

EUREKA

THE MAGAZINE FOR ENGINEERING DESIGN

In this issue: Rapid Prototyping • Sensors, Test & Measurement • Design Software • Medical

Evolution or revolution?

Why getting the right type of innovation is vital





Craig Hudson
Elite Applications Engineer

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Mark Wetherick, Drawing Office Manager, Pascall Electronics.

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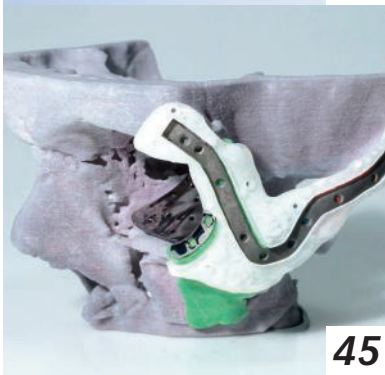
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The power of negative thinking



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

Looking at the details of the Queen Elizabeth Class aircraft carriers currently under construction, it is hard not to be impressed by the ambition, size and sheer technological prowess of the project.

In terms of scale the ships will be 920ft long – nearly as long as four Airbus A380s, with 4.5 acres of deck space. Indeed, the ships' flight decks will be three times bigger than the HMS Invincible, the carrier they replace.

In some ways even more impressive, though, is the way in which automation is being employed on these ships to make them leaner and more efficient than any comparably-sized warship. The result of this is that the ship needs only 679 crew to sail it, rising to 1,600 when including the personnel to operate its air wing. By comparison, the US Nimitz class carriers require 3,000 sailors to get under way and a further 1,800 to operate their aircraft.

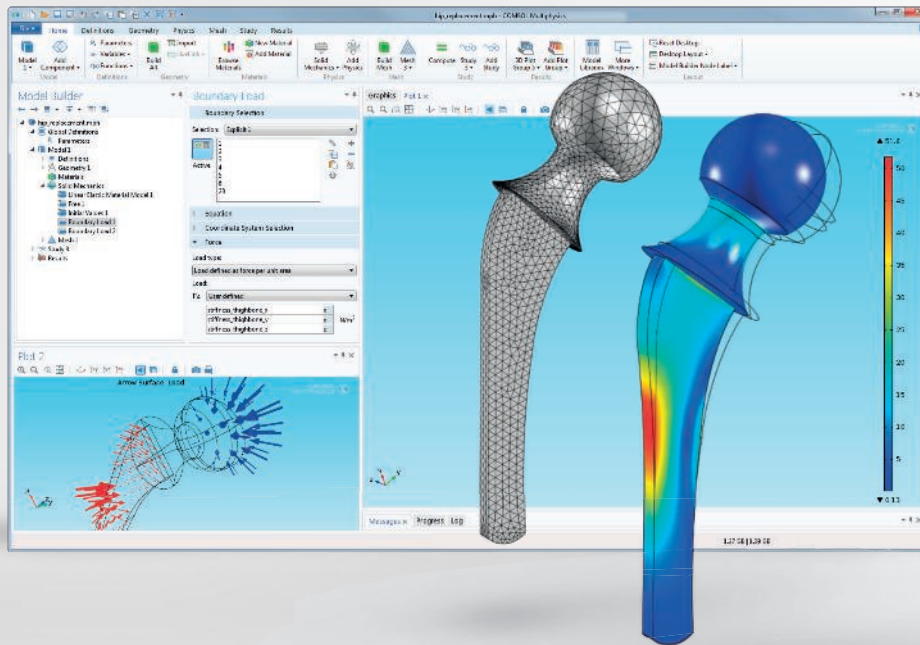
Given that the technology underpinning these ships is almost all British (with BAE Systems running the project), one would hope that people would see this as a positive statement of British engineering expertise and achievement. Wouldn't one?

Of course, any student of the British, knows that our tendency to decry almost anything before it happens makes such positivity unlikely. And, sure enough, below these online stories, one will find any number of negative comments castigating the technology, cost, efficiency, politics and efficacy of these carriers – two years before the first one is even due to enter service!

One can hardly be surprised by such reactions, of course, since they have been a mainstay of virtually every large-scale engineering project I can remember. From the Channel Tunnel ('waste of money'; 'a security threat') to the London Olympics ('a white elephant'; 'an expensive distraction'), the one constant has been that, with any large-scale project, there will be no shortage of people queuing up to tell you how terrible it will be.

It's a free country, of course. And the ability to be negative is as much our birthright as sunny optimism. The problem is that to reflexively expect failure from an engineering project can also undermine confidence in the engineering and engineers in question. This in turn can have a similarly negative effect on the reputation of the profession – something the UK can ill afford at a time when a positive attitude to engineering is needed more than ever.

HIP REPLACEMENT: Analysis of the structural integrity of an orthopedic implant. Results show deformation and stress.



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Festo unveils BionicKangaroo

The development team from the Bionic Learning Network at Festo have spent almost two years realistically emulating the jumping behaviour of the kangaroo and learning from it.

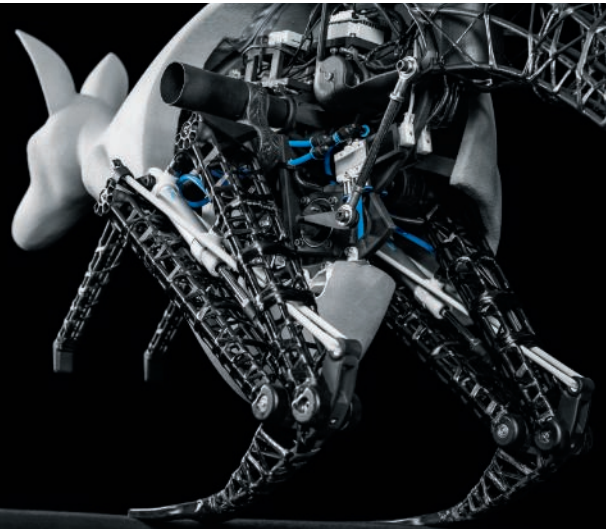
"With the BionicKangaroo we have precisely reproduced the most characteristic features of natural kangaroos: recuperating and storing energy, and then releasing it once more in the next bound," says Dr Heinrich Frontzek, head of corporate communication and future concepts at Festo. "[An important function is the Achilles tendon but] in the artificial kangaroo, we realised the function by means of an elastic spring element made of rubber."

The condition monitoring as well as the precise control technology ensures the required stability when jumping and landing. Festo is also showing how pneumatic and electric drive technology can be combined in a highly dynamic system. The team paid particular attention to the mobile energy supply for the artificial kangaroo.

The kinematic system is made from laser-sintered components reinforced with carbon fibre. As a result, the artificial animal weighs just 7kg with a height of around 1m, and it can jump to a height of 40cm and up to a distance of 80cm.

The BionicKangaroo is controlled by gesture recognition.

www.festo.com



Pupils crowned at National Science + Engineering competition finals

Some amazing young people have been crowned UK Young Engineer of the Year and UK Young Scientists of the Year in the finals of the UK's prestigious National Science + Engineering Competition.

Rebecca Simpson, 19, from Dame Alice Owen's School, Potters Bar has been crowned UK Young Engineer of the Year with her brilliant project, which saw her build a 6ft Arcade Machine to help GCSE students revise their STEM subjects. The machine has two educational games, a joystick and a remote, and can identify six different coin values.

Twins Aneeta and Ameeta Kumar, aged 18, from The Abbey School, Reading were announced as the UK Young Scientists of the Year with their incredible science project, where they studied the possibility of developing an early diagnostic cancer tool – which could ultimately reduce deaths caused by late diagnosis.

The winners of UK Young Engineer of the Year and UK Young Scientists of the Year will each win £2,000, a trophy and an experience prize.

The National Science + Engineering Competition is an annual event open to pupils aged between 11-18, and gives participants the chance to compete for top prizes and international experiences worth over £50,000.

www.nsecuk.org



Jarno Trulli applauds Formula E car

Grand Prix winner Jarno Trulli has applauded the fully-electric Formula E car, the Spark-Renault SRT-01E, following a recent test drive at the La Ferté Gaucher circuit near Choisy-le-Roi, France.

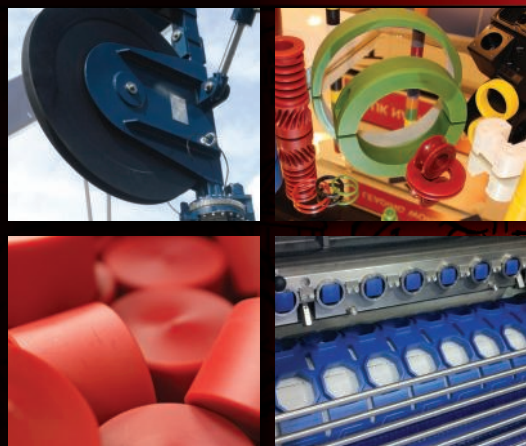
The 39-year-old Italian, who last week signed up to the Championship's Drivers' Club, spent a whole day at the wheel of the now fully-tested single-seater using the final race-going 200kW (270bhp) battery.

Trulli said: "From inside the cockpit it feels like driving a proper Formula One car, the sound is different but you still hear the sound of the electrical engine and gearbox, so in terms of feeling it's perfect for a racing driver. Maybe from the outside it seems different but inside you don't notice it. So far I have enjoyed it because it's a nice car to drive."

The SRT-01E has been designed and built by Spark Racing Technology together with a consortium of the leading manufacturers in motorsport, and will compete in the inaugural FIA Formula E Championship, the world's first global electric race series beginning in September.

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World's first 3D printed bicycle frame developed

Renishaw, the UK's only manufacturer of a metal-based additive manufacturing machine, has used solidThinking Inspire 9.5 software to help create the world's first 3D printed metal bike frame. Chris Williams of Empire Cycles, a leading British bicycle design and manufacturing company, designed the mountain bike to take advantage of Renishaw's additive manufacturing technology, allowing the creation of a titanium frame that is both strong and light.

Renishaw used Inspire to perform the topological optimisation and concept generation. Inspire generated a new material layout within the package space using the loads and supports as input. This provided a concept that not only met performance targets, but also achieved minimum mass.

Inspire generates component designs that maximise manufacturing freedom, leading to stronger and lighter components. The new seat post is 45% lighter than the original.

Robin Weston, marketing manager at Renishaw, explains: "We took the seat post bracket from 360g down to 200g, and the weight savings do not require compensation in other areas. We have not yet fully exploited the possibilities of finite element analysis,

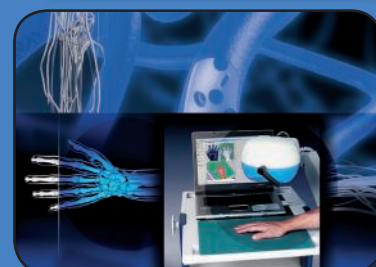
which is a big job for a project like this. What we have been able to do is get close to optimum and test the bike in the real world with a whole host of sensors on the frame, collecting actual data and optimising from there."

With significant weight savings achieved on a single component, along with some reservations Chris Williams had about the original design, the scope suddenly expanded. Williams said: "While we had thought about extruded or hydroformed aluminum tubing or even carbon fibre for the frame bonded onto some titanium bits at the corners of the triangles, we started to look at doing even more.

"As we looked at the main aluminium frame and its 2100g contribution to overall weight, we knew we could help to create something just as strong, but much lighter. From there the idea that we could do more, even all of the major frame components, came together. As no tooling is required, continual design improvements can be made easily, and because component cost is based on volume rather than complexity, some very light parts are possible at minimal cost."

www.renishaw.com

Renishaw will present its work and exhibit the Empire bike at this year's European Altair Technology Conference from June 24th-26th, 2014 in Munich: www.altairatc.com/europe.



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App turns iPhone into vibration checker

ACE has developed a free app for the iPhone that measures vibration and then offers a reliable selection of vibration isolation products.

The VibroChecker app can perform ideal measurements when the iPhone is fully placed on the surface to be measured. Once the app has been started, four symbols appear on the display of the mobile phone. When the icon 'Measure Vibration' is pressed, a new window opens and the measurement can start.

The result appears within 15 seconds. The resulting values are the starting point for step two, the calculation interface. The most important key data is then entered - machine weight, number of contact surfaces and the desired degree of isolation are defined using the interactive and intuitive fields.

Finally, the programme recommends a vibration isolation product from the ACE range, comprising extremely low-frequency isolating air spring elements, ready-to-mount rubber-metal isolators and the tried-and-tested insulation slabs.

