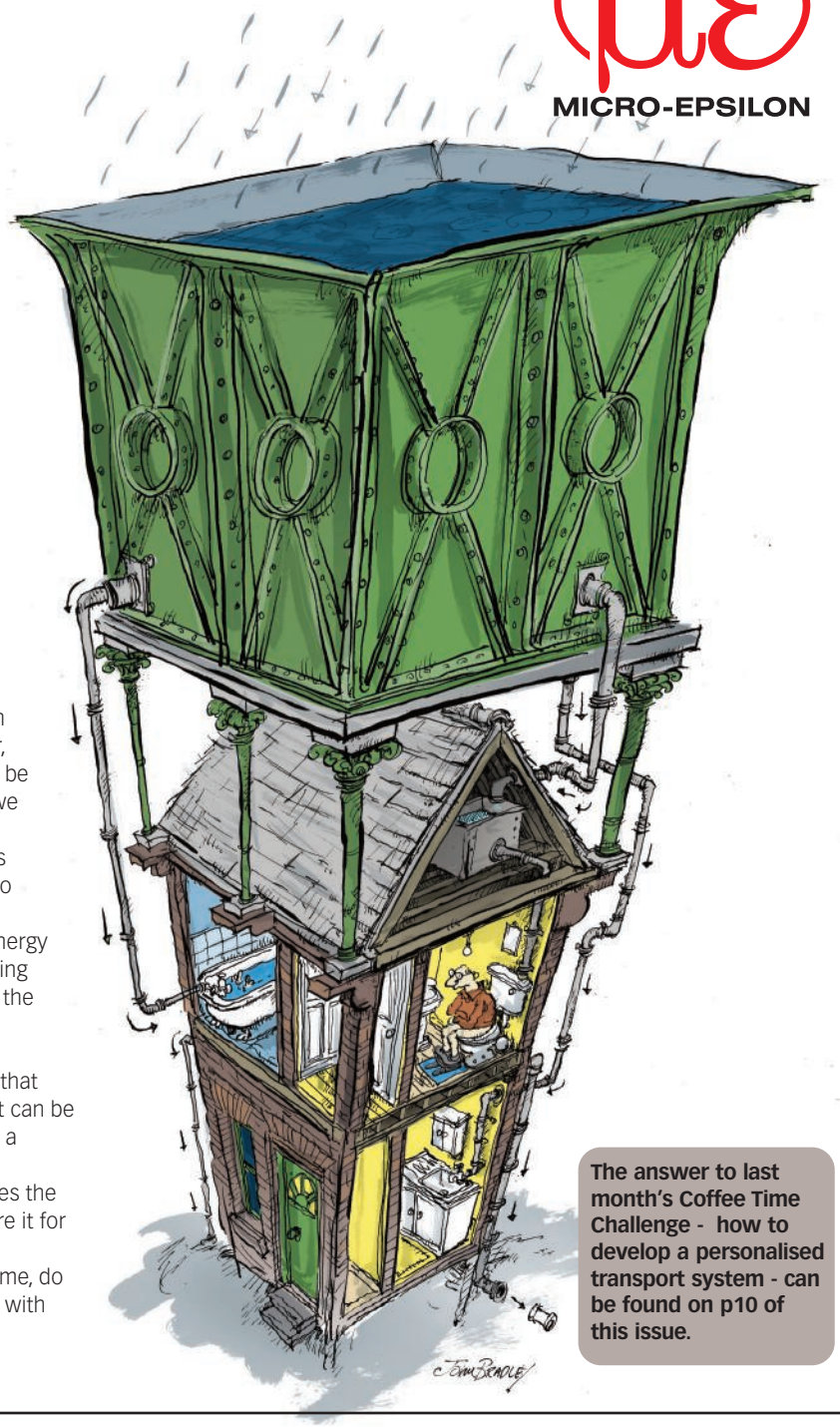
Water, water, everywhere?



Well there are certain parts of the UK, particularly in the winter of 2013/4, where water certainly was everywhere. And then in times of drought we moan that on such a wet island we seem incapable of storing water for the times when we really need it – maybe it is because we have such a wet climate that for the vast majority of the time we do not to worry about lack of rain and we become complacent. However, global climate change is apparently set to affect the UK by providing us with more extremes, both wet and dry. Water management will probably become more important as time goes on.

The challenge

So what we are looking for here is a way of capturing water when available, possibly even reducing the affects of flooding. However, unlike a reservoir, we don't want to just collect water, we want to be able to move that water into a useful location. Most particularly we want to create system for domestic use, capturing rain water, filtering it enough for commercial or household, non-potable uses and storing it in a water tank at sufficient height to allow gravity to distribute it as required throughout the building.

However, climate change we are often told is a result of the energy we consume, so we don't want to further contribute to this by using electricity-guzzling pumps. So any pumping that is required to lift the water must therefore not require electricity or other such non-renewable energy source.

Given that we are not going to be building eco-houses just so that we can incorporate this system, we are looking for a solution that can be easily and cheaply retro-fitted (and maintained), possibly even by a reasonably competent DIY-er.

We have a system in mind that does all of the above – captures the water, cleans it and shifts it to wherever it is that you want to store it for immediate or future use, all without using any electricity.

We will reveal our solution in the April issue, but in the meantime, do you have a solution to this challenge that you would like to share with us, please email the editor at **tfryer@findlay.co.uk**

The answer to last month's Coffee Time Challenge - how to develop a personalised transport system - can be found on p10 of this issue.

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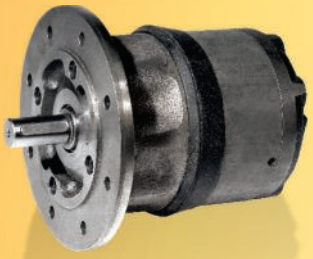

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