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February 2018

DESIGN | INNOVATE | ENGINEER

Eureka!

BRIDGING THE GAP

THE ROBOTIC ADDITIVE MANUFACTURING TECHNOLOGY THAT'S 'PRINTING' BRIDGES

IN THIS ISSUE

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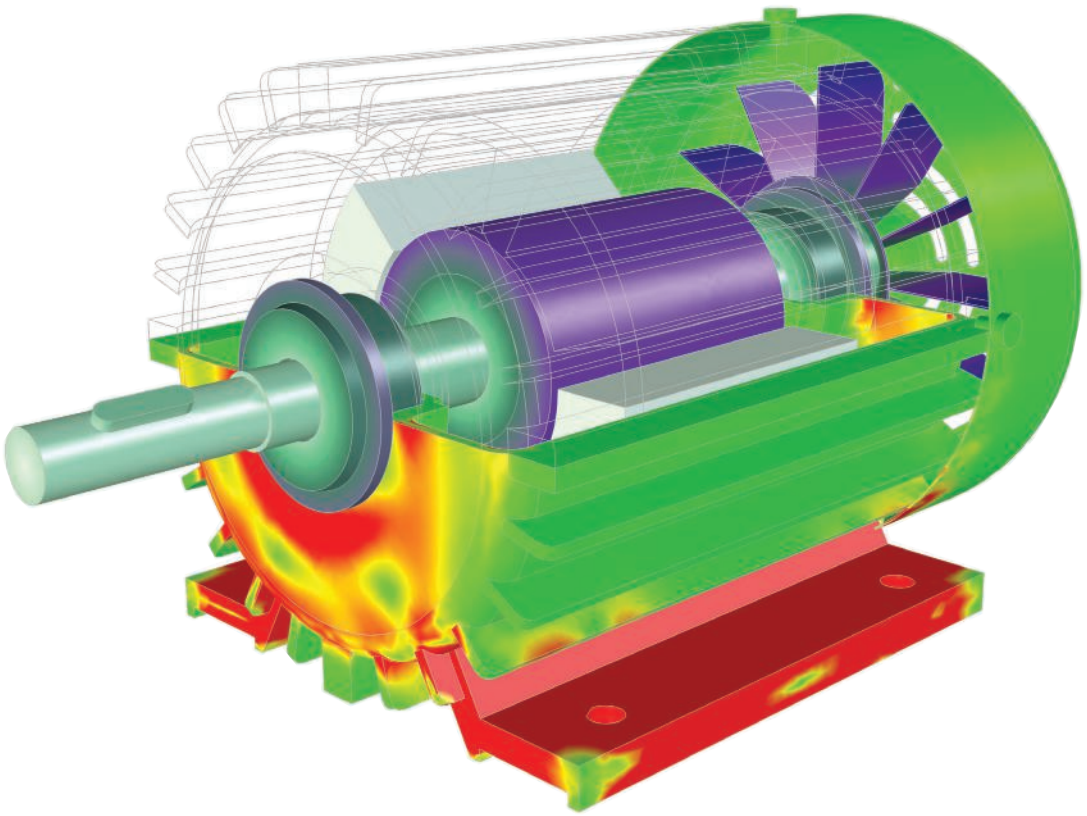

Visualisation of the von Mises stress distribution in the housing of an induction motor by accounting for electromechanical effects.

In the 19th century, two scientists separately invented the AC induction motor. Today, it's a common component in robotics. How did we get here and how can modern-day engineers continue to improve the design?

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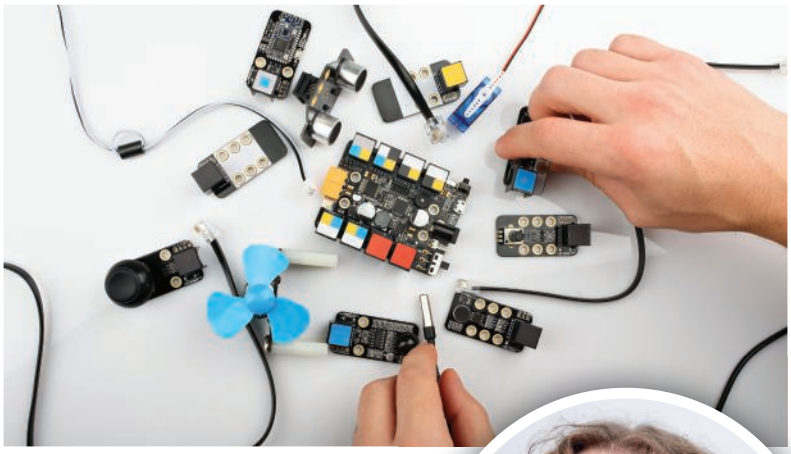

Picture Credit: Adobe Stock

WE NEED TO SHOW RATHER THAN TELL

THEY SAY, 'GOOD things come to those who wait', but that's only if those waiting have put in place some kind of long-term plan. A long-term vision has been severely lacking around UK PLC for some time. But it seems a plan is now in place that looks to address the long-term cause, rather than treat the short-term symptoms.

In the UK, we don't have a problem with technical prowess. We can invent and innovate with the best of them, usually on a fraction of the budget. No, our problems have been quintessentially British in that we don't know how to show off, whether it is to the next generation or the wider world.

For example, we tend to entice future generations with structured and logical argument, rather than wowing them with a host of tech and cool applications. It's a case of showing people what engineering is, rather than telling them.

The problem with engineering is one of image and it starts at school. If a teacher is unsure what an engineer is, what an engineer does, how can we expect the public to 'get it'?! And the term technician and engineer are interchangeably used, but as we all know, there are massive differences.

There is no quick fix and it's going to require a sustained, long term vision to change minds and perceptions. That is now happening with more events and liaisons with schools that show, rather than tell. The roll out is beginning to snowball with more events and visits booked in to 2018 than ever before. This sustained effort is exactly what industry needs.

This also coincides with some other great initiatives such as the introduction of T-Levels as well as 'The Year of Engineering'.

While many engineers are happy to learn more theoretically and out of a book, many do not and would prefer more practical, hands-on and 'doing' classes, especially early on. And, these more practical initial routes have shown more effective in hanging on to young engineering talent, and not lose them to finding careers in other industries.

Justin Cunningham
Editor

MISSION STATEMENT

DESIGN | INNOVATE | ENGINEER

Eureka! connects design engineers with the UK's industrial heartbeat by providing in-depth coverage on the very latest technology developments and industry trends; keeping you inspired, informed and innovative.

Eureka!

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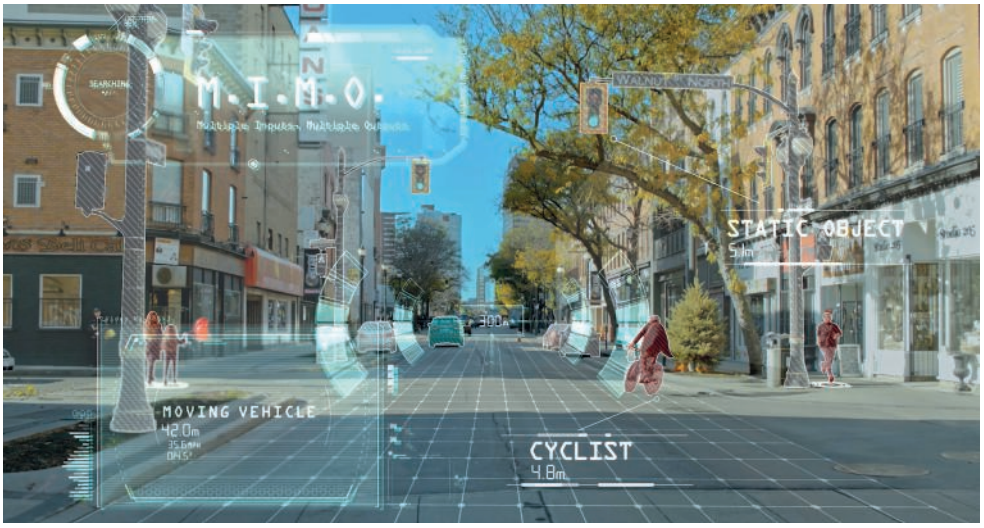
£86m boost for UK nuclear fusion programme

THE GOVERNMENT HAS announced an £86m investment in the UK Atomic Energy Authority's (UKAEA's) nuclear fusion research programme, including the building and operation of a National Fusion Technology Platform at Culham Science Centre, Oxfordshire. This is expected to open in 2020, creating around 100 jobs and many more in the wider nuclear industry supply chain.

This facility will support UK industry and help secure around £1bn in contracts from global fusion projects. Looking further ahead, they will enable UKAEA to develop technology for the first nuclear fusion power plants and put UK industry in a position to exploit the commercialisation of this highly promising low-carbon energy source. It will also signal the UK's intent to continue its participation in international science collaboration after leaving the EU next year.

UKAEA's CEO, Professor Ian Chapman, said: "Fusion is entering the delivery era, with an increasing focus on the key technologies that will be needed for power stations. In the longer term, it means the UK will be at the forefront of developing fusion and bringing cleaner energy to the world."



RADAR IMAGING FOR AUTONOMOUS VEHICLES

AUTOMAKERS ARE CONTINUING to assess the options that will provide vehicles with increasing visibility of the world around them as the industry moves towards autonomous and driverless vehicles.

Global automotive supplier, Magna, has recently developed a radar option that it says 'leapfrogs' the competition. The ICON RADAR offers high-resolution and incorporates military technology that provides precise detection, extensive range and high resiliency.

Swamy Kotagiri, Magna's chief technology officer, said: "Our ICON RADAR takes the best of military technology and improves on it for automotive use – taking a significant step forward toward full autonomy."

With a range of more than 300m and scan speeds 50 times faster than the time it takes to blink, the radar system continuously scans the environment in four dimensions (distance, height, depth and speed), and can detect, track and classify individual objects. It enables the system to detect and communicate to the vehicle a rich topography of static objects such as railings, road debris and speed bumps, as well as track moving objects such as vehicles, cyclists, pedestrians and pets.

It can also distinguish smaller 'objects' like children and cyclists in close proximity to larger, more easily detectable things like parked cars and moving trucks, which is critical to improving safety features like Automatic Emergency Braking.

IGUS SAYS 'YES' TO SCOTTISH HYPERLOOP PROGRAMME

A TEAM FROM the University of Edinburgh working on Hyperloop technology has received engineering support through igus' YES (Young Engineers Support) programme.

Travelling at speeds of up to 760mph, Hyperloop could move passengers between London and Edinburgh in under 50 minutes.

A set of components that proved difficult for HypED were the bearings used in the 5mm-thick laser cut aluminium alloy bell-cranks in the pod's suspension and braking system.

"We assumed that traditional metallic needle or ball bearings would cope with the high vertical and horizontal forces," explained founding member of HypED, Christian Zeppetzauer. "But after learning more about the effects of a vacuum, where lubricant boiling and outgassing can be particular problems, we decided to use plain bearings."

After hearing about the YES programme from the university's Formula Student team, Zeppetzauer contacted igus directly. An igus field engineer visited the team to offer advice on how to best meet the specific design requirements and explain the different bearing material options in detail.