The low-frequency air spring elements PLM and PAL are suitable for isolation measuring tables, testing equipment and high-performance machines. Ready-to-mount rubber-metal isolators are predominantly used for engines, compressors and in transfer systems. The SLAB range is mainly used for tooling and textile machinery for full-surface mounting or for the reliable use for individual, sensitive components, such as isolating elements.

www.ace-controls.co.uk

Flow meter pinpoints energy savings

Spirax Sarco has launched its Target Fixed Area (TFA) steam flow meter for smaller, point-of-use applications to help operators accurately assess energy use, reduce consumption and optimise plant performance.

As a stand-alone unit, the TFA integrates a flow sensing device, temperature sensor and flow computer into a single compact unit reducing installation requirements and consequently maximising plant uptime and increasing productivity.

The compact design of the TFA means it can be easily installed almost anywhere in a steam system, even in confined spaces or within the proximity of a pipe bend, valves or other components. It only needs six pipe diameters of straight pipe upstream and three downstream to ensure the desired flow profile into the meter. This overcomes a major challenge in point of use metering, where there are limited straight pipe runs, so reducing installation costs and overall capital outlay.

With a turndown of up to 10:1, the TFA flow meter is suitable for saturated steam systems and will accurately monitor steam flow even at low velocities, without having to make expensive changes to pipe size. This is important because saturated steam systems are best operated at velocities below 35 m/s. Once the steam flow exceeds 35 m/s, saturated steam can cause erosion and other damage within the pipeline.

www.spiraxsarco.com



Soak box for 3D print post processing

The Quill Vogue Soak Box delivers more than just a warm soak for 3D printed parts and models; it provides the end user with control over post processing cleaning.

Control of the water temperature, control of the water agitation and control of the solution used, give the flexibility needed to clean a wide range of 3D printed parts being produced today.

The Quill Vogue Soak Box has an operating temperature range of up to 100°C, an agitation range of slow to fast and a timer which can be

programmed to allow the Soak Box to run on the required settings for up to a week.

The point of difference of this Soak Box is not only in its ability to clean parts more efficiently and effectively, but also in its flexibility. Being able to remove a number of different support materials and maintain the integrity of the 3D model printed in a range of fusion deposited materials (FDM) from ABS, nylon through to polycarbonate, therefore offering an ongoing solution and a good investment.

www.quillvogue.com

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Briefs

AC-POWERED ELECTRO-MECHANICAL ACTUATORS

The new Tritex II actuators operate from 100-240 VAC, allowing direct connection to factory power sources. Enhanced software features include 16 programmable indicies, linked moves and firmware flash upgrade capability via the actuator's Modbus port. This port, via a RS/485 protocol, allows complete control, programming and monitoring of all aspects of the Tritex II actuator as it performs an application. Planned communications options include Modbus, Ethernet/IP, HART, Modbus TCP/IP, CANopen, and CAN J1939 protocols.

The Tritex II actuator has ample I/O capability: eight digital inputs, four digital outputs, plus one analogue input and output. Feedback choices include analogue Hall effect (standard), incremental encoder for higher positioning resolution and an absolute feedback option that eliminates the need for performing home routines after power loss.

The new Tritex II design offers excellent connectivity with internal terminals accessible through the actuator's removable cover. Tritex II also offers a provision for Imperial or metric threaded ports for cable sealing glands, optional M23/M16 connectors for power and I/O, with an M8 connector for the RS485 port.

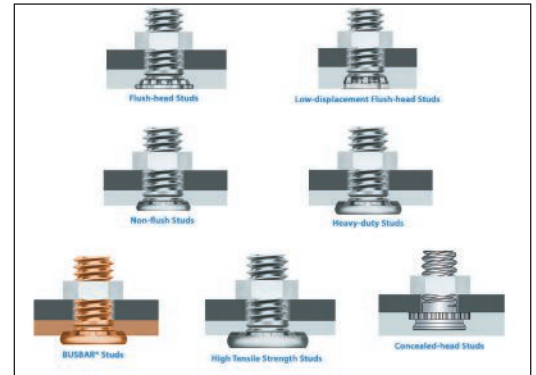
Tritex II linear actuators provide the same form factor as hydraulic and pneumatic actuators and provide for simple, clean all-electric retrofits in what were formerly fluid power applications. They are available with many different mounting options (metric or imperial) such as front flange, rear clevis mount, side mount, trunnion mount, extended tie rod, and rear flange.

www.consultolsen.com

Complete line of studs for thin metal assemblies

PEM self-clinching threaded studs in an expanding range of designs introduce ideal solutions offering application-specific benefits for thin metal attachments. All types of PEM studs provide cost-effective and practical alternatives to weld studs or other joining methods by enabling easier installation with fewer production steps and more reliable performance in service. They install quickly, securely, and permanently using a standard press.

The product line-up includes types of flush-head studs (whose heads will be flush with the sheet in which they are mounted) for use in aluminum or steel sheets as thin as .040" / 1mm and stainless versions offering optimum corrosion resistance in even thinner stainless steel assemblies; low-displacement flush head studs for effective close-to-edge installation; non-flush studs for sheets as thin as .020" / 0.51mm; heavy-duty studs whose heads project above the thin host sheet to distribute the axial tightening force over a larger area and improve



pull through resistance; BUSBAR studs functioning as superior electrical/mechanical attachment points; high-tensile strength studs whose medium carbon alloy steel is heat-treated for high strength and hardness to withstand application demands; and concealed-head studs.

www.pemnet.com

HP/HT brushless servomotors

Heason Technology's HT/HP brushless servomotors for demanding drive applications in oil and gas are designed with proprietary high-performance insulation and pressure compensation or oil flow-through, the motors provide high torque and reliable operation without power loss at high ambient temperatures up to 240°C and pressures of over 2000 bar.

These highly-ruggedised motors are built to order as customised solutions, designed to meet the customer's specific application requirements using specialised alloys and materials for enhanced corrosion and abrasion resistance. Complete with HT/HP compatible connectors and a choice of resolver, Hall Effect sensor, sensorless or customer-

specified feedback, the motors deliver the power density, speed and torque in the compact confines found in today's oil and gas production and exploration environments.

Applications include down hole drilling, plug setting, formation tools as well as marine environment specialised versions for ROV thrusters, robotic manipulators and subsea torque tools.

www.heason.com



Cost-sensitive planar performance

Aerotech's Planar mechanical bearing, ballscrew-driven XY stages offer exceptional performance in a cost-sensitive, low-profile package. Combining two axes of motion in a compact package, the PlanarSL is the perfect solution for applications ranging from surface metrology to high-precision automation.

The Planar comes standard with a precision-ground and preloaded ball screw. Unlike

competitive designs where the ball screw is positioned on the side or off-centre, the PlanarSL ball screw is engineered to drive directly through the centres of friction and stiffness, resulting in superior geometric performance and accuracy. The Planar structural elements have been optimised for the highest possible planar performance.

www.aerotech.com



Hydraulic clamping saves time and space

How can hydraulic bushes improve over their traditional, mechanical counterparts? The ETP range has the answers.

Everyone in every industry needs to save time and space while improving performance. Given this, the traditional mechanical clamping bush suffers a number of key disadvantages.

The first of these is that these traditional methods of connection rely on bolts to secure the shaft. This is problematic enough when installing them, but even more so when maintenance or adjustment are required and the bush has to be removed. In these situations, the securing bolts need to be undone painstakingly, half-turn by half-turn.

This process is time-consuming and laborious in the best of conditions, but in demanding environments, the time and difficulty involved become truly critical issues.

The bolts used in such devices also pose significant problems in terms of design. This is because they require that any machine or installation that incorporates them must allow space not only to accommodate them, but also for the operator or technician to access them for maintenance or adjustment. This can add significantly to the machine's footprint and can lead to compromises in other areas that reduce the efficiency or performance of the design.

ETP's hydraulic bushes allow quick, easy and precise screw mounting in a multitude of applications by virtue of using a single screw for mounting and dismantling of the hub, thus ensuring an extremely quick and easy service



interval time due to the easy adjustment of the hub. This is achieved by the application of the principle of pressure propagation in liquids.

ETP products apply this principle by using a hydraulic pressure medium (usually an inert wax or paste composition) confined in a double-walled sleeve. This is pressurised either using a flange containing one or more screws and a piston with seals for the pressure setting. The moderately-high pressure is distributed evenly along and around the hub and shaft, with the double-walled sleeve expanding uniformly and giving an even contact pressure against shaft and hub – thus effecting locking. The self-contained nature of the products means that this procedure can be repeated many times.

Regardless of whether hubs are being removed or repositioned, mounting and dismantling can be achieved in just a few seconds rather than the tens of minutes that might normally be taken.

While all ETP products are customisable, they are available in a number of varieties. These include:

- ETP-Express, which has only one screw for pressurising and is therefore suitable when there is a need for the fast and accurate repositioning of the hub.
- ETP-POWER, a hydraulic connection that consists of a double-walled hardened steel sleeve filled with a specially-developed pressure medium and a flange for higher torques and stresses
- ETP-TECHNO, whose outer and inner diameter and the side of the flange towards the hub are accurately machined for excellent concentricity.
- ETP-CUSTOM SOLUTIONS – There is also a range of ETP products that can be intelligently controlled or designed to suit individual applications.

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Simplifying condition monitoring

Schaeffler has launched two new products that simplify the distribution of power and input/output (I/O) signals of up to four FAG SmartCheck online condition monitoring devices, resulting in reduced cabling costs and faster, easier installation.

The FAG SmartConnectBox power supply unit enables easy distribution of power supply inputs and outputs to a maximum of four FAG SmartCheck devices. In addition, a standard speed sensor and Schaeffler's new FAG SmartLamp local alarm indicator unit can also be connected to the FAG SmartConnectBox.

Rather than running separate cables from four FAG SmartCheck devices to a speed sensor, this new system provides a cleaner, more elegant solution for customers, particularly when monitoring the condition of large rotating machines such as electric motors, geared motors and variable speed drives.

FAG SmartCheck is an extremely compact, online condition monitoring device that monitors vibration and temperature, as well as a range of other machine and process-specific parameters such as pressure and flow rate. By monitoring these parameters, users are



provided with a broad basis of information in real time, which enables the accurate assessment of machine condition. The device is typically mounted direct to the machine housing. Small and lightweight, the device can fit into areas on a machine where space is restricted.

www.schaeffler.co.uk

Solution to last month's Coffee Time Challenge

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The solution to last month's challenge of finding a new, more efficient method of refrigeration comes from GE, where researchers have now developed a new type of refrigeration technology using magnets that are more environmentally friendly and is predicted to be 20-30% more efficient than current technology and it could be in household fridges by the end of the decade.

Magnetic refrigeration is not a new idea. Ever since German physicist Emil Warburg observed in the 1880s that certain materials changed temperature when exposed to a changing magnetic field – known as the magnetocaloric effect – there have been efforts to create refrigerators based on the technique.

GE teams in the US and

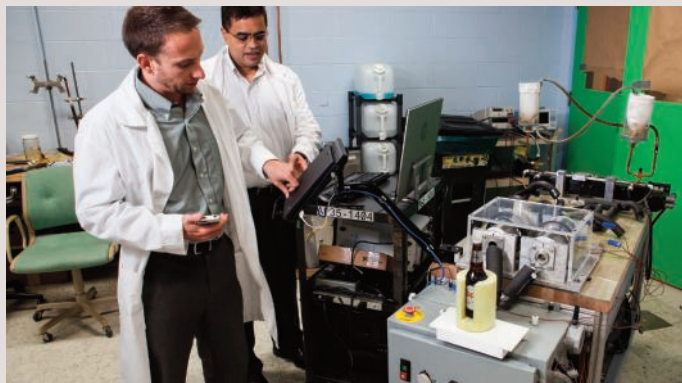
Germany turned their collective efforts to the task a decade ago and built a cascade from special magnetic materials. Each step of the cascade lowered the temperature slightly but after five years of work they were only able to realise cooling of just 2°F (1°C) with a prototype that Michael Benedict, design engineer at GE Appliances, describes as a "huge machine."

A breakthrough then came courtesy of the research team's materials scientists who developed a new type of nickel-manganese alloys for magnets that could function at room temperatures. By arranging these magnets in a series of 50 cooling stages, the team have managed to reduce the temperature of a water-based fluid flowing through them by 80°F (45°C)

with a device that is, according to Benedict, "about the size of a cart."

"Nobody in the world has done this type of multi-stage cooling," said Venkat Venkatakrishnan, a leader of the research team. "We believe we are the first people who shrunk it enough so that it can be transported and shown. We were also the first to go below freezing with the stages."

The team has demonstrated the system for experts from the Department of Energy (DoE), White House staffers and the EPA, and it is now working to further refine the technology. GE hope to achieve a 100°F (56°C) drop in temperature at low power, with the ultimate goal of replacing current refrigerator technology, possibly before the end of the decade.

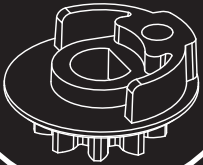


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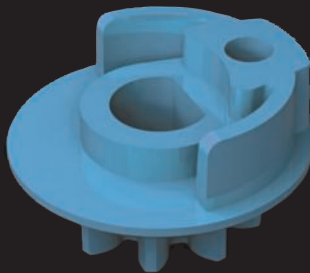
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Defining Innovation

Good design usually involves innovation and these days, good design and innovation are as essential to the marketing message as they are to functionality. So, as the perceived demand to bring 'new and improved' products to market more regularly increases, the burden of continuous improvement through innovation falls on the shoulders of design engineers.

Examples of such a fast-moving innovation culture can be found in a number of companies such as Apple or Dyson, to mention just a few. However, while innovation has always been a key objective of the design engineer, other more practical aspects cannot be allowed to fall by the wayside for fear of developing a 'style over substance' approach to design.

As with many problems, approaching it from first principles is usually a good place to start. Combine this with a fresh dose of inspiration and the rest will follow... hopefully.

A master of design is Dieter Rams. The prolific German Industrial designer came up with 10 principles that make up good design that are as relevant today as they were when he first mooted them in the early 1970s.

At the top of Rams' list is innovation. Indeed many of his principles involve innovation, or at least are areas where innovation can be applied and yielded. So using aesthetics, making products intuitive, unobtrusive and elegant all need an innovative approach. In essence, Rams strove to be innovative by bringing together aesthetic design with functional engineering in the simplest way possible. His message was: don't be complicated for the sake of it, but if it is complicated to engineer, ensure it is simple to use.

Rams also used principles of sustainability by saying products should be long-lasting, environmentally friendly and

minimise waste in every sense possible. Nothing should be superfluous. These are sentiments that are echoed today and will require an innovative mind to address them in the future.

What is innovation?

It is obviously within an engineer's remit to deliver innovation, but it is easier said than done. The term is frequently overused and is in danger of becoming another meaningless buzzword. But innovation as a concept sums up what engineers do, and what they need to do: sales people sell, management manage, engineers innovative.

Engineers consider that good design should incorporate at least some innovative elements, however, when marketers tell you a product is 'innovative', or management demand more of it, what exactly do they mean?

The right kind of innovation

Broadly speaking, innovation falls into two camps: incremental and disruptive. Incremental innovation is what most people mean to when they talk about innovation. This is what's expected from design engineers: improvements over a previous piece of technology or product.

There is a danger, however, that incremental improvement can be confused with incremental change and that is not always a good thing. Incremental innovation must ensure real improvements to really be effective, and not just change for the sake of change. However, with the rate of change in today's society, it is not always easy to spot what is innovative, and what is just different.

Disruptive innovation on the other hand is a very different animal. It is often the product of 'blue sky' research carried out with little or no targeted application or commercial goals. While this sounds like commercial suicide, it is an approach that has led to some of the biggest companies in

the world today. Indeed governments and multinational companies invest heavily in it to help secure long term prosperity.

Dr Stephen Myers, director of accelerators and technology at CERN, says: "If you think of a candle many hundreds of years ago and you incrementally improve it, no matter how much you improve it and how well you do that, you will never end up with a light bulb. A light bulb needs electricity, the vacuum technology, the manufacturing and all these other things.

"Disruptive innovation is looking at the very long term. Burt Maxwell had no idea we would have a communications industry and Einstein didn't know we were going to use special relativity for GPS systems."

Incremental vs. disruptive

With the recent economic situation, many companies both large and small have cut back on blue sky research, and any corresponding disruptive innovation. So how much should you invest in something with no clear return?

Jeff Kodosky, co-founder of National Instruments, says: "It's a challenge and we have debates about it all the time. It seems like we live in a world where we expect continuous improvement and when a widget gets introduced that has a new capability, we want that in our widget.

"It is a characteristic of society that the pace of incremental improvement is accelerating. But we are responsible for that and enjoy when we benefit from it."

Many believe that to overcome the really big issues of the day, blue sky thinking is essential and will lead to ideas and technology that would never have been contrived incrementally. But not all agree.

Dick Elsy, chief executive of the High Value Manufacturing Catapult, says: "Are engineers wasting their time in incrementality when they should be working on bigger challenges? I don't think they are.

Innovation is at the heart of every good design, yet it is almost impossible to define clearly. So just what is innovation and how can design engineers achieve it? Justin Cunningham finds out.

THE RIGHT BALANCE: APPLE USED BOTH DISRUPTIVE AND INCREMENTAL INNOVATION TO GO FROM THE DIETER RAMS-DESIGNED BRAUN T3 ANALOGUE POCKET RADIO, TO ITS FIRST DIGITAL IPOD



Take the automotive industry and compare a car today to one 25 years ago: all incremental improvements. But, at the same time, those engineers are beginning to get to grips with the bigger issues of how you provide mass transportation for everyone without screwing the planet up. That is being stimulated by governments saying, 'we must reduce CO2 output'. And the engineering machine has kicked in to address it.

"So, correctly targeted incrementality can fix some of the bigger problems. But, you can't stop people working on trivial gadgets and get them to start working on bigger picture things unless you incentivise them to do so."

Innovator's dilemma

Getting too comfortable with incremental improvements on a single technology has its downsides, however. While many improvements and innovations in one technology might still be possible, not looking further can mean new technology can be passed off as too risky or not relevant. There is a danger of the, 'it will never catch on' mentality stopping real progress.

"To have a long term strategy, design engineers and companies need to have a certain amount of disruptive innovation happening," says Kodosky. "So you need to try things out because it is possible, even before anyone has figured out what you are going to do with it."

"Getting that balance right is a challenge and in tough times that is the kind of stuff that gets cut. But, that is also what plays into the success of companies 10 or 20 years in the future."

Too much innovation?

By its very nature, innovation can be expensive, unpredictable and is inherently risky. And while it is necessary, can you ever have too much of it?

Dr Myers says: "A group leader of the controls group who was trying to build the control system for LHC said to me, 'the last thing I want is innovation! I want them to build the control system and make it work. He didn't want someone trying something different."

"So, there is a balance to be made between using well-established technology and using it well, and going for something newer and riskier, and trying to be innovative with it. But, I do think you need to do the latter a bit more, even if it is a bit more risky."

Similarly, having extra restraints on a project can actually yield better results. It is certainly not true that more funding, and better facilities, automatically lead to more innovation. In fact it can be quite the opposite.

"Two years ago we were doing more with less," Dr Loren Picco of

the Centre for Nanoscience and Quantum Information at the University of Bristol. "There is an interesting balance to be struck. By not just buying the thing that solves your problem for you and having a more constrained budget, you can generate more interesting ideas as a result and actually get more creative."

The question of what exactly is innovation remains, but where to look for it and how to incorporate it in to a design can more easily be defined. Certainly using Rams' list is a good place to start as it clearly identifies what more can be done, and aspects that can be targeted.

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The genius of Dieter Rams

Is innovative

The possibilities for progression are not, by any means, exhausted. Technological development is always offering new opportunities for original designs. But imaginative design always develops in tandem with improving technology, and can never be an end in itself.

Makes a product useful

A product is bought to be used. It has to satisfy not only functional requirements, but also psychological and aesthetic criteria. Good design emphasises the usefulness of a product while disregarding anything that could detract from it.

Is aesthetic

The aesthetic quality of a product is integral to its usefulness because products are used every day and have an effect on people and their well-being. Only well-executed objects can be beautiful.

Makes a product understandable

It clarifies the product's structure. Better still, it can make the product clearly express its function by making use of the user's intuition. At best, it is self-explanatory.

Is unobtrusive

Products fulfilling a purpose are like tools. They are neither decorative objects nor works of art. Their design should therefore be both neutral and restrained, to leave room for the user's self-expression.

Is honest

It does not make a product appear more innovative, powerful or valuable than it really is. It does not attempt to manipulate the consumer with promises that cannot be kept.

Good design...



Is long-lasting

It avoids being fashionable and therefore never appears antiquated. Unlike fashionable design it lasts many years, even in today's throwaway society.

Is thorough down to the last detail

Nothing must be arbitrary or left to chance. Care and accuracy in the design process show respect towards the consumer.

Is environmentally friendly

Design makes an important contribution to the preservation of the environment. It conserves resources and minimises physical and visual pollution throughout the lifecycle of the product.

Is as little design as possible

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Having an effect

For more than 25 years Crawley Creatures have been making animatronics for film, TV, commercials and exhibitions. From life sized dinosaurs to dragonflies, pigs to penguins, mammoths to mice and sparrows to spiders, the company has used its in-house sculpting, 3D CAD design, laser scanning, 3D rapid prototyping, engineering, casting and artwork finishing. It has won many awards, including a Millennium Products Award, an Emmy (and three more nominations), two BAFTA wins (and four nominations) and two Royal Television Society awards.

Creature Creator

From leading prosthetics and animatronics company for the entertainment industry to supplying the defence industry with test equipment has not been as big a leap as one might imagine.

Paul Fanning reports.

The borders between art, entertainment and engineering are fairly well defined, one might have thought. However, one company that has always blurred them is Buckingham-based Crawley Creatures.

Jez Gibson-Harris, Crawley Creatures' director, makes it very clear that he has no engineering background. "In fact I studied silversmithing at art college", he says, "but I had a friend in the movie industry and that was really my start."

This work in the film industry was initially as a freelance sculptor and his most high-profile job was as part of the six-man team that created the huge animatronic model of Jabba the Hutt that featured in the 'Return of the Jedi' instalment of the Star Wars saga. Gibson-Harris then went on to found Crawley Creatures in 1986, working in the feature film industry making models, animatronics and prosthetic make up 'FX'.

However, while Gibson-Harris is not an engineer, he is clear that the company's success relies heavily on the engineering talent he has gathered around him. He heaps praise on his chief design engineer Mike Franklin ("an evil genius") and his robotics engineer Matt Goodliffe, saying: "I've been lucky in being able to attract people with huge talent and genuinely inventive minds."

Although the company was originally envisaged as being largely about prosthetics and sculpted models, it soon became apparent that the demand was going to be for animatronics and that meant engineering. Says Gibson-Harris: "The business has become more and more 'engineering-heavy' over the years to the point where, if anything, it's more dominated by the engineering than the aesthetics."

Probably the high point for the company as far as its work in the entertainment industry is concerned was its work on the BBC/Discovery Channel programme 'Walking With Dinosaurs', which garnered it plaudits as various as a Millennium Products Award, an Emmy (and three more nominations), two BAFTA wins (and four nominations) and two Royal Television Society awards.

However, as Gibson-Harris makes clear, this success was very much the crest of a wave, as the industry was changing and with it Crawley Creatures' business model. Says Gibson-Harris: "The fact is that CGI [computer generated imaging] was taking over the special effects business, so there was less and less need for animatronics."

Having seen the writing on the wall, however, Gibson-Harris had already been making moves to apply the company's expertise in other areas. These have included exhibits for museums, trade stands

and models for teaching purposes. In fact, Gibson-Harris describes the company's output as including "dinosaurs, early human reconstructions, a nice line in mammoths and medical models".

More recently, however, the company's predominant market has become the defence industry, for which it produces bespoke equipment for the evaluation of respirator and headgear design, as well as the testing of CBRN (Chemical, biological, radiological and nuclear defence) suits.

This first came about in 2002, when Crawley Creatures was approached by DSTL (Defence Science and Technology Limited) based at Porton Down to produce an animatronic head to help in their

evaluation of respirator and headgear design. The result was 'The Porton Head', which is anthropometrically correct, with a soft polymer skin and is servo-controlled with complete head function (including jaw and lips) and even mimes to a passage of prose as it runs through its movement regimes.

"Everything we do is basically bespoke and every customer wants something different."

Subsequent, to this, the company has picked up a range of work in these areas. So much so, in fact, that in 2005, Crawley Creatures was reincorporated and the name i-Bodi Technology was formed as a name to cater for those areas of defence in which it now works.

This change has not signalled a change in the company so much as reflected a change in the market. In fact, as Gibson-Harris concedes, the company is and remains essentially project-based, meaning that it is both difficult to categorise and extremely hard to plan for long-term. "Everything we do is basically bespoke and every customer wants something different. So, while we are able to apply our existing skills to these solutions, there's always something new."

To meet these demands, the company is investing in new technology and in-house resources, including various 3D CAD packages, 3D printing, 3D laser scanning. It also intends to take on more staff in the product design and 3D sculpting areas.

Says Gibson-Harris: "Our origins are from a creative and inventive background and so much of our work is bespoke, so innovation and problem solving are what we do."

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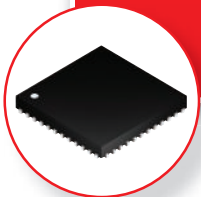
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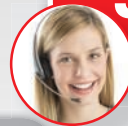
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The increase in connectivity and smart products is creating opportunities for manufacturers in the way they service products. But, how will this affect the design engineer? Justin Cunningham finds out.