Zeppetzauer said: "We eventually used a combination of heavy duty iglidur Q2 and iglidur X, which can handle high temperatures and extreme environments. We've found that the bearings are so durable that the aluminium bell-cranks wear out before they do."

As well as being wear-resistant, the polymer bearings are lightweight and don't require any grease or external lubrication (which can boil during operation in a vacuum, or suffer from outgassing, adversely affecting material properties) – making them maintenance-free.

TECH **BRIEF**

REVOLUTIONARY SPINDLE BEARING SENSORS

SCHAEFFLER HAS INTEGRATED sensors directly into spindle bearings to create effective, easy-to-use devices for main spindle monitoring, increasing machine availability, productivity and quality.

Most machine tool downtime can be traced back to defective spindles, particularly spindle bearing damage caused by collisions and continuous, undetected overloading.

To combat this, the device reduces spindle failures by enabling very fast spindle deactivation in the event of a collision. The system also allows machine operators to detect adverse operating conditions and make targeted adjustments to the machining process.

The sensor ring transmits a warning signal to the machine's control system if the deflections measured on the rolling elements exceed a specific threshold, which is set individually for every spindle and machine type.

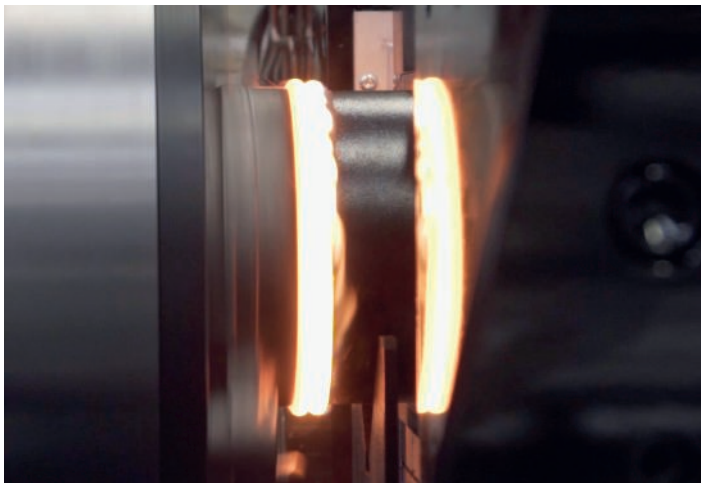
AXLE FRICTION WELDING IMPROVES PART CYCLE TIME

JOINING SOLUTIONS PROVIDER MTI and technology company HMK (a Siemens motion partner) have collaborated to develop a double axle friction welding machine worth more than £2m for a trailer manufacturer.

The 16 metre friction welding machine welds a complete axle in just one cycle and is claimed to reduce cycle times by up to 10%. It utilises Siemens' SIMOTION motion control system and Industry 4.0-ready SINAMICS motor and drive technology.

MTI managing director, Richard Jones, said: "MTI invested 2000 hours to design this machine, but the cost and efficiency benefits it will deliver to customers are unbeatable."

The fully automated, double axle friction welder eliminates slow and manual part load and unload operations. Fully finished



axles are delivered with precision part accuracy and statistical data monitoring for the quality process.

Jones added: "It's already well-exceeded expectations and we look forward to introducing the double axle friction welder to new clients and markets."

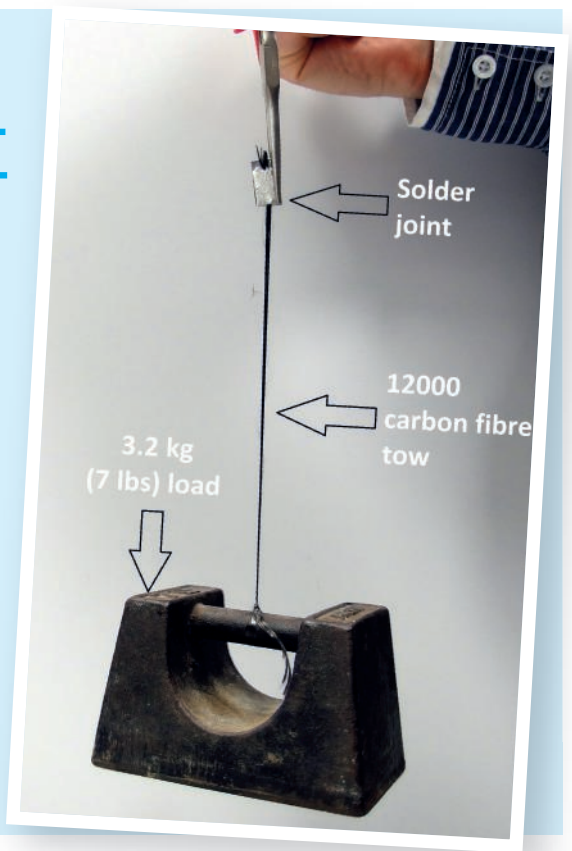
MTI is now focusing on introducing the double axle friction welder to new customers in the axle and trailer industry as well as expanding into the truck and lorry transmission market.

TECH **BRIEF**

'SOLDERING' CARBON FIBRE

MATERIALS EXPERT GOODFELLOW has announced C-Solder, the trade name for a group of new tin-based, flux-free soldering alloys that enable the joining of carbon materials. The resulting bond is said to be both mechanically strong and electrically conductive.

Carbon materials including carbon fibres or carbon nanotube fibres in carbon-carbon arrangements can be joined as well as carbon to metals such as copper aluminium, titanium, stainless steel, and even ceramic or glass materials. Additionally, aluminium to aluminium joins can be achieved without using flux. The solder has a melting point of 232˚C, a density of 7.4g/cm^3, excellent flow, good wetting of surfaces, is electrically and thermally conductive, not affected by cleaning solvents, not flammable, as well as flux- and lead-free.



BUSINESS NEWS

SCHAEFFLER TAKES OVER COMPACT DYNAMICS

Schaeffler has acquired the remaining 49% stake in Compact Dynamics from SEMIKRON, one year after acquiring the majority stake in the company, expanding its electric motor expertise.

THALES BUYS OUT GEMALTO

Thales and Gemalto have reached a merger agreement. With the acquisition of Gemalto's digital security portfolio, Thales will be positioned to offer an end-to-end solution for the digital security market.

ABB JOINS FORMULA E

Formula E has signed a deal with ABB to make it the title partner of the 'ABB FIA Formula E Championship'. The multi-year partnership is a first of its kind for Formula E and the first time an FIA sanctioned single-seater championship has had a title sponsor, emphasising the position of Formula E as a key place to be for forward thinking brands and manufacturers.

BP AND CASTROL TO CONTINUE WORK WITH VOLKSWAGEN

BP and Castrol have announced the renewal of their global strategic partnership agreement with the Volkswagen Group for the supply of fuels and lubricants.

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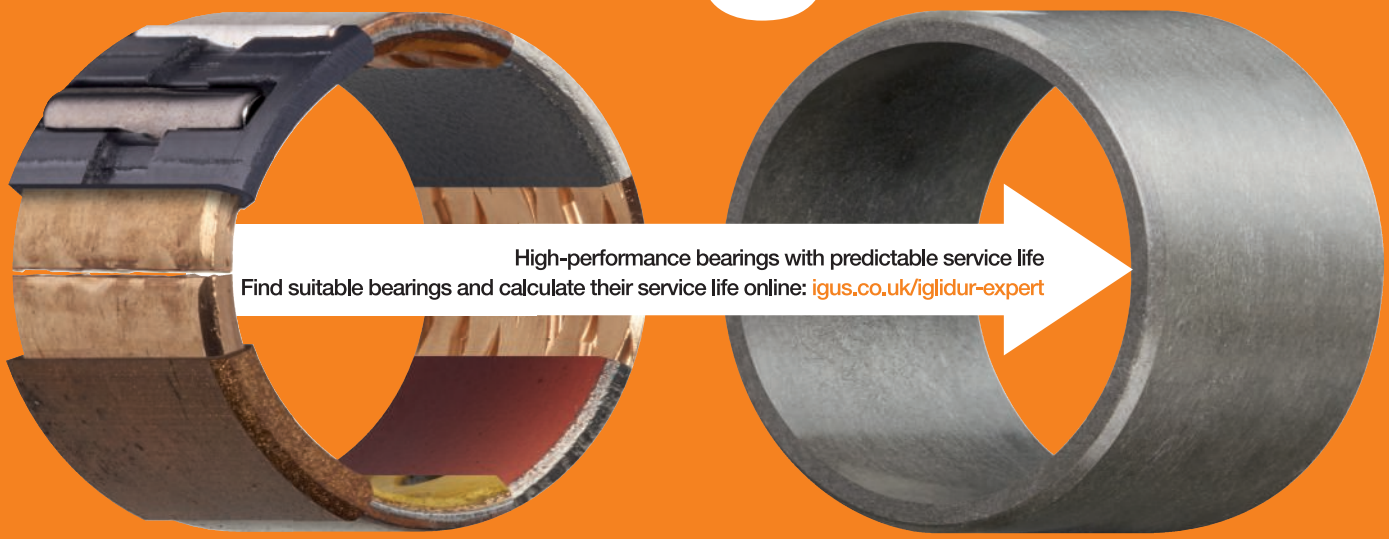

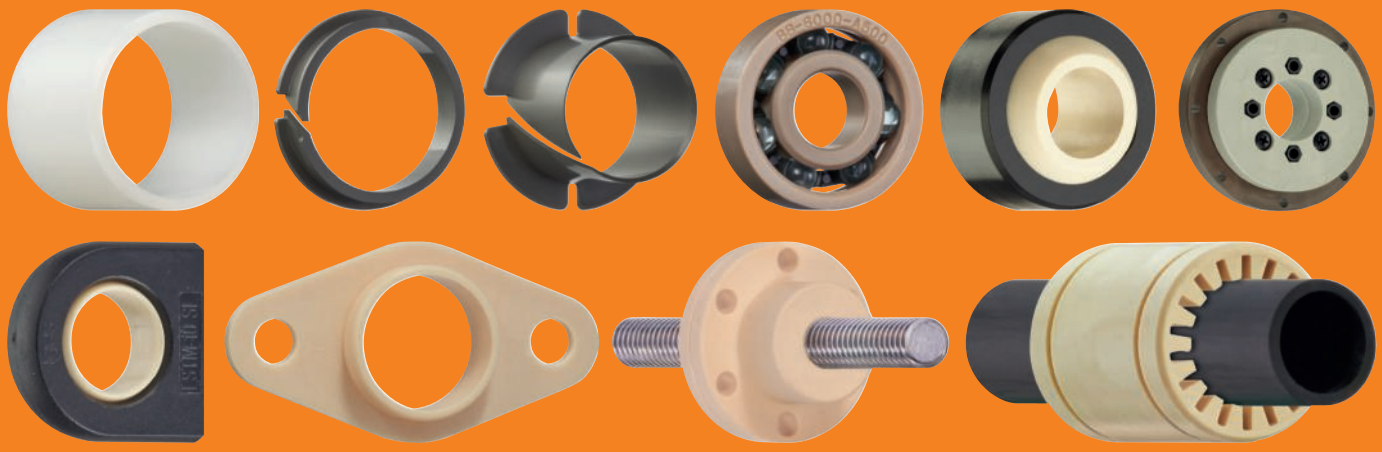

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AUTOCLAVE BOTTLENECK SET TO BE REMOVED

MANUFACTURING A RANGE of components, from wind turbine blades to car panels, could become significantly quicker and more cost-effective thanks to a project underway in Prestwick, Scotland.

The initiative, involving Spirit AeroSystems and the University of Strathclyde, supported by £50,000 of funding from CENSIS, the Scottish Innovation Centre for Sensor and Imaging Systems, has found a more cost-effective method of producing composite parts, replacing the traditional autoclave 'curing' process with an intelligent and tailored heating tool.

An autoclave typically represents around $4million in upfront capital expenditure, the consortium's multi-zone heated tool removes the need for this while allowing users to monitor and match a cure cycle to a component's geometric characteristics and how it is reacting to the process.

Depending on a component's geometry, the project could reduce operating costs by as much as 50%, through reduced CAPEX, factory space and energy consumption, while cutting cycle times by up to 40%.

Stevie Brown, lead engineer at Spirit's Advanced Technology Centre in Prestwick, explained: "Instead of curing components at a standard temperature for hours at a time, we can now tailor the cycle time to match individual part geometries. The autoclave has been a bottleneck in manufacturing lines, and removing it will reduce cycle times for components, cut production costs and decrease energy consumption."

MICRO-EPSILON

SOLUTION TO LAST MONTH'S COFFEE TIME CHALLENGE

The solution to last month's Coffee Time Challenge comes from Swedish-based Hövding. The company has developed a new type of bicycle helmet inspired by car airbags.

The aim was to develop a 'helmet' that cyclists of all ages are happy to wear as it is so indiscreet. The result is the airbag helmet that provides up to eight times better protection compared to traditional bicycle helmets.

The airbag is designed like a hood and made from an ultra-strong nylon fabric that won't rip when scraped against the ground. Hövding protects nearly all of the head, while leaving the field of vision open. The inflated airbag covers a much larger area than a traditional cycle helmet and is designed according to current accident statistics.

The airbag fixes to the neck of clothing and provides soft and gentle shock absorption. Pressure remains constant for several seconds, making it able to withstand multiple impacts during the same accident. The gas inflator is placed in a holder in the collar on the cyclist's back.

MOVERS & SHAKERS

XTRAC SHAKE-UP

Xtrac, a producer of high performance transmissions for the motorsport and automotive industries, has announced that Joe Greenwell is to be appointed non-executive chairman with effect from July 2018. Greenwell will take over from Peter Digby, who becomes company president. Xtrac's chief executive, Adrian Moore will continue to head up the executive team responsible for day-to-day operations.

NEW MD FOR ALBIS

Josephine Bagnall has been appointed managing director of ALBIS (UK), taking over the responsibility from Ian Mills who will remain on the Board.

RP TECHNOLOGIES' NEW OPS ENGINEER

RP Technologies has employed Neil Lewis as operations engineer. In his new role and Lewis will manage projects through the tool room and moulding facility until components are ready for dispatch, working closely with customers.

APC APPOINTS NEW NATIONAL NETWORK PROGRAMME LEAD

Philippa Oldham has joined the Advanced Propulsion Centre (APC) to lead its National Network Programme. She comes from the IMechE, where she served as head of transport and manufacturing since 2011.

BUILDING BRIDGES

Step one, buy an old industrial robot. Step two, attach a MIG welder. Step three, put one either side of a waterway. Step four, fabricate until they meet in the middle. If it were only that simple, as Justin Cunningham finds out.

Building bridges has been a preoccupation of mankind for centuries. Over the years, designs have been as varied as the materials used to build them and while you may think engineers have got it all figured out when it comes to bridge design and construction, a project to build a bridge across an Amsterdam canal is challenging conventional wisdom.

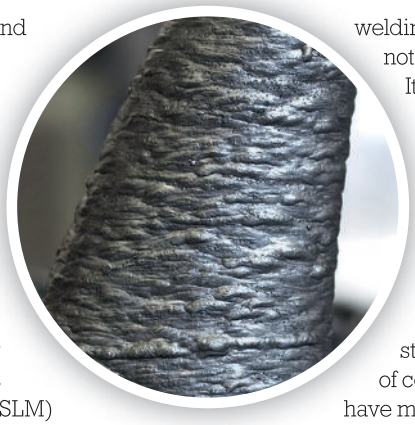
Amsterdam-based start-up MX3D is 3D printing a 12-metre-long stainless-steel pedestrian bridge to be installed across the busy Oudezijds Achterburgwal canal in the old city centre later this year. The concept is relatively simple: put a welder on a robot arm, place one on either side of a waterway and begin 'printing' until they meet in the middle. Easy, right?

Chief technology officer from MX3D, Tim Geurtjens, explains: ''When we started we thought let's get an old robot arm – the kind you see on car production lines – and put a simple €1000 welder on the end. We thought, 'this is going to be easy'. But things turned out to be much more complicated.''

Broadly speaking, the technology is about adding layers of material. However, MX3D is not using modern additive techniques like selective laser melting (SLM) or even direct metal laser sintering (DMLS). Instead they've chosen a more traditional process… welding.

''It is a MIG welding technique,'' says Geurtjens. ''It is melting the base material and adding a metal wire and that is fusing together. We are basically building with molten metal.

''One of the most complicated things was to get control of the welding process. You can study welding for your entire life and still not know everything about it. It is a very synergic process – if you change one value, everything changes as well – we really underestimated that.''



While the team initially considered printing the bridge in steel, they quickly moved towards stainless steel to overcome problems of corrosion. Using steel would have meant that a coating would be needed, which would completely cover the bridge's surface, hiding the fact it was made of steel and more importantly the fact it had been 3D printed.

''Changing material to stainless steel was a very expensive decision,'' says Geurtjens. ''Stainless-steel is not cheap but this is maybe the only 3D printed bridge we are ever going to make, so let's do it right.''

A key part was the control of the process, which was primarily driven by bespoke software that the team developed themselves to optimise all the various parameters. There was a lot of trial and error involved and while some simulation was used, the practicality of the process meant that a significant amount of practice was needed to prove out the process and properties of the printed material.

''We are developing software, parameters and printing strategies for the different kinds of 3D printable 'lines','' explains Geurtjens. ''For instance, vertical, horizontal or spiralling lines require different settings, such as pulse time, pause

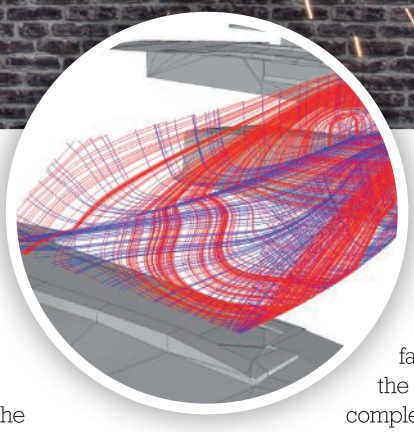
time, layer height or tool orientation. All of that is incorporated in the software.''

The control is now so good that the team can print intricate structures, far more like the organic structures often printed in smaller 'in-box' additive machines. The process also does away with support structures due to the inherent strength of the material. This creates an 'out of box' 3D printing method that makes it possible to create 3D objects in almost any size.

PROGRESS

While the concept of 3D printing a bridge in situ is an exciting and intriguing one, the practicality comes with a host of challenges, least of which is actually getting the technology to work. In short, it's a health and safety, and operational nightmare.

As with most welding processes, sparks are emitted from the welding head which are bright enough to damage eyesight if looked at directly. In addition, getting the necessary permits to build the bridge would be a long winded, if not impossible, undertaking. The other difficulty is that access to the site would be limited due to the narrow streets.



''From the beginning, we knew we wanted to have the bridge there,'' says Geurtjens. ''But we walked around and thought this is never going to work. We'd need to set up shop there, so have an office, power supplies, shield everything off, shield off the robot and welder from the weather and weatherproof the equipment. The logistics and cost would make it very difficult.''

The team therefore decided to create a lab in which to develop the process and begin fabrication of the bridge as intended. Once built the bridge could be tested and put through the necessary rigour required for a public foot bridge, before it could be transported, assembled in place and commissioned. To date, the team has fabricated half the bridge using the technique and expect to complete fabrication within the next few months.

SMART BRIDGE

Given the pioneering nature of the build, the process has numerous permutations as well as the possibility of voids produced during printing or perhaps the inclusion of oxides on the material. It means it's difficult to know how the structure will hold up over time. To answer this question, the team plans to lace the structure with sensors to measure, monitor and analyse the performance of the bridge which, upon completion, will be the world's largest 3D printed metal structure. »

» The sensors will collect data on structural measurements such as strain, displacement and vibration and measure environmental factors such as air quality and temperature, enabling engineers to measure the bridge's 'health' in real-time and monitor how it changes over its life.

Geurtjens explains: ''We will make the bridge a smart bridge by fitting it with all kinds of sensors and accelerometers as well as measuring temperature and humidity – basically any sensor we can lay our hands on we'll put on the bridge and start measuring. First of all though, we will measure the structure's integrity.

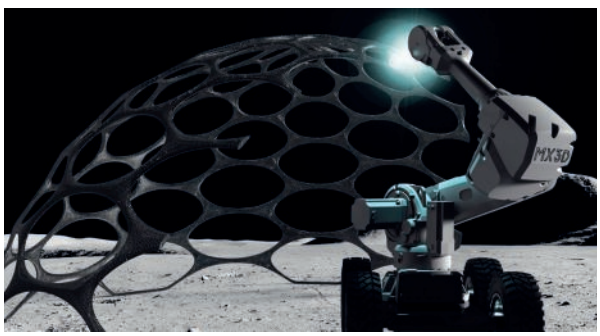
''Obviously, to get a permit for the bridge is quite challenging as it is very hard to prove that a new material and process like this is actually strong enough to be used. So, we will do some full load tests, equivalent to 300 people on top of it to measure deformation and measure the health of the bridge.

''But we won't stop there. What we will do is measure structural integrity and see what the bridge does. Then afterwards, we'll leave the sensors there, so when we put the bridge on location we will keep measuring and generating data from it.''

Autodesk is supplying the cloud services that will power the bridge's data collection and processing. MX3D is also working with researchers from The Alan Turing Institute to develop machine learning algorithms that will enable the bridge to interpret its environment. This data will also allow MX3D to 'teach' the bridge to understand what is happening on it, such as how many people are crossing it and how quickly.

The data from the sensors will also be input into a 'digital twin' of the bridge, a living computer model that will reflect the physical bridge through its life, with growing accuracy in real-time as the data comes in. The performance and behaviour of the physical bridge can be tested against its digital twin, which will provide valuable insights into designs for future 3D printed metallic structures. It will also enable the current 3D bridge to be modified to suit any required changes in use, ensuring it is safe and secure for pedestrians under all conditions.

''We have a complete digital model of the bridge and have done some strength analysis on it,'' says Geurtjens. ''We then have to validate the digital model of the bridge by doing some physical tests as we need to make sure the theoretical situation is the same as the real situation.''