Since its inception, the internet has reached ever further into our daily personal and working lives with detailed information on almost anything just a touch of a button away. Difficult questions are now simply answered by the phrase, 'Google it'. So what next for the communications revolution and how is this going to affect design engineers?

Trainers will be able to advise on running style, and capture all sorts of information that will then be captured by sports companies who will be able to make a trainer specifically for your usage, gait and typical impact force. Kitchen appliances will monitor efficiency and record any component failures, and cars will be able to self

However, to realise this vision of the future fully, a feedback loop to the designer needs to be created. It will also mean more effective designs, as nothing will be based on estimates and assumptions, instead real-world data from products already in the field will send back detailed load cases, wear rates and points of failure.

PLM and design software provider PTC has been keen to encompass more robust data flow between service, supply chain and design for some time. While its Service Lifecycle Management (SLM) software has been successful in extracting CAD information and repurposing it for the service of products, it now

While a change in revenue and business model is one thing, hardware will still need to be designed, made, shipped and maintained. And that will still be down to the engineer to design. So, will a shift in a company's service model significantly affect design?

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because of the requirements that need to go in to the equipment to maintain, monitor and operate it more efficiently in the future.

"So, how we select and use that information for failure mode and effective analysis will move to the forefront because the requirements of the business and revenue model are going to force it."

Making it happen

Key to this philosophy is making products, or 'things', smart by connecting them to the internet and allowing the communication of data. It is this ability that saw PTC acquire technology start-up ThingWorx late last year. ThingWorx is essentially an application builder that looks to facilitate the development of the

Internet of Things by allowing designers to leverage connectivity during the development of mechanical hardware.

"It is using the data in the systems to better operate and service them," says Smith. "And this has to start in the engineering process. That is where we see things are going: to smart connected products. But what has been lacking is a ubiquitous connection for these devices so you can create platforms and applications."

"The companies that survive and grow are the companies that will embrace this idea of connectivity and use the information to do useful things and optimise what they are doing from design all the way through the supply chain. If you think you can design and make products and

then get a separate service organisation to pick them up then you are going to be in trouble."

While the Internet of Things is an exciting prospect and the thought of Googling your missing running shoes, or having a look at the health of a bearing on your washing machine is intriguing, the practical impact on the design process is more difficult to decipher.

One of PTC's predictions is that it will be a product's functionality, facilitated by software, that will become a more significant selling point. And this can already be seen in the smartphone market. While aesthetics are of course important, it is the operating system that is at the heart of many people's choices, i.e. Android, iOS or Windows. PTC expects this to go further and software to play a much more central role in the business model of manufacturers and the way they operate, maintain and upgrade.

However, it is less clear how the mechanical parts of products might be affected by all of this. One thought is that it might lead to more modular designs that allow key components to be replaced more quickly and easily.

"You will definitely see more efficiency in the overall supply chain and have better first-time fix rates," says Smith.

However, at first glance this appears to be at odds with the overriding philosophy that is being pushed by PTC of 'products as a service'. Is the Internet of Things about designing products that minimise the service requirement, or is it about changing the business model toward servicing?

Actually PTC believes the future is both and that the two are not alternatives but part of the same story. And many commentators agree. Exploiting big data to leverage product advantage and the service that goes with it is about driving efficiency throughout the whole business. More efficient serviceability, service at the most appropriate time – so just before a bearing fails for example – adds the most value to both users and to companies.

More data means more control and the ability to drive efficiency in to the supply chain, aftermarket service business, and critically in to the design process, which will be the driving force for the whole system. And it's this that's at the heart of the Internet of Things and is what PTC is keen to integrate in to its current software offerings.

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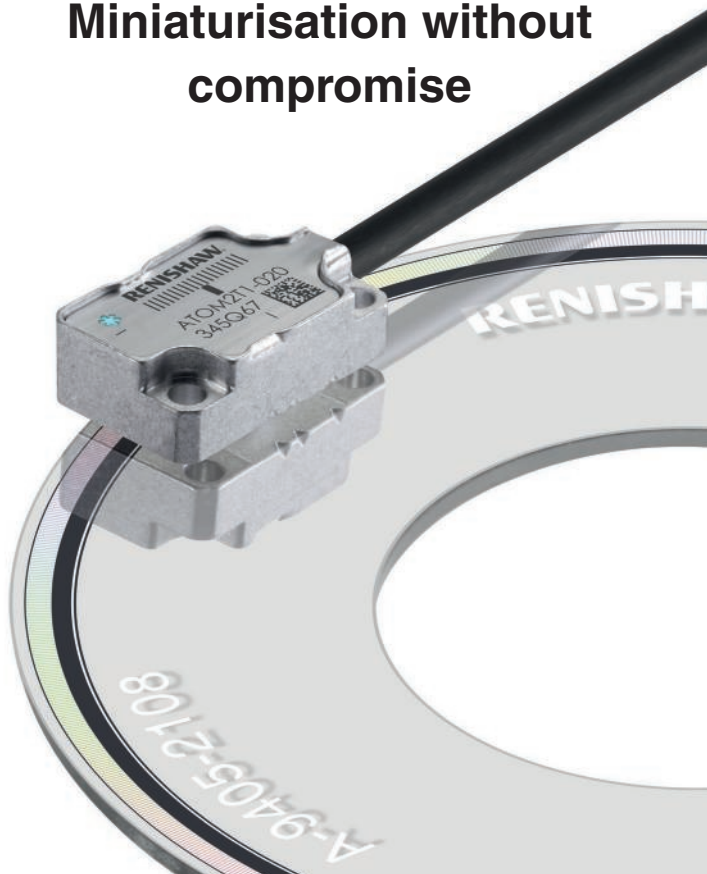
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Pipe welding problems solved?

As the number of pipelines is set to increase, can technology enable faster construction and better welds while avoiding all the usual problems? Here, Eureka finds out.

Global expenditure on pipeline construction and servicing is expected to reach \$216 billion over the next five years, with over 270,000km of extra pipeline expected to be installed. However, one of the limiting factors in the lifespan of these pipelines is corrosion.

While Corrosion Resistant Alloy (CRA) clad pipe is becoming increasingly important in preventing corrosion, the welding process is critical to the successful fabrication of CRA clad pipes. By getting the process right it ensures minimised maintenance, reduced failure rates and extends potential operating life. In addition, large operators are now asking for tighter tolerances to maximise production life, and also to make the pipelines safer through better welds.

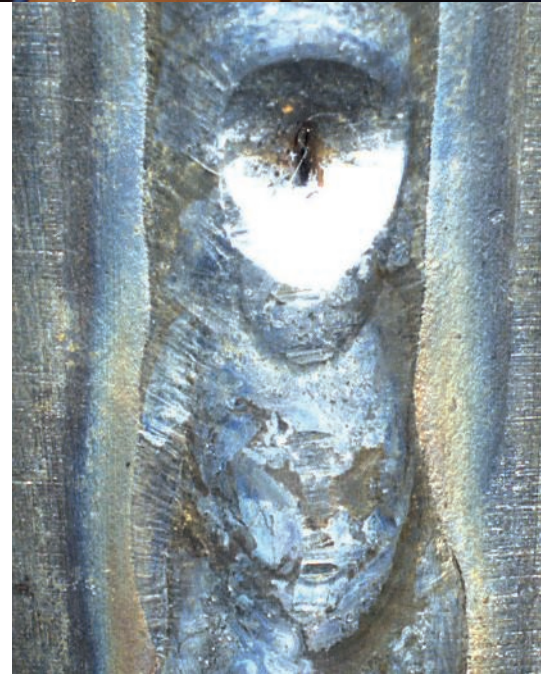
The result is that weld quality has become a high priority. To answer the industry demand, Hertfordshire-based Optical Metrology Services

(OMS) has developed an internal weld inspection system to ensure the weld quality of joins.

A key focus for OMS was the dimensional measurement of oil and gas pipes and other structures where correct dimensions are critical such as military gun barrels, processing tubing and other manufactured industrial cylindrical objects. It wanted to develop methods of examining the quality of internal welds in detail, from both a visual and a measurement perspective, as existing methods had proven inadequate and unreliable.

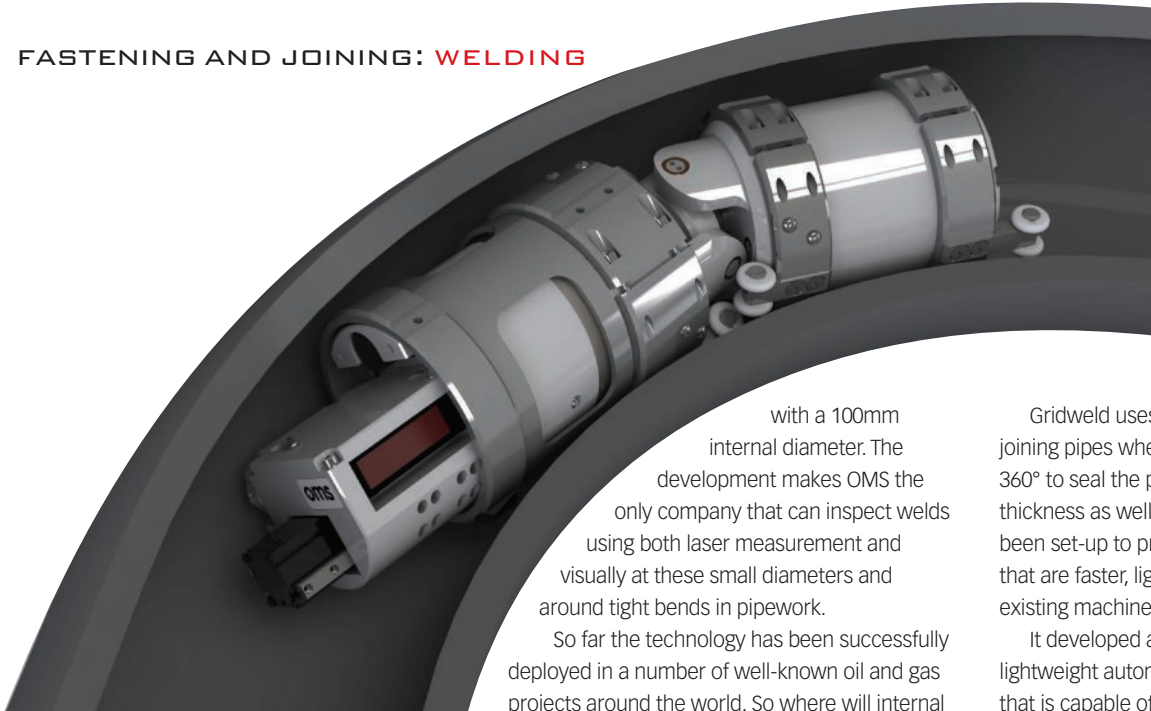
"A considerable gap has existed in the technology for measuring the critical features of CRA welds such as HiLo (joint misalignment), weld height, width, and lack of penetration or fusion," says Hugh Davies, director of client solutions at Optical Metrology Services (OMS). "However, our OMS WeldChecker system comprises a high-resolution digital camera for video inspection, and a laser scanner to gather pipe geometry across both the pipes' inner walls near to the weld, and across the entire weld itself."

It is these parameters that have proven critical during Pre-Qualification Tests (PQT) for the welding process. By carrying out this inspection, OMS can better understand the welding parameters and show full compliance within the specifications typical of pipeline assembly.



"The ability to give closure on tough decisions regularly encountered by the welding inspector could prove invaluable in saving time," says Davies. "It also ensures only the highest-quality welds are accepted, leading to longer life of the welds and pipeline. However, timing is critical in order to maximise the benefits of the system.

"Video-only inspection tends to raise as many



WeldChecker has the same design concept as a London 'bendy bus' with a modular and flexible design

with a 100mm internal diameter. The development makes OMS the only company that can inspect welds using both laser measurement and visually at these small diameters and around tight bends in pipework.

So far the technology has been successfully deployed in a number of well-known oil and gas projects around the world. So where will internal weld scanning technology go from here?

"OMS is currently looking at the application of this technology in a number of different situations," says Davies. "One application is to mount the tool to the line up clamps for use in the critical welding path both onshore and offshore during pipeline welding. Another application is the inspection of tie-in welds on welded spooled stalks of pipe. This means while these pipes are spooled onto the vessel, the WeldChecker would be driven by a crawler. Finally, it could be used on older pipes and structures to measure the extent of corrosion or pitting, or to measure the extent of features in the pipe wall."

While innovative weld inspection tools are advancing, so too are the welding machines themselves. The issue of ensuring good welds, first time round, is a problem that is being addressed by pipeline assembly technology firm, Gridweld. The Birmingham company has developed an orbital welding system specifically to cope with the demand from the oil and gas sector.

Gridweld uses a specialised technique for joining pipes where the weld arc is rotated around 360° to seal the pipe joints, give a uniform weld thickness as well as overall quality. Gridweld has been set-up to provide orbital welding systems that are faster, lighter, and more efficient than existing machines on the market.

It developed a system called 'Scorpion', a lightweight automatic pipeline welding system that is capable of independent movement to enable the operator to weld steep gradients and accommodate differing pipe wall thicknesses. At just 16kg the device is much easier to attach to the pipeline band than heavyweight counterparts, and can be set up and operated by a smaller welding crew.

Welding passes can be re-selected during operation and the insulated shroud and shield assembly ensure tip replacement is minimal. The onboard control box enables welding parameters to be stored and the software can be upgraded onsite. Each device uses four brushed DC motors from the Maxon DCX family of configurable products to ensure precise and controllable movement.

The challenges of ensuring repeatable and quality welds in pipelines is an increasing area of importance and technological innovation as the industry looks to resolve many of the current issues experienced on the ground during construction.

www.omsmeasure.com

www.gridweldsystems.co.uk

www.maxonmotor.co.uk

questions as it answers, often meaning that pipe joints need to be cut out to mitigate any risks, even if they turn out to be acceptable upon closer inspection later."

And while ultrasonic testing is available and very detailed, it can only be performed after the weld has been fully completed. This means there will have to be multiple weld passes before finishing the cap of the weld. As a result, if a flaw is found, it may result in many hours of work to put right, adding to the time and expense already wasted.

OMS has developed a inspection device it calls the WeldChecker. The device is placed inside the tubes and is able to move through the pipes and inspect the welds after just the second pass. If a flaw in the root weld is found, it can be cut out immediately saving time and money before it is too late.

Another challenge is the ability to inspect welds around curved pipes. Many of OMS' clients use CRA materials on subsea structures such as PLETs (Pipeline End Terminators) and PLEMs (Pipeline End Manifolds). These structures tend to have very tight bends, often as little as 1D.

"Assessing the lack of technology in the area, we designed and produced a new version of the WeldChecker that has the same design concept as a London 'bendy-bus' with a modular and flexible design," says Davies. "The advance in hardware has driven the capability forward, allowing previously inaccessible welds to be measured for compliance, guaranteeing they meet the specification."

Taking the technology to the next level, OMS has developed more compact tools that are now able to fit inside very small pipe diameters. It's now possible to deploy its WeldChecker in piping



OMS has developed more compact tools that are able to fit inside very small pipe diameters



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AB14-694

Making light work of fastening

How are fastening methods being used to reduce weight in the automotive industry? Paul Fanning finds a couple of examples.

The need to reduce weight in automotive design is an ongoing obsession for the industry that shows no signs of abating. Where every gram counts, then, it should come as no surprise that fastening methods are as much a focus for lightweighting as any other; a fact that has led to some interesting technological developments.

Against this backdrop, the trend towards hybrid and electric vehicles continues, with constant pressure from the marketplace for cleaner, more efficient cars and cost reductions wherever possible. As a result there is a premium being put on manufacturers to design and produce ever lighter, more efficient and more aerodynamic vehicles.

One method for this is the rise of the use of adhesive tapes in the automotive industry. The benefits of adhesive tapes are that they are clean, light and strong. From a process and performance perspective, they help to simplify assembly operations and offer overall aesthetic and quality benefits to improve many product designs. In addition, the equal distribution of stress across a bond area means no weaknesses are present and a powerful bond is formed, ensuring the best design solution.

As one of the leading providers of adhesive tape technologies, tesa offers an extensive range of performance enhancing solutions for the sector.

A wide range of exterior parts require reliable bonding of individual components, as well as permanent attachment to the vehicle. tesa's range of double-sided tapes for mounting exterior parts offer outstanding resilience to external factors such as moisture, UV radiation and temperature fluctuations.



The External Mortorq bolt is gaining ground in the automotive sector

The secure bonding of different materials is also needed in the interior, for example on the headliner, in the seats, or on the dashboard. With its double sided tapes, tesa is helping automotive designers respond to the latest trends and bring their interior designs to life, providing secure bonding on the diverse substrates often used in interiors, while ensuring noise damping – an

lowest head height possible while reducing overall weight. Furthermore, in transmission applications the Mortorq Super drive has provided excellent tool life, yielding a six-time increase that has resulted in fewer line stoppages for tool changes and greater productivity.

Other new innovations include Phillips' new External Mortorq Super bolt, which was originally designed for the aerospace industry, but is quickly gaining applications in the automotive market.

The reduced head height and weight of the External Mortorq Super bolt provides superior torque transfer that is optimised in the removal direction to assure ease of service in the aftermarket (the bolt head design is also compatible with common hex and bi-hex sockets) and at end of vehicle life.

In addition to manufacturing the Phillips Drive Systems at its factories in the Far East, TR's application engineers are working closely with its Automotive Tier 1 customers at its design and engineering centres in Europe, Asia and the USA, providing support on their use in numerous automotive applications, including car seats, cockpit modules, PowerTrain, door and instrument panels, steering systems, chassis and transmissions, as well as engines and brakes.

www.tesa.co.uk

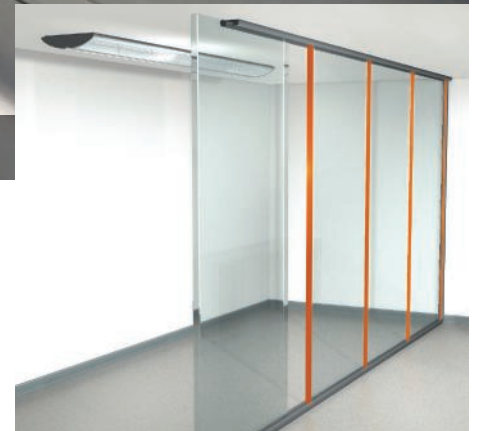
www.trfastenings.com



The use of adhesive tapes is helping automotive designers provide secure bonding on diverse substrates

essential element in guaranteeing customer satisfaction, product differentiation and elimination of re-working costs.

Another lightweight fastening solution comes from Phillips' Mortorq Super high-strength internal drive. Manufactured and distributed by TR Fastenings, this innovative system provides the



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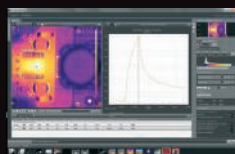
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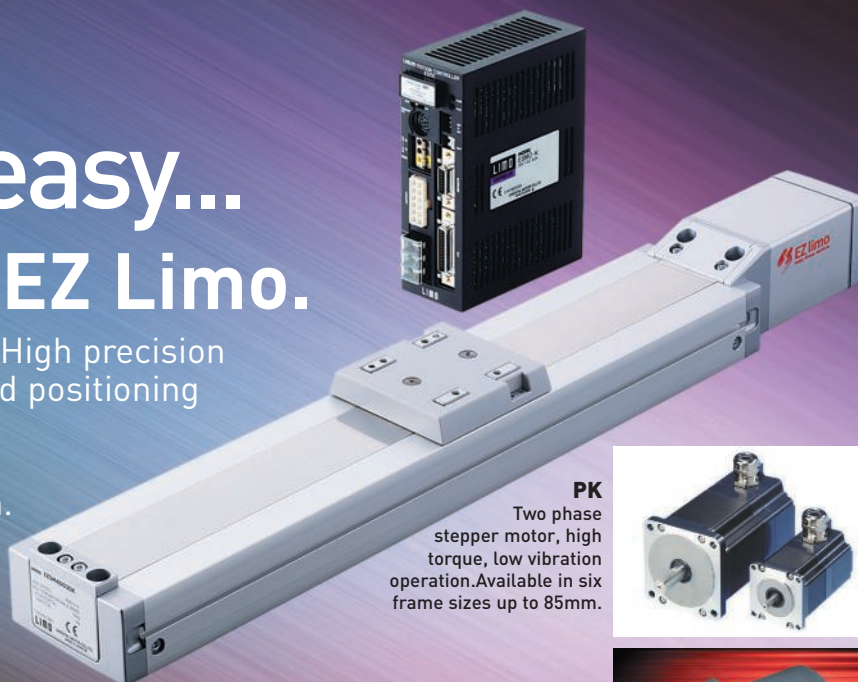
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Finding the right application

How and where can Hall effect rotary-position sensors be used?
Eureka talks to Honeywell to find out.

Designed to measure, monitor and provide feedback, Hall effect rotary-position sensors can be used in a variety of transport applications such as cars, trucks, buses and boats as well as in a wide range of industrial applications.

Hall effect rotary-position sensors are designed to measure the angle position of a moving element by using a magnetic field instead of mechanical brushes or dials. They use a magnetically-biased, Hall effect integrated circuit (IC) that senses rotary movement of the actuator shaft over a set operating range. Rotation of the actuator shaft changes a magnet's position relative to the IC. The resulting flux density change is then converted to a linear output which can be used to provide feedback to either the operator or vehicle sub-system.

Solid-state Hall effect technology provides non-contact operation. The internal section of the sensor uses a magnetic field, not a physical brush or wiper that is used in potentiometers. Wipers used in potentiometers can cause friction, which can reduce the product's life. Using non-contact magnetic Hall effect technology in a rotary-position sensor helps reduce the number of worn-out mechanisms, lowers actuation torque and extends the product's service life.

So what are the specifications that design engineers should consider when choosing Hall effect rotary position sensors? The first is durability. It is vital to consider the type of environment in which the device will be used. For harsh environments, engineers should specify a package that meets IP67 qualifications for enhanced durability. This is especially important for vehicles and machines that are being designed to operate in harsh climates and environments.

Operating life is another

Solid-state Hall effect technology provides non-contact operation

significant factor. How long is the device specified to operate? Clearly it is vital to check the product's data sheet to determine its documented cycle life. It may be better to have the sensor manufacturer perform this testing so that engineering staff do not have to spend time doing this testing work.

Designers also need to ask whether to specify an integral connector. Two important advantages of designing in a sensor with an integral connector are its smaller size and extended life. An integral connected sensor can be smaller than the overall package size of a sensor that relies upon a pigtail connection. This enables developers to design and build smaller overall system packages.

Use of an integral connector increases durability because pigtails are notoriously fragile.

The question of EMI/EMC resistance is also critical. Radio waves of different frequencies can interrupt electronics. Automotive-grade EMI/EMC protection provides reliability in sensor performance against radio frequencies in the environment.

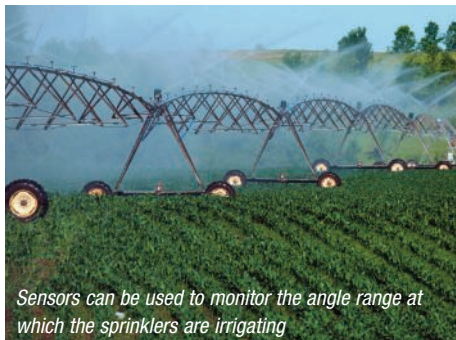


Whether or not you can use a standardised I/O may also be a factor. Using industry-standard AMP termination, 32mm mounting pitch and universal pin-out styles may help you save time and money. A standard I/O can greatly simplify drop-in replacement because the mounting points, profile and pin-outs are similar to those of the incumbent device.

Finally, it is important to ask how flexible the sensors for the design need to be? For instance, are you working with one power setting or should the sensor be able to work with a variety of input voltages. It could be beneficial to use position sensors that provide a wide span of operating voltages or ranges. A variety of operating ranges can provide design engineers with the resolution needed in the span of travel in many common applications.

One application for which the Hall effect rotary position sensor is particularly suitable is in heavy-duty vehicle equipment. For instance, they may be used to replace the mechanical cable connection between the foot pedal and the engine. A mechanical cable can stretch or rust, potentially requiring regular maintenance and recalibration. Eliminating the mechanical cable can improve the engine control system response, benefitting the vehicle's emission, improving reliability and reducing excess weight. This type of drive-by-wire system can be both safer and less expensive than cable-connected systems.

For example, a rotary position sensor may be mounted adjacent to the pedal to measure how far down the pedal is pressed. The harder the operator presses, the deeper the pedal is depressed, allowing more fuel and air to be delivered to the engine, so the vehicle moves faster. When the operator removes their foot from the pedal, the Hall effect rotary position sensor senses the change in position and sends



Sensors can be used to monitor the angle range at which the sprinklers are irrigating



The control of process valves is necessary in a wide variety of industrial applications, including packaging

a signal to the engine to reduce the flow of fuel and air across the throttle plate. The vehicle responds to this signal by slowing down.