As well as the material and process, there is also the potential for unknown behaviour in the hollow structure. Does a 3D printed hollow beam, for example, have the same buckling and failure modes as a normal hollow extruded steel beam?

''That is an issue,'' says Geurtjens. ''There is a little bit of lattice work inside, and we thought about printing a full lattice inside but it didn't prove to be necessary. The design was made in collaboration with the engineers from Arup and the idea was, first of all, let's look at what kind of loads can be placed on a bridge and how that would affect the design.''

FUTURE POTENTIAL

The future for the techniques being developed by MX3D are as wide and varied as you'd expect from such a project. From a building and fabrication point of view it is envisioned that the robot and welding arm could be turned into moving fabrication robots. The vision is that the robotic arms will be placed on wheels that can drive around a site, for example, in swarms and produce anything from bridges to bike frames. The technology could even be sent to the moon where it could produce structures for colonisation.

''We spent a year and half testing and developing the techniques and have come up with a strategy that's worked really well,'' says Geurtjens. ''It was just a bit too slow for now to do on the canal, but the most important thing is we get the bridge done. The dream is still there for the next project to print in this way. But, with the first project we figured it is more important to get it there.''

DATA TO DESIGN

The engineers at MX3D use Lenovo's ThinkStation P910 for its extreme performance edge to handle all of its data and run topology optimisation applications like Autodesk Fusion 360.

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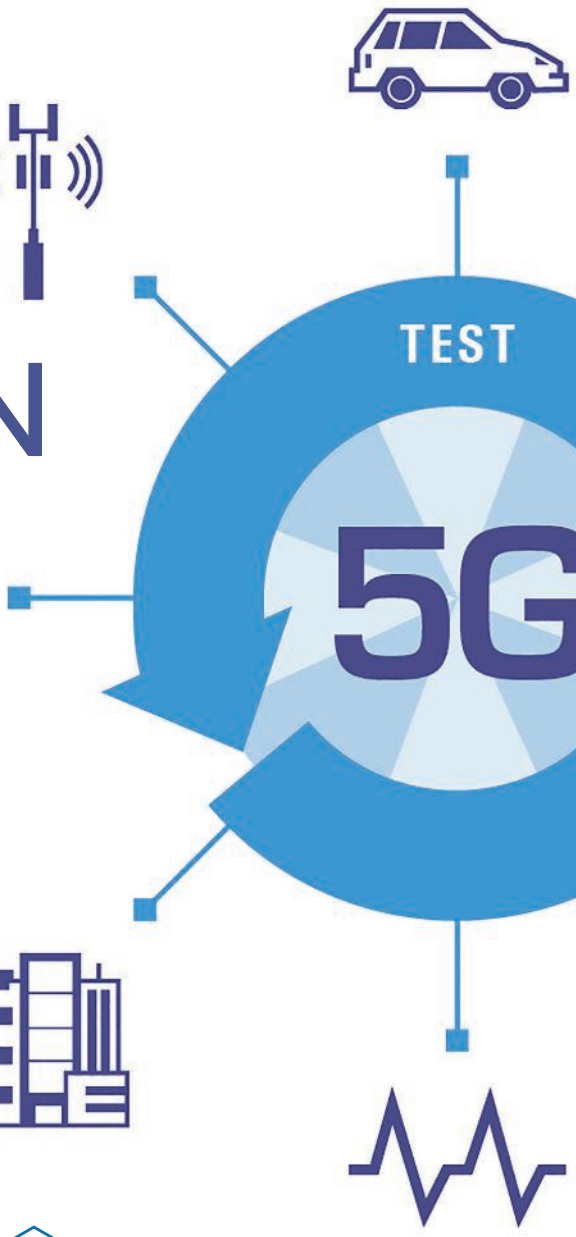


Recent developments in 5G have brought the expected roll-out timetable forward. Tom Austin-Morgan finds out what we can expect, and when.

It looks as if 5th generation mobile network technology could be developed as soon as 2020, despite 4G infrastructure not yet being fully implemented. The original date for the roll-out of was expected to be 2025. So what's changed?

While 4G download speeds typically hover around 100Mbps, the speed of 5G, at least theoretically, would be between 1-10Gbps.

"We're still only 60-65% infrastructurally rolled-out on 4G globally and we're already talking about 5G," says Jeffrey Phillips, section manager of product marketing at National Instruments. "About 18 months ago we thought 5G was going to be a 2025 thing, now it's 2020, the 3GPP (3rd Generation Partnership Project) Committee continues to pull in those timelines as we make progress in this area that we never thought possible. We have made so much progress in this area in the last 18 months, it's crazy."

5G is not just about speed however, it also presents researchers with a challenge to improve other known, but no less important, issues such as regional coverage uniformity and the overall energy-efficiency of networks.

And while faster data access is certainly exciting, there are a number of challenges remaining. The spectrum that service operators paid governments billions of dollars to acquire has simply run out. Today's networks use anywhere from 700MHz to almost 3GHz, but it has to share this bandwidth with a variety of public and private entities. This challenge can be met in two ways. First is to explore new spectra, the second is to develop new technologies to send more bits to users in the currently allocated spectra space available.

"One of the undervalued, or underrated, aspects of 5G is that many current trends are built around it – Internet of Things, Machine Learning – which are reliant on the network and our ability to transmit data quickly and seamlessly, to get not just the volume, but the reliability of the data transmission across the network," Phillips says.

The SDR (software defined radio) market, is an area in which NI has seen a lot of progress. However, the biggest opportunities around test are built around its PXI platform.

Jeffrey Phillips, section manager of product marketing at National Instruments.

"A lot of the successes we've seen in our work with Lund University and Bristol University have been based on PXI and FlexRIO and the openness of the FPGAs," Phillips continues. "PXI also happens to be the same platform that a lot of our customers run their production test floors on. The advantage of that is that the prototyping code and the algorithms we're developing will be the same algorithms – that also run on the same hardware – when we transition to test. The customers like Nokia, Samsung and Facebook are going to see tremendous cost-savings and

about within 5G research. They're starting to merge on each other very quickly.

"But the thing about mm-wave and MIMO is the ability now to duplex the signals not just horizontally, but also vertically and that's helping us get beamforming technologies to get around corners and into buildings that we couldn't get into with strong signals before."

This beamforming technique can already be found in high-end wifi routers, enabling the focused targeting of a network signal rather than projecting in a wide, inexact arc like 4G. Wherever you are on a 5G network, beamforming will create a strong, direct link to your device, boosting performance and minimising interference even in densely populated areas.

5G is not just for mobile devices though, Phillips says, and there are already 5G applications at work in other markets.

"Look at automotive and robotics, those are two of the most common applications of the networking capabilities around 5G," he says. "You don't see industry waiting on the outcome in order to start putting these things in place, we're already well into stage two of the five stages of autonomous vehicles. The algorithms and the standards aren't yet fully-baked, but they will be very soon."

Vehicle-to-vehicle communication is another prime area where work needs to be done to reduce the amount of power needed to transmit and acquire the necessary data to keep a fully-automated network of roads and motorways moving smoothly, especially through intersections.

"We are within an arm's reach of having millions of 5G-enabled devices," predicts Phillips. "We're going to see 4G stop from infrastructurally rolling-out and we'll start moving over to 5G before the majority of the world is on 4G.

"Within 5G the standards that are showing up, the sophistication, the hardware... we really feel uniquely positioned within the market," says Phillips. "Our customers are uniquely positioned to build on top of our platform because of the role software plays and the modularity and scale that we see within PXI. It allows acquired data to be processed at the node, in the handset – at the edge – which means real-time decisions and outcomes are possible."

There is little doubt, the impact of 5G will be transformational for both consumers and industrial applications. The countdown to 5G is ticking down and is getting closer to realisation every day, which means more applications are being identified such as driverless cars and 'smart' transports and infrastructure; Industry 4.0; and ultra-highspeed broadband everywhere.

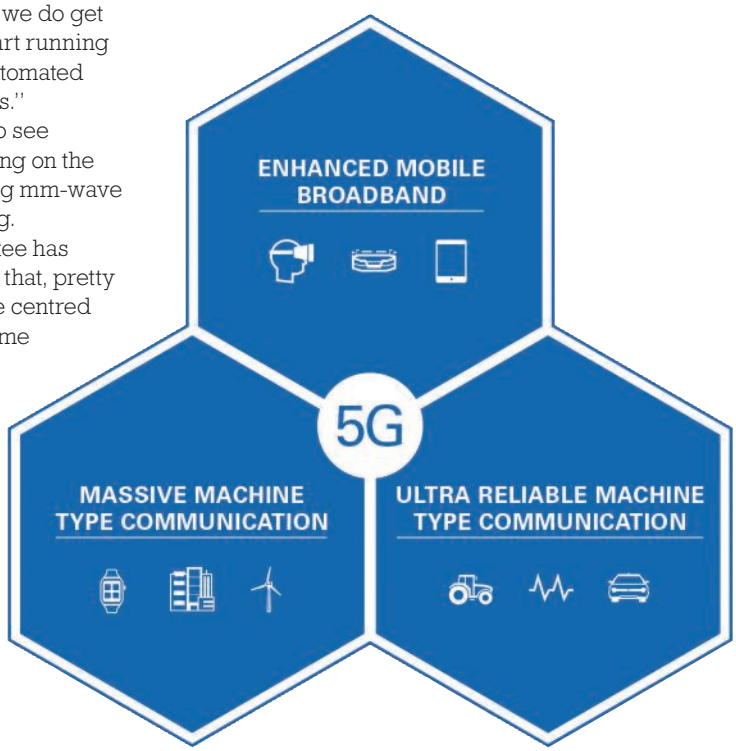
HOW 5G WILL DRIVE THE WORLD IN 2020

- 10Gbps speeds;
- More than 50 billion connected devices;
- Mobile traffic is expected to exceed 127 exabytes;
- Mobile subscriptions expected to exceed 9.6 billion;
- Battery life will be 10 times longer;
- Time to download a two-hour HD movie: less than 3 seconds.

efficiency boosts when we do get to that transition and start running production tests and automated testing on those devices."

NI has also started to see other companies jumping on the bandwagon, introducing mm-wave systems and processing.

"The 3GPP Committee has been very forthcoming that, pretty much, 5G is going to be centred around mm-wave in some form or fashion," adds Phillips. "There's a lot of MIMO (multiple-input and multiple-output) applications showing up within the mm-wave frequencies that are starting to blend together some of the traditional vectors that we talk



CODE WARS

As vehicles become more reliant on software, the amount of code needed to run everything from the engine to the driveline is huge, bringing diverse challenges to OEMs and suppliers alike. James Scoltock reports.

Automotive software development is exploding. The rise of alternative powertrains, more complicated drivetrains and an increasing reliance on electronic systems means that software is key to even starting a vehicle nowadays.

That is putting pressure on vehicle manufacturers and the engineers developing the cars we drive.

Ford has a long history of producing numerous technologies in-house and the rise of software and its inherent importance has become a huge part of its vehicle development programmes.

Ford's chief engineer for driveline engineering, Craig Renneker, comments: "Back in 2003 we had a brand new five-speed automatic transmission and at that time the software to control it was about 155,000 lines of code. Our new 10-speed that we recently launched in the Ford F-150 pick-up truck has just over a million lines of code."