These sensors can also be used in buses and heavy-duty ride-height systems to sense the travel of the suspension system. Buses use 'kneeling' systems to lower their height so that passengers can board easily. The Hall effect rotary-position sensor can be used on both ends of this application: one position sensor monitors the position of the control lever, and a second position sensor is deployed on a suspension arm or a linkage to monitor ride height.

Accurate position sensing validates that the vehicle is at the correct height for the application system's requirement, improving vehicle ingress/egress. Large trailer trucks may also use Hall effect rotary-position sensors to monitor trailer heights to improve warehouse docking efficiency.

In addition, these sensors can be used to monitor tilt/trim position for speedboats. The sensor accurately reports the angle position of the propeller, which can help the operator avoid damage and maintain optimum performance.

Another interesting application is for irrigation sprinkler systems used by large farms.




The sensor can monitor the angle range at which the sprinklers are irrigating. Is the irrigation system watering the section of the field intended, or is the system watering 360°? This knowledge can help the farmer reduce water consumption and increase crop yield.

The control of process valves is vital in a wide range of industrial applications. Oil fields, nuclear power plants, food processing plants and beverage manufacturers require that valves accurately monitor positions. Hall effect rotary-position sensors are used to monitor position in large and small valves to help ensure that the valve is closed or if it is open, how open.

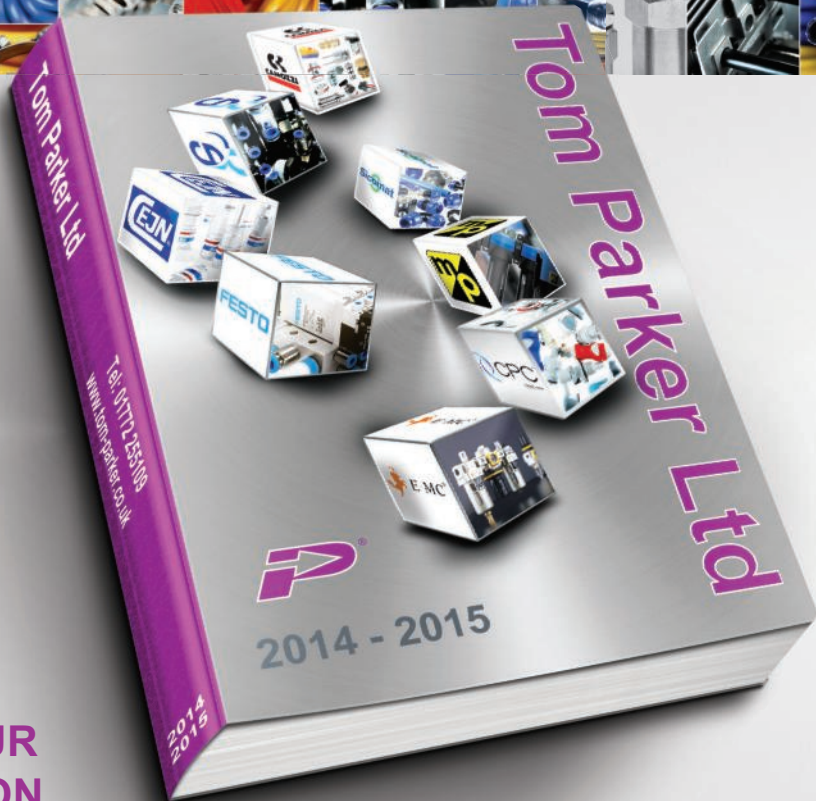
Heating, ventilation and air conditioning systems also use rotary position sensors for damper control. On a cold day, an open damper may feed cold air into a room, causing the HVAC system to engage heat. An open damper may feed air into a room that has open windows, reducing the system's efficiency and increasing heating and cooling costs. Effective use of Hall effect rotary-position sensors, in conjunction with temperature sensors, allows the building manager to better control the HVAC system and reduce operating costs.

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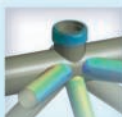
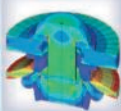
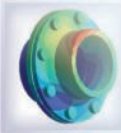
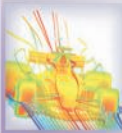
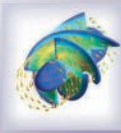
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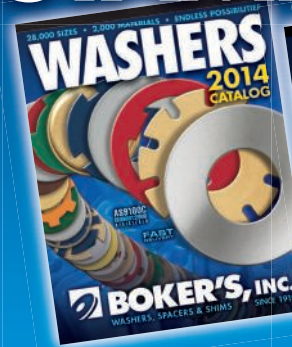
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Representative data

While the automotive industry claims to reduce emissions, testing during 'real-world' drive cycles may not tell the whole story. Justin Cunningham finds out how this data is being captured.

The last 15 years has seen sustained effort by the automotive industry to reduce tailpipe emissions and improve efficiency. However, while reported figures mark dramatic improvements, there have been questions about how representative the claims are.

Engine emissions are often measured in a laboratory with a new engine running over a preset drive cycle. And while this intends to reflect real-world conditions, emission values can be considerably better in the lab, than on the road.

In addition, road tests used to derive mpg and CO₂ figures, have been reported in some cases as using slick tyres pumped to higher than normal pressures to minimise rolling resistance, disconnection of brakes, body panels taped up to and wing mirrors removed.

The gap is increasingly growing between quoted and real figures according to some, as carmakers have been able to refine their testing tactics. According to official figures, average emissions from cars in the European Union fell

from about 180g of CO₂/km to less than 150g of CO₂/km between 2001 and 2011. By comparison, real-world emissions were 190g of CO₂/km and fell to only about 180g of CO₂/km.

It follows that real-time emission figures are likely to be given increasing priority in coming decades. To help find exactly what is being emitted from some vehicles, Millbrook Proving Ground in Bedford, has introduced a Portable Emissions Measurement System (PEMS), made by US-based Sensors Inc.

The system has been designed to gather emission data from the exhaust of a normal car as it is driven. Emission data captured during this time will be a much more accurate reflection of tailpipe emissions. The test is not meant to catch manufacturers out, but rather give its design engineers more accurate data about real-world emissions. The ultimate goal is to reduce real-world tailpipe emissions and bring them in line with quoted figures.

"Essentially, PEMS are used to test mobile

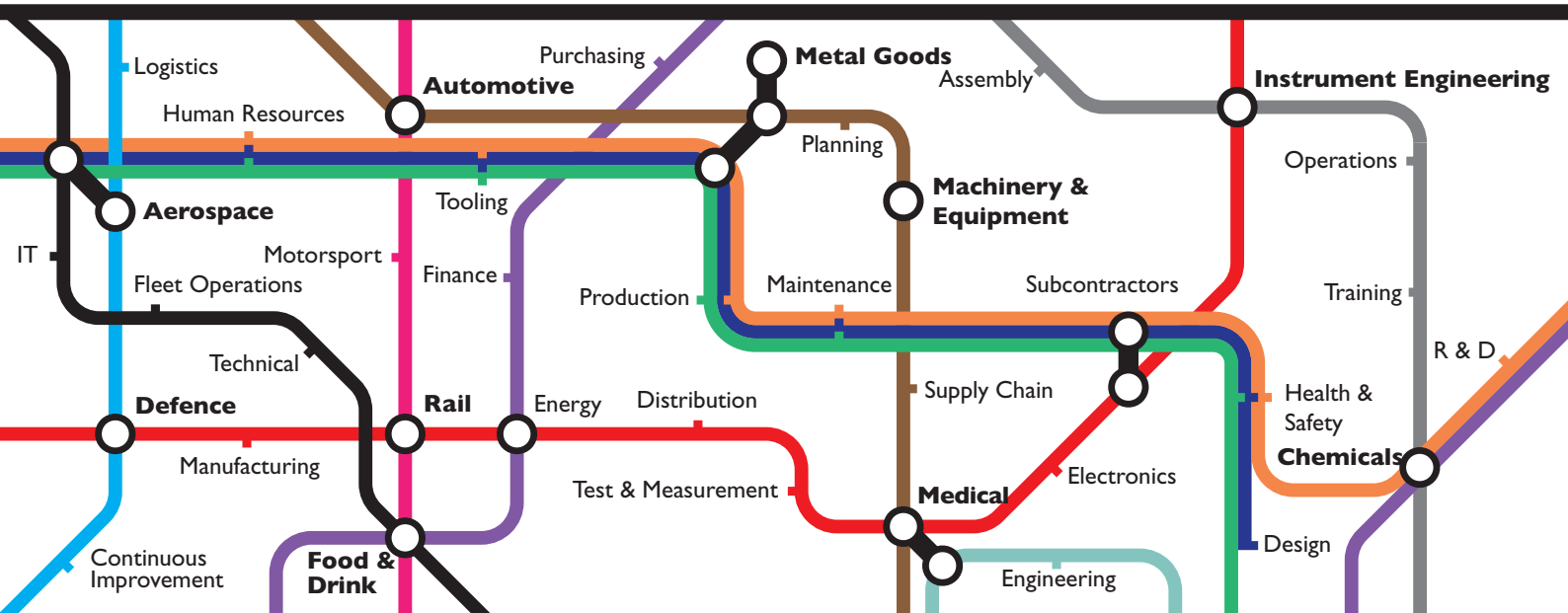
source emissions for the purposes of compliance, regulation, and decision making," says Phil Stones, manager of emissions and fuel economy at Millbrook's Technology Centre. "It can reliably and consistently obtain information that may not always be possible to replicate elsewhere."

Sensors Inc produces a high speed exhaust flow meter that has a sampling rate of up to 2500Hz and four differential pressure transducers. This is packaged with a number of real-time gas analysers and data processing equipment to accurately determine and capture all sorts of emissions that meet European emissions legislation including: HC, CO, NO_x, NO, NO₂, O₂, and CO₂. The equipment can be used on a wide variety of engine sizes and fuels including petrol, diesel, liquefied petroleum gas (LPG), compressed natural gas (CNG), as well as other alternative fuels. And with vehicles becoming ever more sophisticated with hybrid and plug-in capability, the PEMS equipment also allows tests for extended periods.

The PEMS is suitable for use on vehicles ranging from small cars to trucks, buses, and military vehicles, and can be designed for on-road an off-road exhaust emissions and fuel consumption measurements.

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Silent running

**How successful is the search for low-noise hydraulic systems?
Paul Fanning looks at some of the latest developments.**

Hydraulic systems have many applications and benefits, but few people would associate their use with a quiet working environment. By their nature hydraulics make noise, and the health and safety issues relating to noise have been recognised for many years with legislation now placing clear demands on manufacturers to reduce its levels.

The main source of noise in hydraulic systems is from the pump that supplies the flow. Most of the pumps used are positive displacement pumps. Of the positive displacement pumps, axial piston swash plate types are mostly preferred due to their reliability and efficiency.

A company that has taken positive steps to address the problem of noise is Bosch Rexroth, which developed its Silence Plus generation of external gear pumps. The Silence Plus reduces the noise level by an average of 15 dB(A) compared with conventional external gear pumps. The pleasant, significantly lower, inherent sound is perceived in all pressure and speed ranges.

Silence Plus results in a lower noise level for both the operator and other persons in the

vicinity, meaning that no other noise-reducing secondary measurements are necessary, while the low-wear design also ensures efficiency and long service life.

A non-involute rounded tooth profile, combined with helical cut teeth, forms the heart of the Silence Plus. Thanks to permanent tooth contact, the fluid is transported almost continuously and noiselessly. The possibility of noise from trapped oil between the tooth flanks is prevented in the first place.

Just what level of performance the Silence Plus can achieve has been shown in its use by materials handling company Hiab Moffett in development of what is claimed to be the world's quietest truck-mounted forklift.

In order to ensure the machine's operation could be as silent as possible a key area of focus was the gear pump. With Bosch Rexroth already supplying hydrostatic drives and gear pumps across the vast majority of Hiab Moffett's Truck mounted forklifts, Kevin Turnbull, engineering director, approached Craig Grant, mobile applications manager at Bosch Rexroth, to see if the company could provide a solution.

Speaking about Hiab Moffett's decision to develop a near-silent truck mounted forklift, Turnbull says: "There has been a trend in recent years, where deliveries are not just to typical building sites or industrial estates, but also to residential areas. With this increased move towards more residential areas, operators need to be aware of lower noise emission thresholds, particularly at night or in the early mornings when most supermarket deliveries take place. Because of this, we were seeing increasing demand for quieter forklift trucks, and took it upon ourselves to develop a near silent version for those customers where keeping noise pollution to a minimum is a top priority."

Speaking about the project, Grant says: "Having worked with Hiab Moffett for a number of years, we knew that noise pollution was becoming an increasing concern for the company's customer base. While there was a product on the market that professed to reduce noise emissions, it hadn't been specifically developed for mobile applications. Fortunately, when Hiab Moffett approached us, we had just brought a product to market that, as well as

meeting its demands for an electrically-powered pump, operated with near-silent hydraulic functions."