To put that into perspective NASA's Space Shuttle required roughly 400,000 lines of code.

There are a number of reasons driving the increasing amount of software needed in vehicles, particularly the driveline.

The integration with the engine control is more sophisticated, the customer features are more varied, including electronic park select, manual shift selection and adaptive shifting, for example. All of these features cause the software requirements to grow.

"A million lines of software for an automatic transmission and there is additional software for the engine that's almost double that, and then the all-wheel drive system has a substantial chunk of code too," says Renneker. "We're talking about millions of lines of code to operate a modern driveline."

But the embedded code is something that is helping to differentiate vehicles in a competitive market.

Michael Schomisch, manager of software and electronics at GKN says: "Driveline software is increasingly becoming a differentiator for a vehicle's driving experience and the OEM. This becomes specifically visible in our Twinster all-wheel drive system, which delivers a different driving behaviour not only for high performance vehicles but also for everyday cars."

In GKN's Twinster system the base hardware can remain relatively unchanged but the underlying code will help it achieve different performance levels depending on the vehicle it is integrated into.

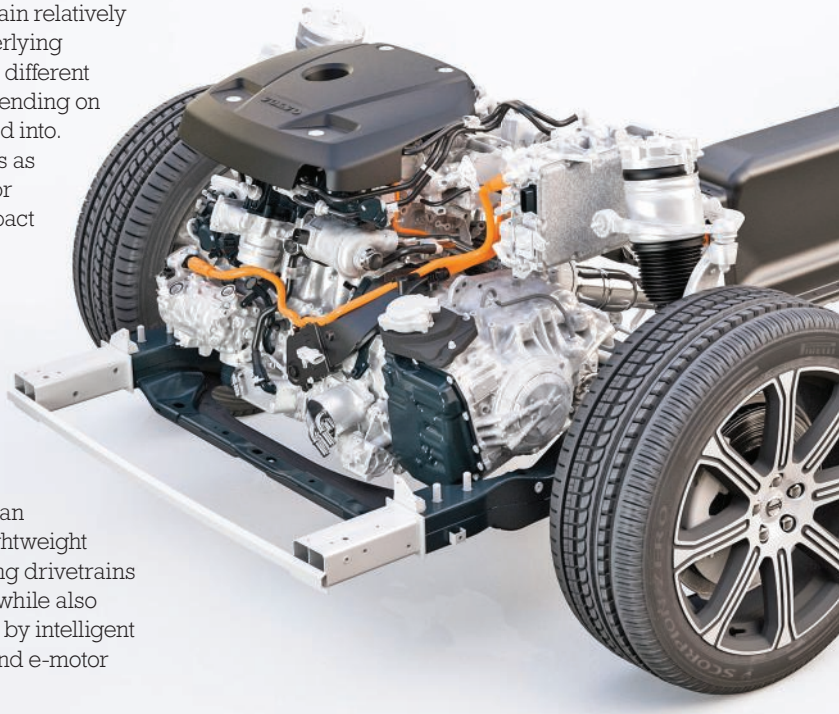
"Whether it's vehicles as diverse as a large SUV or high-performance compact car, software really makes the difference," says Schomisch. "And software also has a strong contribution to increased CO_2 efficiency – both, in all-wheel drive and electric drivetrains."

For GKN, software is an enabler for small and lightweight but still highly performing drivetrains through smart controls, while also actively reducing losses by intelligent disconnect, gearshifts and e-motor control.

In 2003 a Ford 5-speed automatic transmission had 155,000 lines of code. Its new 10-speed has over a million. To put that in perspective, NASA's Space Shuttle required roughly 400,000 lines

But, Schomisch makes the point that as the amount of active driveline and chassis systems increase, integration capability becomes more important.

"Our software is designed to fully integrate with the other systems to deliver higher level controls for individual system functions such as gearshift and e-motor controls, functions to mitigate adverse driveline effects such as NVH, oscillations or drag losses as well as interfaces to allow other systems to take benefit of our driveline technologies," he says.



Whether it's a large SUV or high-performance compact car, software can make all the difference.

Volvo is one of many OEMs that uses GKN driveline technologies in its vehicles and is increasingly aware of the role software plays.

Volvo's senior director of propulsion controls and calibration, Lutz Stiegler says: ''Drivelines are becoming more complex and customer expectations of how they behave are getting broader, hence the software that controls the systems is getting more complex and becoming a more important component of a vehicle.''

For Stiegler and his engineers the main task is optimal torque delivery and distribution from the source, whether it's the combustion engine or electric motor, to the individual axle.

That's important considering Volvo's move into providing not only combustion powertrains in its vehicles but also mixing combustion and electric propulsion in its plug-in hybrid variants.

But while finding the balance in software development is the here and now, Stiegler and his team are also looking to the future.

''Over-the-air driveline updates are one option that we intend to use in the future. There's also an extremely wide range of opportunities to link the driveline controls to the 'connected car'. One example is further energy optimisation via drive cycle and traffic flow prediction,'' he says.

But the explosion in embedded software in a vehicle's driveline, the possibility of over-the-air updates and the connected car bring challenges that every firm, whether an OEM like Ford or Volvo or a Tier One supplier, must find solutions to.

Many might think that it's the processing power required to run all the code that would cause the biggest issue, but Renneker says that isn't the case, saying, ''Moore's law seems to work pretty well''. Instead it's memory and the human factor that are causing the biggest headaches.

Renneker adds: ''The issue we've had in the driveline world is that automotive memory is very expensive. People tend to think of it being cheap, you can go to your local store and buy a gigabyte memory chip for a few dollars, but the memory that has the capability to live in an automotive environment – with extreme temperatures and extreme vibration – tends to be very expensive.''

As technologies like transmissions and other driveline systems have a long incubation period, the growth of the software during that time can cause issues. Most pertinently, how much memory to integrate.

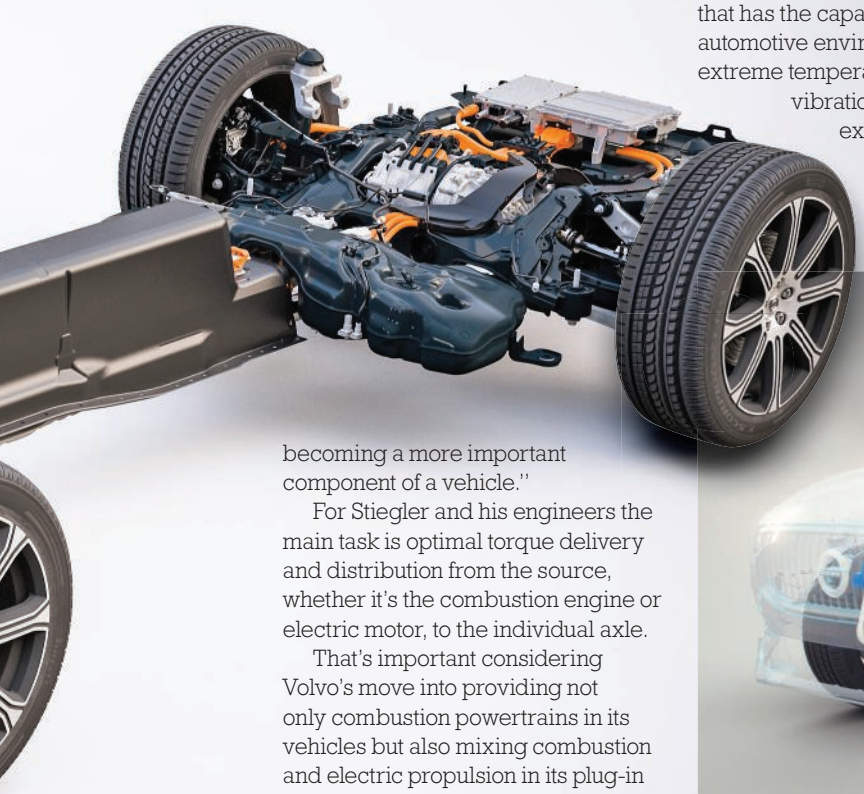
''We continue to struggle with having enough memory because engineers can invent things that outpace the memory, so we have a lot of fights to decide how much to put in a module,'' says Renneker.

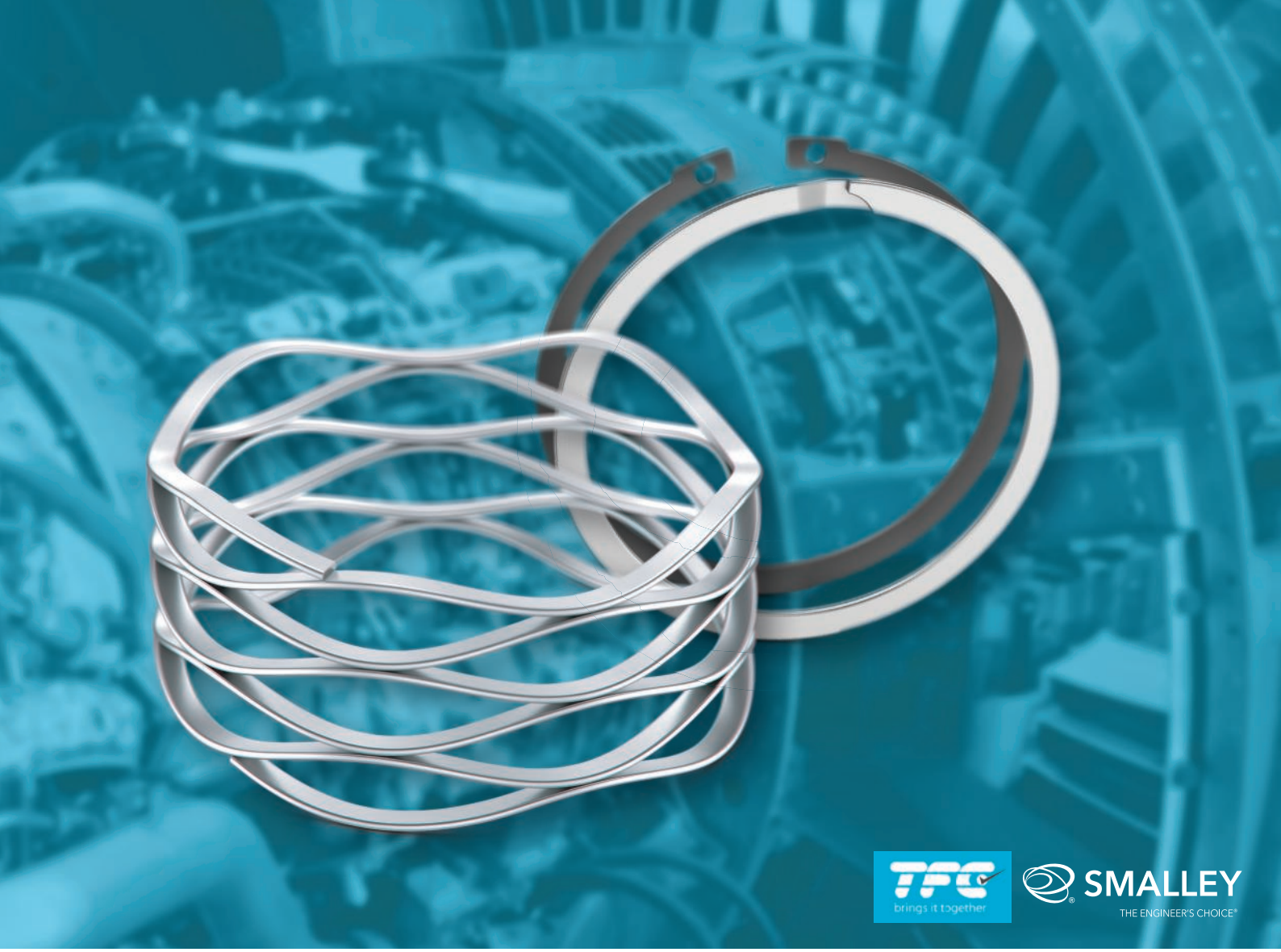
But hardware specifications aren't the biggest challenge. That's reserved to the engineers themselves and bringing in the right people and the numbers needed to write the code itself.

''That is our primary resource constraint today,'' explains Renneker. ''The problem is that we're drawing on the same market that the entire consumer products world is drawing on. These engineers are in demand, and it's very difficult to find, train and retain them. It's a big challenge for us.''

It's unlikely to get easier, looking at firms like Facebook, an outwardly simple social media website, it still requires 61,000,000 lines of code to work. That in turn means a huge drain on the pool of software engineers automotive firms can recruit from.

The vehicles we drive, and the technologies that underpin them will become increasingly complex, reliant ever more on the lines of code that control every aspect of their running. OEMs and suppliers, while aware of the importance, are going to have to work hard to meet the challenges this brings.





Wave Springs & Spirolox Rings
improve design space & weight options

Springs have been an essential component in aircraft manufacture since building the first "flying machines" over 100 years ago. In those early days, it would have been some uncomplicated coil springs and leaf springs. Compare that with a modern airliner that includes thousands of different springs on numerous assemblies throughout the plane.

Today's aerospace engineers face many design challenges, including the requirement to make assemblies more compact and lighter in weight. For over thirty years TFC's engineering team have assisted companies across the sector to achieve these design goals by specifying Smalley® wave springs in place of traditional coil springs, and Spirolox Retaining Rings in place of standard circlips.

Wave springs are not a new concept, Smalley® as the global leader in this field have been manufacturing them for over fifty years and have proven their value in a wide variety of applications and industry sectors; 4mm springs in medical and electronic devices, to 3m diameter products.
The main advantage of selecting Wave Springs is their space-saving properties. They exhibit reductions in operation heights due to a shorter solid height. The flat-wire springs operate on a bending principle to generate the required spring force to tight tolerances. From the outset, TFC recognised the advantages of Wave Springs and have always had a team of engineers available to discuss the potential use of this technology.

Spirolox or Spiral Retaining Rings are supplied in line with designated Aerospace specifications. They are interchangeable with the standard snap ring and circlip grooves to provide a full 360-degree retaining surface in a range of materials.

TFC engineers are regularly working with design teams to develop bespoke wave springs and rings for application in both commercial and military aircraft. These can be produced quickly and economically with no tooling costs, making them perfect for large runs, prototypes and mid-stream design changes.
Wave springs have multiple uses; cabin applications, fuel systems, auxiliary power units, one recent program included the design of a bearing preload spring to allow for both tolerance variation during assembly and thermal expansion during flight.

TFC Ltd is an AS9100c/AS9120 approved provider of fasteners, components and supply chain services to industry. All products are supported by either ISO, AS or individual OEM approvals with lot traceability certification as required.
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ELECTRIFYING AIRCRAFT

Major aerospace firms are developing hybrid-electric propulsion for commercial aircraft, an advance that could help cut emissions, noise and fuel use. Tom Austin-Morgan finds out more.

Three major OEMs in the aerospace industry have come together to collaborate on the future of aircraft propulsion, namely to create a hybrid-electric propulsion demonstrator for commercial aircraft, bringing together some of the world's foremost experts in electrical and propulsion technologies.

The demonstrator, called the 'E-Fan X', will be fitted on a BAe 146 flying testbed and is anticipated to be flown as soon as 2020 following a comprehensive ground test campaign. As part of the tests, one of the aircraft's four gas turbine engines will be replaced by a 2MW electric motor. Later, once the E-Fan X has been proven, a second gas turbine will be replaced.

Paul Eremenko, Airbus' chief technology officer, says: ''We see hybrid-electric propulsion as a compelling technology for the future of aviation.

''The E-Fan X is an important next step in our goal of making electric flight a reality in the foreseeable future. The lessons we learned from a long history of electric flight demonstrators – starting with the Cri-Cri, including the e-Genius, E-Star, and culminating most recently with the E-Fan 1.2, as well as the fruits of the E-Aircraft Systems House collaboration with Siemens – will pave the way to a hybrid single-aisle commercial aircraft that is safe, efficient, and cost-effective.''

Dr Frank Anton, head of Siemens eAircraft; Mark Cousin, Airbus head of demonstrators; Paul Stein, Rolls-Royce CTO.

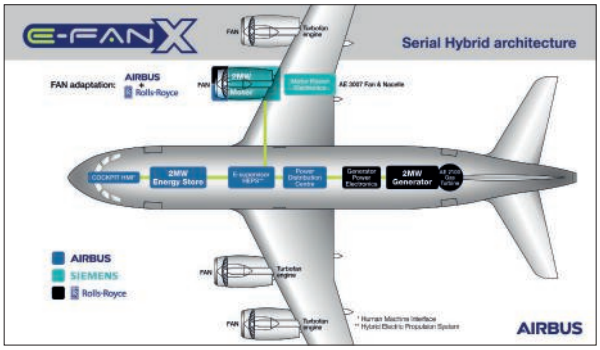
The E-Fan X demonstrator will explore the challenges of high-power propulsion systems, such as thermal effects, electric thrust management, altitude and dynamic effects on electric systems and electromagnetic compatibility issues.

The objective is to push and mature the technology, performance, safety and reliability to enable quick progression of the hybrid-electric technology.

The programme also aims to establish the requirements for future certification of electrically powered aircraft while training a new generation of designers and engineers to bring hybrid-electric commercial aircraft one step closer to reality. »

» As part of the E-Fan X programme, Airbus, Rolls-Royce, and Siemens will each contribute experience and know-how in their respective fields of expertise:

- Airbus will be responsible for overall integration as well as the control architecture of the hybrid-electric propulsion system and batteries, and its integration with flight controls.
- Rolls-Royce will be responsible for the turbo-shaft engine, 2MW generator, and power electronics. Along with Airbus, Rolls-Royce will also work on the fan adaptation to the existing nacelle and the Siemens electric motor.
- Siemens will deliver the 2MW electric motors and their power electronic control unit, as well as the inverter, DC/DC converter, and power distribution system. This comes on top of the E-Aircraft Systems House collaboration between Airbus and Siemens, launched in 2016, which aims to develop and mature various electric propulsion system components and their terrestrial demonstration across various power classes.



Airbus, Rolls-Royce, and Siemens will each contribute know-how in their respective fields of expertise as part of the E-Fan X programme.

Paul Stein, chief technology officer at Rolls-Royce, says: ''The E-Fan X enables us to build on our wealth of electrical expertise to revolutionise flight and welcome in the third generation of aviation. This is an exciting time for us as this technological advancement will result in Rolls-Royce creating the world's most powerful flying generator.''

One of the biggest challenges for the aviation sector is the move towards a means of transport with improved environmental performance, which is more efficient and less reliant on fossil fuels. The E-Fan X project partners have committed to meeting the technical environmental goals set out by the European Commission's Flightpath 2050 Vision for Aviation that stipulates a 60% reduction in CO_2, reduction of NOx by 90% and noise reduction by 75%.

These cannot be achieved with existing technologies. Therefore, Airbus, Rolls-Royce and Siemens are focusing research work in different technology areas including electrification. Electric and hybrid-electric propulsion are seen as among the most promising technologies for addressing these challenges.

''Siemens has been driving innovation in core technology fields at full speed,'' says Roland Busch, chief technology officer of Siemens. ''In April 2016, we opened a new chapter in electric-mobility with the collaboration with Airbus. Building up electric propulsion for aircraft, we are creating new perspectives for our company and also for our customers and society. With the E-Fan X partnership, we now take the next step to demonstrate the technology in the air.''

SIEMENS ELECTRIC MOTOR SETS AIR-SPEED RECORDS

In March 2017, the Extra 330LE aerobatic plane, powered by an electric propulsion system from Siemens, set two new speed records. At the Dinslaken Schwarze Heide airfield in Germany, the electric aircraft reached a top speed of 337.50kph over a distance of 3km, 13.48kph faster than the previous record set in 2013.

The World Air Sports Federation (FAI) officially recognised the record flight in the category 'Electric airplanes with a take-off weight less than 1000kg'. In a slightly modified configuration with an overall weight exceeding 1 tonne, The Extra also set a new FAI world record in the category 'above 1000kg' reaching 342.86kph.

The Extra 330LE also became the world's first electric aircraft to tow a glider in to the sky. The plane took a type LS8-neo glider up to a height of 600m in only 76s.

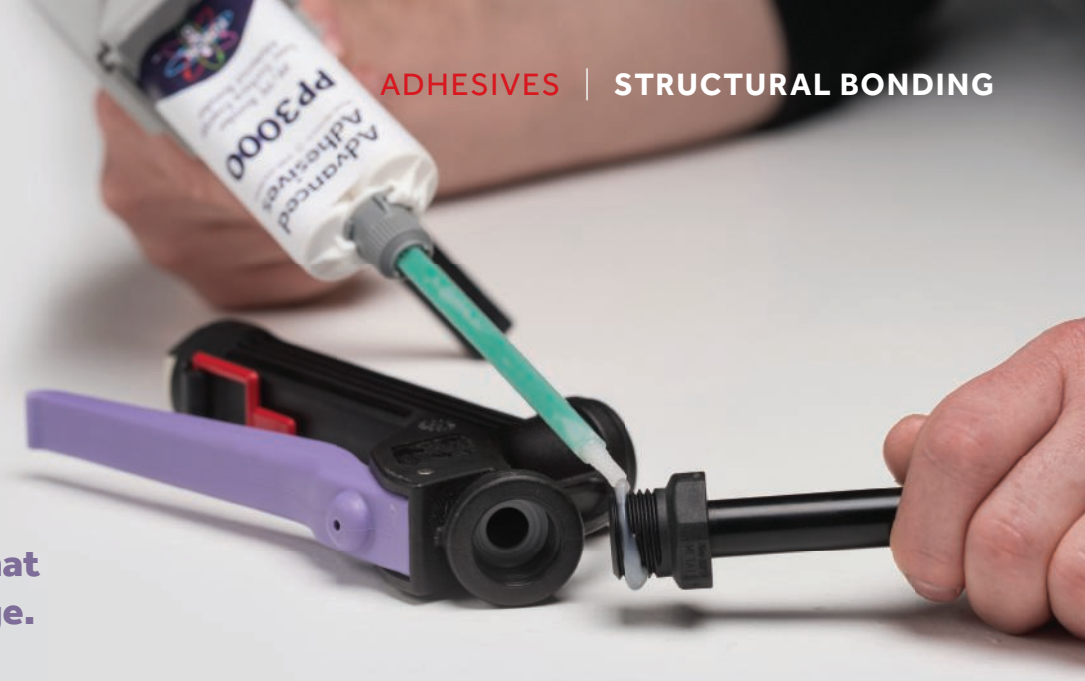
"This aerotow provides further highly visible evidence of our record-setting motor's performance capabilities," says Frank Anton, head of eAircraft at the Siemens venture capital unit next47. "Just six such propulsion units would be sufficient to power a typical 19-seat hybrid-electric airplane."