To demonstrate noise reduction potential of the new pump, Grant provided sound files of a traditional gear pump running at 1500rpm across different pressures alongside the company's silence pump and the latest Silence Plus pump.

Describing how the new Silence Plus Gear Pump is able to reduce operational noise, he says: "In a traditional external gear pump, there is a single-point non-continuous contact between the tooth and the groove, which results in

in the Noise Abatement Society Awards 2011, and provides a more robust bespoke design for use on moving vehicles.

In order to ensure the new gear pump was up to the challenge of a mobile application, Bosch Rexroth added its own patented wear-free axial force compensation technology to improve longevity.

Since the initial stages of the project, Bosch Rexroth engineers have worked in collaboration with Hiab Moffett to create a working prototype which has since been awarded its own highly commended award from the Noise Abatement

very strong vibrations that are not damped sufficiently by the aluminium bell housings commonly used today.

Moreover, rigid bell housings do not provide acoustic insulation against structure-borne sound between the electric motor and the hydraulic pump. In unfavourable circumstances the thin-walled aluminium bell housing even acts as a resonance chamber that further increases the oscillation amplitude and thereby amplifies the pump's running noise.

R+L Hydraulics was involved in a joint project aimed at developing a solution to this problem.



The Silence Plus gear pump from Bosch Rexroth (right) is typically able to reduce pump vibration by 75%, as well as reducing vibration from other components, while the NRS system (left) can reduce the total acoustic power output by as much as 50%, the equivalent of about 10dB(A)

pulsation of the fluid and it is this pulsation that causes much of the vibration that results in high operating noise. The reason we are able to reduce operation noise by an average of 15dB(A) is the Silence Plus Gear Pump's round tooth profile, which allows fluid to flow continuously, as a result of permanent tooth contact. The reduction in pump vibration, which is typically as much as 75%, also reduces vibration in other components in the hydraulic system, which means it can make a significant impact on the noise of the machine as a whole."

Developed specifically for mobile applications, and forklift trucks in particular, the Rexroth Silence Plus Gear Pump was highly commended

Society in 2012. Following on from the award success, the world's first virtually silent truck mounted electric forklift is now in pre-production.

A different approach to the problem comes from hydraulics specialist R+L Hydraulics, which offers a system for reducing hydraulic equipment noise emissions. Consisting of a textile shrouding for hydraulic unit bell housings, the patented NRS system can reduce the total acoustic power output by up to 50% i.e. the equivalent of about 10dB(A). The NRS system can be fitted without dismantling the hydraulic unit and is a cost-effective solution as original equipment or for retrofitting to existing hydraulic equipment.

The pulsation of hydraulic pumps generates

The brief was to develop a practical, cost-effective system that could also be retrofitted to existing equipment with poor sound and vibration insulation.

The housing consists of a novel recyclable 3D "high distance" polyester fabric that is tear resistant, resistant against all commercially available hydraulic fluids and is temperature resistant from -40°C to +120°C. The NRS system is available in four different widths and three lengths both as original equipment and as a retrofitting kit.

www.bosch-rexroth.co.uk

www.jbj.co.uk

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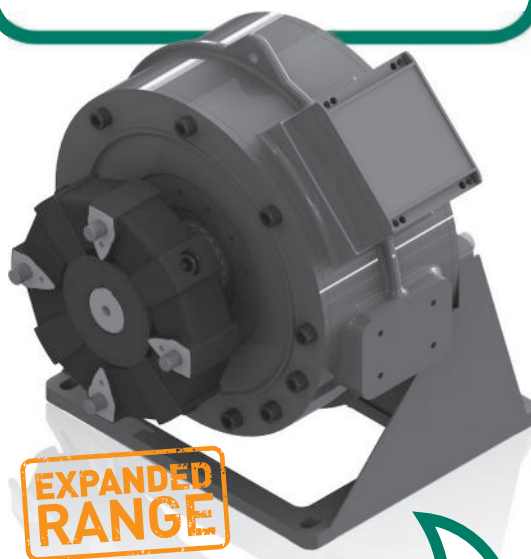
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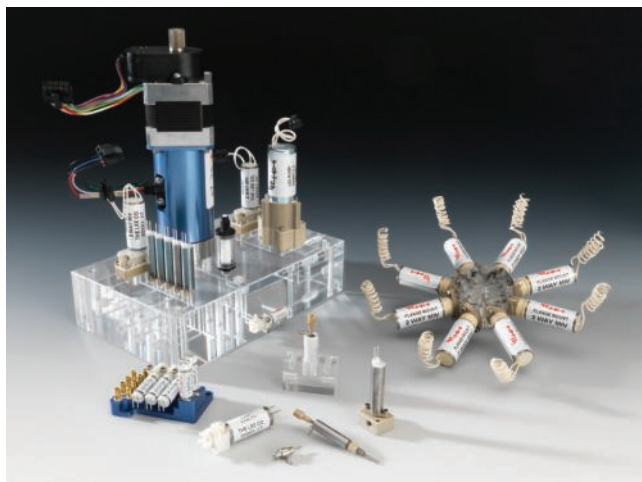
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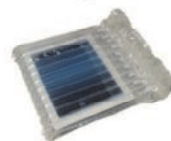


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3D printing revolutionises surgery

Behind the hype, how is additive manufacturing really changing medical practice? Paul Fanning finds out.

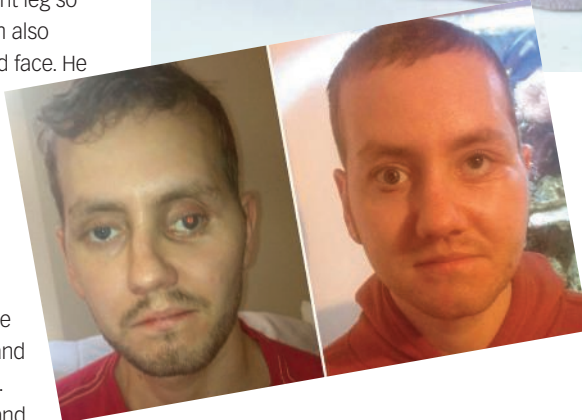
The outlandish claims made for the capabilities of 3D printing are a bugbear for many and nowhere do they get much more outlandish than in the medical sphere. Indeed, reports of 3D printed tissue and even organs being a possibility for the future are a regular fixture in the news.

However, while these possibilities are obviously exciting, they can have a tendency to obscure the remarkable ways in which additive manufacturing are already being used in medicine to improve patient outcomes.

One remarkable recent instance involves Belgian company LayerWise using metal 3D printing to produce patient-specific titanium implants as part of a pioneering facial reconstruction.

Stephen Power was severely injured in a motorcycling accident near Cardiff where he broke both arms and damaged his right leg so badly it required a bone graft. Stephen also suffered major injuries to his head and face. He only regained consciousness after several months in hospital.

A specialist team led by consultant maxillofacial surgeon Adrian Sugar at the Morriston Hospital in Swansea, successfully dealt with all facial injuries except Power's left cheek and eye socket. The patient's cheekbone was too far out and his eye was sunken and had dropped. Due to the close proximity of critical and sensitive anatomical structures, the team applied a more accurate expertise approach. This strategy ensured no further damage to his eye in order to maintain his eyesight. The expertise approach entailed the latest 3D computer-aided practices applied by PDR and innovative 3D printing of the titanium implant and fixation plate by LayerWise.



Motorcyclist Stephen Power was severely injured in an accident near Cardiff. He broke both arms and his right leg was damaged so badly it required a bone graft. Stephen also suffered major injuries to his head and face. He only regained consciousness after several months in the hospital.

LayerWise manufactured the implant and fixation plate in medical-grade titanium (Ti6Al4V ELI) in accordance with the ISO 13485 standard.

"The 3D printing technology mastered by LayerWise is perfectly suited for producing this kind of ultra strong, precise and lightweight titanium implants," says Peter Mercelis, managing director of LayerWise.

Romy Ballieux from LayerWise's Medical Business Unit says: "The reconstructive orbital floor plate plays an essential role in the repositioning of the eye in light of the targeted facial symmetry and eye alignment.

"LayerWise produced the floor plate, and polished its upper surface to minimise friction with soft tissues. The floor plate was fixated to the zygomatic bone through the plate's dedicated slip with attachment holes. The 3D printing technology successfully maintained the accuracy of the precise medical imaging data, pre-operative planning and implant design. The

0.1mm geometric accuracy of the floor plate's freeform surfaces could not be achieved using traditional manufacturing methods."

Accuracy is even more critical with regard to the fixation plate. This fairly long, slim, curved 3D printed plate requires precise positioning to be able to tie together many fractured bone pieces of the cheek region. A custom-fitting guide was used to fit securely around the anatomy, with slots located to guide the surgeon's movement when positioning the plate. The fixation plate restored the correct anatomical connection between the frontal, zygomatic and temporal bone. This connection contributed to the successful reconstruction of the patient's anatomy, providing the best possible facial symmetry.

Ballieux notes: "Dedicated medical engineering specialising in the production aspects of metal 3D printing was key in achieving the impressive facial reconstruction in such a short timespan. The digital process resulted in the 3D printed implant and fixation plate produced in a single manufacturing step in only a couple of hours."

Following his recovery, Power describes the results of the surgery as 'totally life changing'. Instead of using a hat and glasses to mask his injuries, he is now more able to do day-to-day things and go outside. The improved facial symmetry and alignment of his eyes, achieved with the LayerWise implant and fixation plate have also clearly made a big difference to the patient.

"We are confident that our metal 3D printing technology is capable of improving the quality of life of many more patients," says Ballieux. "The fast-turnaround digital process, from medical imaging up to the finalised 3D printed implants, delivers the required implant geometry and precision to obtain such great facial reconstructions."

These implants were the result of a close collaboration between LayerWise specialists and PDR design experts Sean Peel and Dr. Dominic Eggbeer. PDR has a formal collaboration with the Maxillofacial Unit at Morriston Hospital: CARTIS



A highly complex example of the use of additive manufacturing in surgery involved it used in the USA to create a unique knee joint for a cat named Cyrano

(Centre for Applied Reconstructive Technologies in Surgery).

Another interesting, if perhaps slightly more frivolous example (albeit not for the patient) comes from the US, where additive manufacturing was used to create a unique knee joint for a cat.

The veterinary surgeon in question, Dr Denis Marcellin-Little, has worked with additive manufacturing for more than 10 years, with much of his research focusing on medical applications, including over 300 models for practising and designing surgeries. Early on, it was decided that the two main components of the artificial knee would be made using direct metal laser-sintering (DMLS) machine from EOS.

DMLS can work with a number of different metals; two of which titanium and cobalt

chromium – are frequently used for implants. Each has its advantages.

"Titanium is great for bone ingrowth," Marcellin-Little points out, "but it's much softer than cobalt chromium."

The loads on a titanium femoral head would wear the metal down eventually. Because the implant components would already be thin in some places, they might be subject to breaking or cracking if they eroded further.

"So, cobalt chromium was our best choice," says Marcellin-Little.

The selection of DMLS for manufacturing the knee was crucial to its design. The addition of the stems and the incorporation of features to match up with custom drilling and cutting guides gave the metal components shapes that were not readily manufacturable by traditional moulding or subtractive cutting processes.

After several iterations and a thorough final review, the team sent the metal component

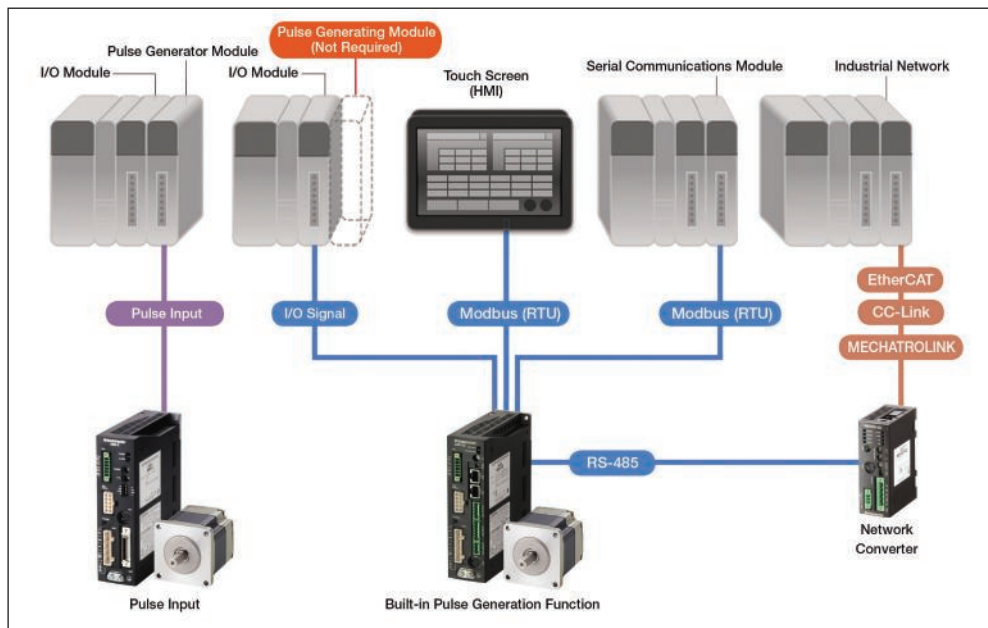
models to EOS' global headquarters in Krailing, Germany for manufacture. The cobalt-chrome parts presented a special challenge.