In addition, the lightweight electric motor already held a world record for power-to-weight ratio: weighing just 50kg, it supplies a constant electric output of 260kW, which is five times more than comparable propulsion systems.

As an aerobatic plane, The Extra 330LE serves as the flying test bed for the new propulsion system and is particularly well suited for taking the components to their stress limits, for testing and enhancing them.

Currently, there are no plans for series production of this electric plane. However, electric propulsion systems are scalable and Siemens, Airbus and Rolls-Royce intend to develop hybrid-electric regional aircraft based on this record-setting motor.

"By 2030, we expect to see the first planes carrying up to 100 passengers to have a range of about 1000km," claims Anton.



For all the benefits, the uptake of adhesives for structural applications has been limited and is greatly affected by material and surface preparation. Here, Eureka! finds out how that might be about to change.

MAKE THE IMPOSSIBLE... POSSIBLE

North-East bonding experts, Advanced Adhesives, was tasked recently with solving the issue of bonding low surface energy materials (LSEs) structurally for several high-profile applications where the requirement was for a structural bond without any additional fixings and with no surface pre-treatments.

Managing director Graham Crozier explains: ''We like a challenge and to meet the brief we set to work developing an innovative adhesive technology based on a unique chemistry. The upshot was the development of our PP3000 bonding solution.''

Formulated to specifically bond LSE materials to each other structurally, PP3000 has the ability to bond LSEs to other substrates, plastics, metals, glass and composites. It even bonds to E-coat, ensuring varying materials can be freely combined. The adhesive is a 2-part MMA based, equal mix ratio material, packaged in 50ml and 400ml dual mix cartridges for easy application, which self-mixes the material, so application is of a pre-mixed adhesive.

''Many designers and manufacturers within the manufacturing industry are turning to the use of low surface energy plastics such as thermoplastic polyolefin, TPO, polypropylene, PP and polyethylenes like HDPE, due to the many benefits they have over conventional plastics: low cost, durability, ease of processing and having superior chemical resistance and temperature stability,'' says Crozier. ''However, these are among the most difficult-to-bond materials, due to their non-polar, 'wax-like' surfaces, and can lead to issues when manufacturers need to assemble and join these plastics.''

When a liquid adhesive is applied to the surface of an LSE plastic, PP, PE, TPO or HDPE, the adhesive beads up, instead of 'wetting out' on the surface – much like when it rains just after you have polished your car and the rain beads up on the car body. ''This poor wetting out on LSE plastics, where the liquid adhesive will not spread and make intimate contact with the surfaces, results in poor adhesion thus resulting in poor bond strength. Conversely, with a higher surface energy substrate where the surface energy of the adhesive is less than that of the substrate, the adhesive will spread and 'wet out' the surfaces, giving the intimate contact required and thus good adhesion.''

Formulated to bond low surface energy materials to each other structurally, PP3000 can bond plastics, metals, glass and composites.

THE CHALLENGE

LSE surfaces would traditionally have to be mechanically attached or solvent welded, as true adhesion could not be achieved. Mechanical attachments such as screws, fixings etc require additional requirements in the moulding process to create features for the fixings to be used and, by using fasteners, potentially creating stress concentration areas where the plastic can fail prematurely, while also resulting in unsightly surfaces.

''In addition to fixings/fasteners, there are several techniques that are used to increase the surface energy of an LSE plastic, making it easier to bond – plasma, corona, flame treatment or solvent-based adhesion promoters. Once these treatments have been applied, it increases the surface energy and allows the liquid adhesive to wet out and give an increased bond level; but rarely to a genuine structural strength. »

» These additional treatments have a knock-on effect in the increased production cost and production process time, adding cost to the assembly of a component.''

Advanced Adhesive's PP3000 is already hugely successful in some large-scale applications, with two UK vehicle manufacturers using the adhesive to bond instrument panels, dashboard assemblies, with truly impressive results from their testing. ''Testing was carried out alongside four other adhesives, at different temperatures, environmental conditions and environmental cycles,'' states Crozier. ''PP3000 was the only adhesive that passed the complete test and gave total substrate failure throughout the testing procedure, regardless of the environmental conditions or test procedures where other adhesives failed. PP3000 was tested with plasma-treated components, alongside non-plasma treated components and the PP3000 proved to perform equally as well, proving a structural bond achievement with no need for additional surface treatments.''

LSE surfaces would traditionally have to be mechanically attached or solvent welded, as true adhesion could not be achieved

PP3000 passed testing regardless of environmental conditions or test procedures.

SUPER STRENGTH

The PP3000 was also tested for an application for bonding LGF polypropylene against other adhesives and gave substrate failure at the peak temperature requirement of 95°C with a 1mm and 2mm bond line thickness. It also yielded strengths greater than seven times that of the next best adhesive in these tests.

''PP3000 components were then bonded and again tested, but to an increased temperature of 120°C to test for a greater resistance capability of the adhesive and the components,'' he says. ''Again, the adhesive gave substrate failure, proving the adhesive was stronger than the substrates, even at this increased temperature. The PP3000 is being used very successfully in this automotive application.''

Examples of other successful applications with PP3000 are for bonding motorhome fairings and panels, motorbike fairings, automotive bumper components, bonding of moulded components, bonding of sports equipment etc – even bonding PP baby bath mouldings.

Apart from Advanced Adhesives' own in-depth trials, extensive testing has been carried out on PP3000 by prospective manufacturers looking to use the adhesive. Along with strength testing, chemical resistance has also been carried out, with proven environmental stability and retained strength resistance to many substances, including petrol, diesel, IPA, motor oil, Xylene, water at 60°C and salt spray conditioning.

''The adhesive strength is tested to ISO 4587, which is an overlap shear test where the substrates are bonded together with a pre-determined overlap, then allowed to cure,'' explains Crozier. ''After curing, the adhesive bonds are pulled in the shear mode at a constant speed, and the maximum force to failure is recorded. By achieving substrate failure on many components, the adhesive was proved to be stronger than most of the varying test materials themselves, thus delivering genuine structural bond strength on LSE substrates.''

Within the range now, the PP3000 has other adhesives of the same chemistry available to compliment this original material, developed further for specific applications, but all based on the original proven chemistry of the PP3000. Variants include a low viscosity grade, PP3000LV, for applications where a thin bond line is required or for larger surface areas to be bonded together with an ultra-high viscosity version. Also, PP3000UHV for applications where the adhesive needs to be applied to vertical surfaces or to fill a larger gap. Black variants are available, too, for applications where a black bond line is required aesthetically.

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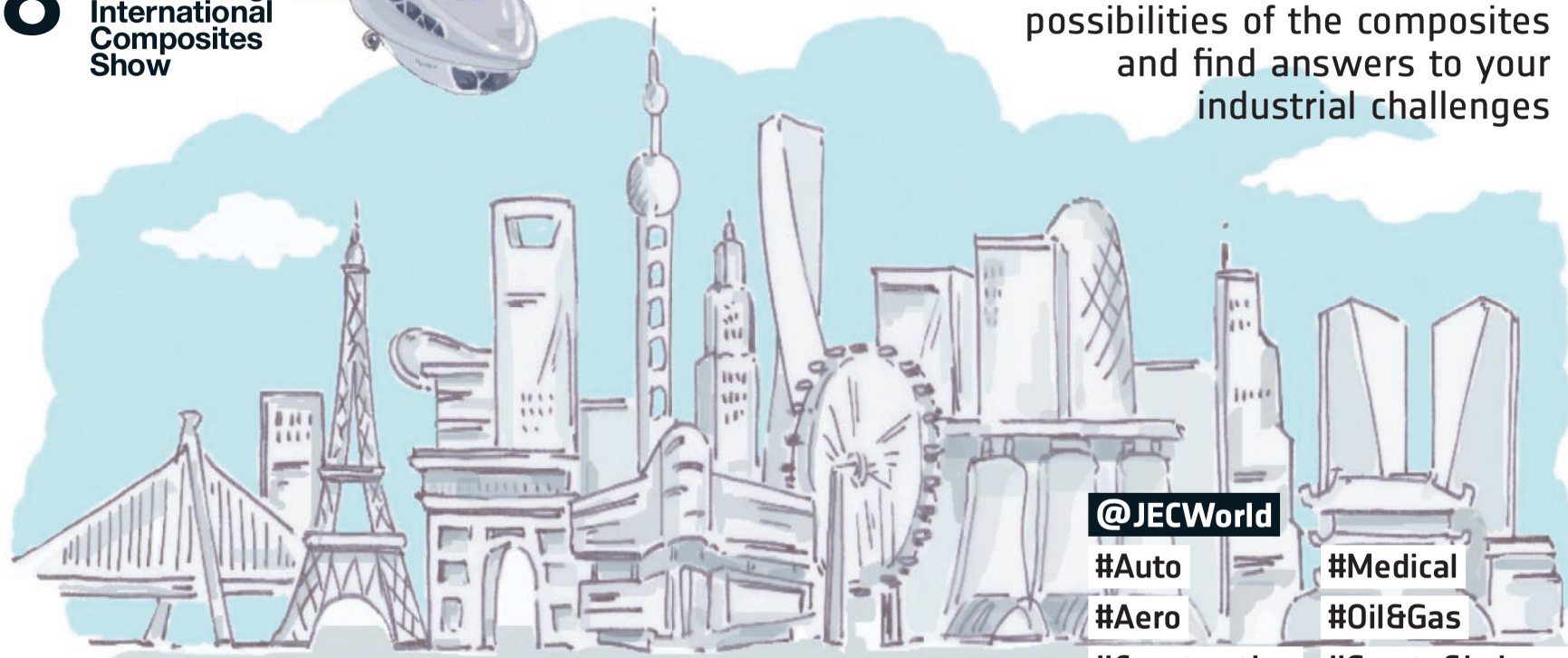

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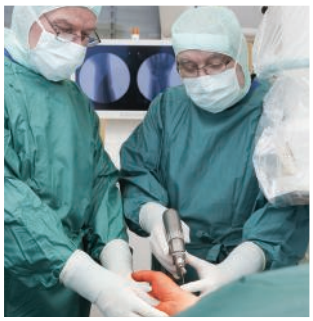


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SPECIFIER: MOTORS IN ROBOTICS

Many have found high power density and precision to be prerequisites when specifying motors for robotic applications. Here, Eureka! hears from the experts about how to find the most suited motor for your future robot-based projects.

HIGH POWER DENSITY

Within a compact unit, maxon DC motors provide a continuous torque rating of up to 1Nm. This can be increased using a gearhead. The ironless copper winding allows for a great volume/power ratio.