Although EOS had been adding surface roughness and porosity to titanium dental prostheses and implants for years, this was the first porous cobalt-chrome device they had produced. EOS successfully manufactured six sets of the metal components and shipped them back to the U.S. The surgery was successful and one of the greatest benefits of this project is the additional experience the researchers gained by designing for additive manufacturing.

"When I look back and compare the implants we were building with AM 10 years ago to what we design now, it's like night and day," Marcellin-Little says. "The recent ones are more refined, more precise, and more sophisticated... The main change this technology has brought is that the manufacturing process is no longer a barrier to the imagination of an orthopaedic clinician who needs to create something very specific."

www.layerwise.com
www.eos.info



Flex keeps it simple

Flexibility of connectivity is what the FLEX range of products from Oriental Motor is all about.

When it comes to the purchasing of motors and control equipment, possibly the most commonly-asked question (after the machine's specifications have been established) is: "Will it communicate with my PLC?"

The fear of purchasing equipment incompatible with their existing control system or network protocols often leads to customers choosing systems that are more expensive or more complex than they need – simply because the alternative loss of connectivity is too frightening to contemplate. Given this, a group of products with the broadest possible range of compatibility regardless of network protocol would seem invaluable. And that is exactly what Oriental Motor's 'FLEX' range of products offers the consumer.

FLEX is a product family name for Oriental Motor products that are designed to work directly through I/O control, Modbus RTU and via popular Factory Automation (FA) networks, such as EtherCAT, when using Oriental Motor network converters.

FLEX products allow for simple wiring, quick setup, flexibility of communication protocols and an overall reduction of system complexity. FLEX stepper motor and driver packages are equipped with an integrated controller. Therefore Easy



The RKII high-efficiency, low-power, five-phase stepper motors in action. The units offer pulse input or built in controller (stored data) operation and are available with built-in encoder and harmonic gear.

To see a video go to <http://bit.ly/1krkRF3>

Control without the use of a PLC is possible allowing operating data to be set in the driver, which means that no positioning module or pulse generating module are necessary, resulting in the motor being able to start and stop with just hand switches for basic applications.

Motor operation can be executed via I/O in combination with Modbus (RTU), with or without a PLC, allowing for parameters such as travelling distances and speeds to be set using an HMI touch screen. Operating data, parameter settings or operating commands can be input or accessed via serial RS-485 communications when using a PC or a PLC serial communication module.

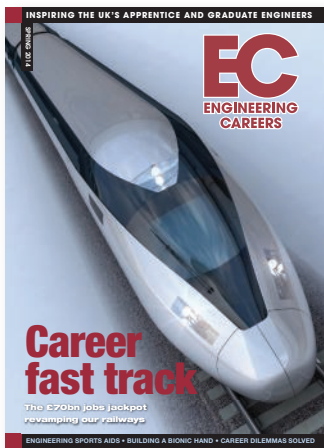
Of course, the ability to communicate is all very well, but the quality of the products

themselves is just as crucial. And here, the FLEX system again offers peace of mind. The high-efficiency (closed loop) AR series stepper motors, for instance, can offer an advantage over a servomotor due higher torque capability at low to medium speeds, for the same power, and additionally in a more compact package. Furthermore the AR series can handle a 30:1 inertia ratio mismatch between load and rotor (compared to 5:1, typically, with a servo) resulting in the need for a planetary gearhead being removed, further reducing the overall cost of the application.

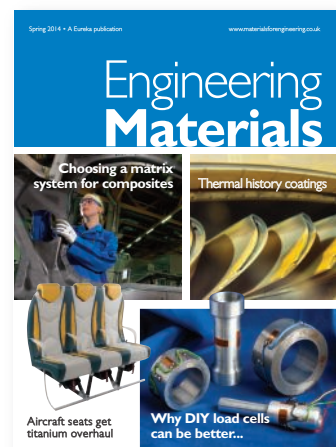
Regardless of which of the FLEX products the consumer wishes to use for their application be it a closed loop stepper motor, linear or rotary actuator, or brushless DC motor the MEXE02 software and OPX-2A control module is common to all. Additionally the closed loop stepper motor and linear or rotary actuator share a common driver. Because the software and driver are common to all products, once one product is online, more can be added without difficulty. This 'plug and play' aspect of the products is crucial to making the installation process as simple as possible, keeping downtime to an absolute minimum and offering the end user complete peace of mind.

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Wearable Tech IP Essentials

The trend for wearable electronics is on the rise, but what are the IP implications?

Jonathan Jackson, D Young & Co LLP offers some answers.

The link between fashion and technology has been long established. This trend was evident over thirty years ago when the Walkman was the latest 'must have' high tech product. A few years ago, white ear buds associated with the iPod became a fashion statement. More recently, Beats headphones are the latest gadget wear.

Many technology companies have identified this trend and have started developing so-called wearable technology. Much of this technology is designed for style as much as function.

It is predicted that by 2016 we will buy nearly 93 million wearable devices a year. Many of these wearable technology products interact with other technology products such as smartphones.

As wearable technology is designed to look cool and be desired by tech-savvy consumers, these products will be sold at a premium price. Manufacturers therefore need to consider the Intellectual Property available to protect their products.

Registered designs

Registered designs protect the appearance of a particular product or graphical user interface (GUI). In electronics, the distinctive appearance of a particular product or of a GUI is sometimes crucial to the success of that product. Indeed, such is the importance of design in electronics, Steve Jobs at Apple considered Jonathan Ive (who designed the iPod, iPhone, iPad and iOS 7 amongst others) as his "spiritual partner at Apple".

Apple filed Registered Designs for the shape of an iPad, iPhone and associated GUIs. Apple then sued Samsung alleging that their Galaxy Tablet range infringed these designs. These designs took centre stage in the recent global battle between Apple and Samsung.

In the area of wearable technology, the

appearance of a product will be, arguably, even more important. This will be carefully considered by manufacturers. However, in order to protect this distinctive appearance, manufacturers need to equally consider protecting the appearance using registered designs.

Patents

Patents protect the way in which a product operates. Specifically, a patent protects the way in which the product solves a technical problem. In the field of wearable technology, there are a number of issues to consider.

Firstly, although it is not possible to use patents to protect the appearance of a product (that is the purpose of registered designs), the wearable technology will usually include sensors measuring certain parameters such as a pedometer in a Sony SmartBand or location of the user in a Nike SmartWatch. These sensors may be capable of patent protection if the sensors are improvements over known sensors. For example, if the sensors consume less battery power or are smaller than known sensors.

Secondly, many wearable technology devices, in use, communicate information with other connected devices, such as a smartphone. The smartphone runs a dedicated app, usually produced by the manufacturer, in order to communicate with the wearable device. Therefore, the manufacturer will wish to protect both the wearable technology and separately the app. This will stop other manufacturers copying

aspects of the app. However, in certain instances, it may not be possible to protect the app separately. Although beyond the scope of this article, in order for an app to be protected in its own right, the app must solve a technical problem. Examples of such technical problem include communicating with the wearable technology in a more efficient manner. An article examining this in more detail is provided at www.dyoung.com/article-bigdata.

Trade marks

A particular brand name or logo used to market the wearable technology product can be protected as a trade mark. Registered trade marks ensure that the goodwill and business reputation built up under that brand name or logo is protected in relation to specified goods or services. As wearable technology contains features that relate to both fashion and function, it will be important to ensure that trade mark protection is obtained for both aspects. For example, Smart Glasses would require protection both for the glasses themselves and the display device technology.

Conclusion

Wearable technology will provide many opportunities for technology companies over the next few years. In order to secure their market share, it is important for technology companies to protect every aspect of their wearable technology; from the appearance of the product, the way in which their product operates, to any branding associated with their product. This synergistic approach will protect the market should their competitors get too close or should any copy-cat products appear. If you require any further advice on this topic, please contact the author.

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Lighting up the road

**Can a better light improve safety for the UK's cyclists?
And if so, how can it be powered?**

Using a bicycle to get around has become hugely popular in the UK, both in the city and the suburbs. And while UK Councils and the Highways Agency are drawing up plans and policies to improve the safety of cyclists on public roads, riders themselves must ensure they are taking the necessary precautions, notably that they are seen.

Using lights is essential, and strobing bright flashes have become synonymous with cyclists. However, as these are mostly battery powered, they can dim and stop working without warning. If the rider is a long way from home this potentially opens them up to a dangerous ride back in the dark.

The classic solution of dynamo power offers a solution here, and with sufficient pedal power the lights will remain on. However, there are significant drawbacks with the original design. Pull up at the traffic-lights and the lights that were shining away dim and disappear in seconds. They also add a significant amount of friction to the wheel, meaning the rider often has to pedal twice as hard.

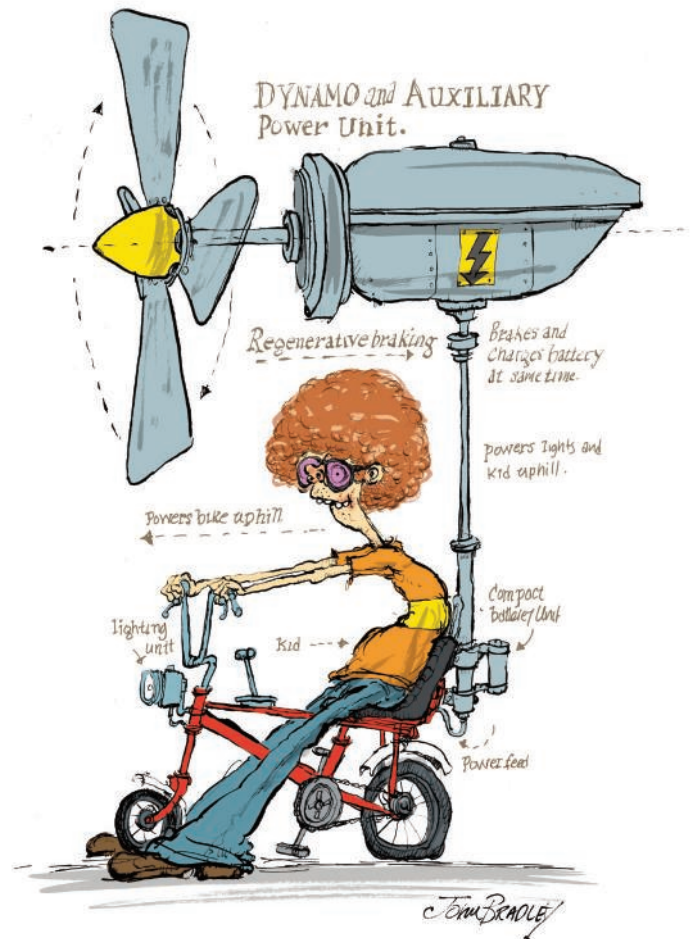
The challenge

The challenge this month is therefore to come up with bike lights that do not require disposable batteries, by addressing the two major drawbacks of dynamo power.

Making the dynamo itself near frictionless would be a good start. While there have been great improvements in bearings, turning the magnets of a dynamo needed to generate the alternating current, still requires significant exertion by the cyclist.

Perhaps mounting the dynamo in a different position, in the bike hub or on the chain, would prove more efficient? However, fundamentally, the generation of power by mechanical means needs to be re-thought. Energy to power the lights will obviously need to come from somewhere, so perhaps vibration might be the answer?

In addition, the lights need to be able to store some energy to prevent the classic dimming of dynamo powered lights when riding slowly or at a standstill. This should be pretty easy for most to figure



out, and remember it must be battery-free. Of course, as this is for a bicycle it should be relatively lightweight. And making it quiet and doing away with the whirring sounds of the old systems would round off the design perfectly.

The idea we have in mind answers these problems elegantly and addresses all of the issues mentioned above. The solution to this challenge will appear in the May issue of *Eureka*. In the meantime, see what you can come up with.

The answer to last month's Coffee Time Challenge of how to make refrigeration more efficient and effective can be found in our Technology Briefs section on page 14.

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