Compact units with high performance are beneficial for applications such as robotic arms used to assist humans with consistent heavy loads in warehouses (maxon's RE 40 and RE 65 DC motors). The RE65 offers a nominal torque of approximately 900mNm and can be overloaded depending on the duty cycle.

High power density refers to the maximum torque and speed rating within a small volume and the speed/torque gradient of the motor. This defines the strength of the motor when additional load is applied; for every mNm of torque applied, the speed output of the motor is decreased.

$$n = (k_n * U_{mot}) - \left(\left(\frac{\Delta n}{\Delta M}\right) * M\right)$$

WHERE: n = Output speed (under load) (rpm), kn = Speed constant (rpm/V), Umot = Voltage applied, Δn/ΔM = Speed/Torque gradient (rpm/mNm), M = Output torque (mNm)

maxon offers a speed/torque gradient as low as 0.306 rpm/mNm (EC-i 52 180W) that is used in direct drive applications where there is a fluctuating load.

Humanoid robots require a small powerful unit (high power density). The EC-4 pole 22 motor has a high output power as it has two pole pairs. A ceramic gearhead transmits more torque to the output shaft without causing internal wear.

ABOUT THE AUTHOR

Amir Janjua is a technical engineer at maxon motor UK

HIGH CONTROLLABILITY

maxon DC motors offer a linear relationship between the voltage applied and the speed output, in addition to the current and torque output.

$$n = (k_n * U_{mot}) - \left(\left(\frac{\Delta n}{\Delta M}\right) * M\right)$$

WHERE: n = Output speed (no load) (rpm), kn = Speed constant (rpm/V) and Umot = Voltage applied

$$M = k_M * I_{mot}$$

WHERE: M = Output torque (mNm), kM = Torque constant (mNm/A) and Imot = Electrical current

HIGH ACCELERATION

Coreless DC motors allow high acceleration, critical in pick and place systems and delta robots. In addition to low inertia, maxon offers a low mechanical time. For highly dynamic applications (constant acceleration/deceleration), a motor with low rotor inertia is fundamental.

Acceleration is determined by the torque required and the inertia of the load and rotor. If the load has an

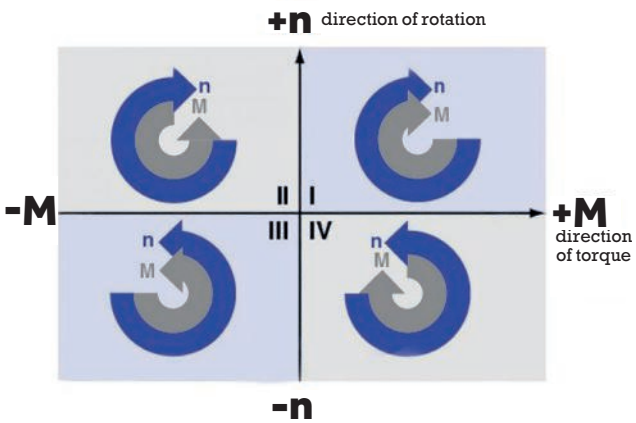
inertia more than 10x rotor inertia, a gearbox is required. Using a gearbox, the motor would see a 'reflected load inertia'.

$$J^*_{LOAD} = \frac{J_{LOAD}}{i^2}$$

WHERE: J* = Reflected load inertia (seen by motor), J = Load inertia and i = Gearbox reduction ratio

For high acceleration and deceleration, the power supply and controller should be reviewed. For deceleration torque is applied in the opposite direction to slow it to a halt. This prompts high current from the power supply and/or controller. There is also reversed energy supplied to the controller and the power supply.

4-Quadrant controllers (ESCON and EPOS) are recommended for highly dynamic applications.



LOW POWER CONSUMPTION

Portable robotic applications are operated by battery power and require a long duty cycle. When using a maxon gearhead the number of stages should be kept to a minimum as the efficiency decreases. It is best to choose a gearhead with a rated torque output comparable to the required torque output.

HIGHLY ROBUST

The maxon DCX and RE products have metal housing and flanges suiting them for robust applications, such as temperature, vibration and shock. They can be modified to suit specific requirements. From the BLDC range, the EC-Max has a robust steel housing.

When operating in extreme temperatures, maxon suggests -20 to 100°C. Modifications can allow the motors to operate beyond this, including adjustments to the PCB, grease and cables.

The EC-i 52 180W is used in direct drive applications with fluctuating loads, while the EC-4 pole is used in humanoid robots.

Underwater inspection robots are required to be robust and efficient. The RE40 + GP42 gearbox is the perfect combination of physical design, service life and ability to cope with high pressure.

SPEED AND TORQUE REQUIREMENTS

For robotic applications, high torque is usually the main requirement rather than speed. If a gearhead is not suitable, maxon has high torque motors rather than high speed. maxon offers several brushless motors which are multipole, hence particularly suited towards robotic applications.

Whilst the flat motor has up to 12 pole pairs (EC 90 Flat), it has a high rotor inertia, making it unsuitable for dynamic applications that require high acceleration. Flat motors are useful for applications such as humanoid robots, where a high torque, compact unit is required, that doesn't have a high dynamic requirement.

EC FLAT FRAMELESS

Robotic arms have space and weight restrictions, and high torque is required not high speed. maxon's frameless motor can be fully integrated. It is delivered as a rotor and stator and has an open design with room for cables, that also allows for higher rates of heat dissipation, so the unit can be overloaded on an intermittent basis when required.

EC-I 30

The EC-i 30 is ideal for highly dynamic applications due to low mechanical time constant and internal multipole rotor. It is a compact unit with a high-power density, offering a nominal torque of up to 110mNm. The modular system allows an increase of torque with various gearheads from the GP32 range and the 32mm spindle range. The motor offers a very low speed/torque gradient (4.07 rpm/mNm). It is compatible with a wide range of encoders, including the Encoder 16 EASY Absolute for where an absolute position is required.

ENCODERS IN ROBOTICS

Many robotic applications consist of mechanically interdependent axes, meaning incremental encoders may not be sufficient. Incremental encoders require a homing procedure to determine the position of the motor shaft, requiring additional time.

maxon offers absolute encoders which eliminate the homing procedure. The absolute position is detected within one revolution for single turn encoders and several revolutions for multi turn encoders.

Single turn absolute encoders are suitable for direct drive rotational systems and for multi turn absolute encoders linear drive systems.

Considerations for an encoder for a robotic application:

- Counts per turn (increments)
- Accuracy
- Use of an index channel
- Use of a line driver
- Maximum supported speed
- Suitability for ambient conditions, such as dust, oil, magnetic fields etc.

IN SUMMARY

While certain robotic applications seem very simple in operation, there may be very high requirements with regards to reliability, environmental conditions and the physical attributes of the motor unit. In addition to the output performance, these factors must be taken into consideration.

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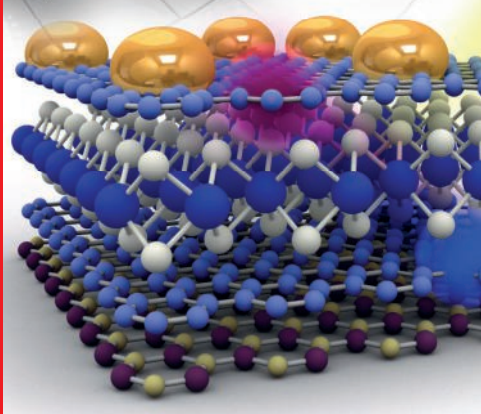

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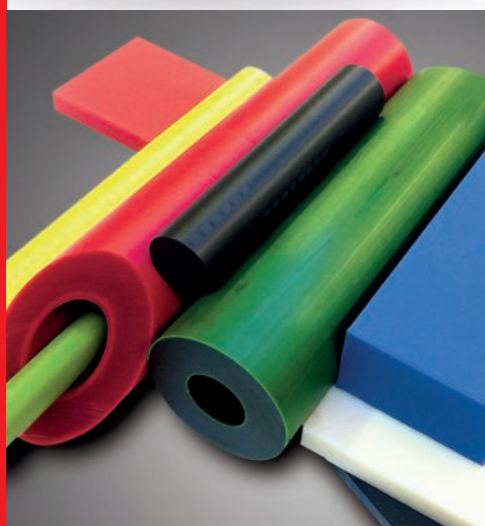

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ABOUT 4.0

PUMPED UP

There's a general misconception that enhanced connectivity, smart manufacturing and Industry 4.0 are for big operations with ultra-sophisticated data capture strategies. However, any business can benefit as it's all about thinking smarter, as Eureka! finds out.

With the race towards Industry 4.0 on, progressive cavity (PC) pump specialist SEEPEX is assisting SME customers to think ahead and utilise smart technology to boost process productivity.

"All processes can benefit from preparation for Industry 4.0 or 'future proofing'," says Lesley Eaton, business development and marketing manager at SEEPEX UK. "There's a general misconception that enhanced connectivity, Smart Manufacturing and Industry 4.0 are for big operations with ultra-sophisticated data capture strategies. Yet, like most decisions in business, it's about thinking smarter, selecting the right pumping equipment for the job and factoring in current and future demands."

At the start of 2017, the manufacturers' organisation EEF published its 4IR report. Gauging where organisations are in their transformation process, the research offered some valuable insight. However, the report, like many others, highlights the uncertainty about how to apply Industry 4.0 technologies to business operations. While 99% agreed that the 4th industrial revolution will be about getting actionable insights from data, 58% of those interviewed reported that they are still getting to grips with the concept and are less certain about what it actually entails.

Undoubtedly, technology and its application will be the enabler. And while there is a widespread expectation among companies that investment in new technology will be required, the EEF report indicated that 61% of manufacturers agree they could be using current digital technologies more effectively to boost their levels of productivity.

JOINING THE DOTS

Smart PC pumps offer a perfect example of how embedded technology can optimise even common and straightforward equipment. Here, when data is captured effectively it can assist with forward planning.

Take the integration of software. Done effectively, this can assist with automated production, and online machine data capture, making preventative and predictive maintenance a realistic possibility. Importantly for businesses tight on resources, it doesn't mean more data is being generated; it just becomes more accessible and relevant. »

SENSORS AND SENSIBILITY

» Intelligent data generated by sensors is the basis for all smart machine control and automation, and is equally applicable in PC pump control. An example of application could be using transducers as pressure or lever controls which speed up and slow down the PC pump, varying the flow rate as required. Rather than using an on/off response when fill levels are reached, these pressure transducers send a variable signal to a PLC integrated to a variable speed drive. Because the transducer detects differences in vessel product levels, the speed at which the product is delivered increases or slows accordingly. This in turn reduces the wear rate of the pump, extending the service life and reducing the total cost of ownership of equipment.

Likewise, there are a number of PC pumps fitted with sensors using IO-Link interface capabilities to switch pumps on or off. Replacing these with variable sensing technology reduces the reliance on remote processing of data, enabling intelligent analysis of performance as well as enabling variable flow rates. In addition, flow meters linked to variable frequency drives (VFDs) allow for real time feedback and speed control of motors to achieve accurate product flow. When the information from flow meters is analysed in conjunction with pressure transducers then PC pump wear is determined and predictive maintenance schedules can be set.

Pipework, valves and downstream equipment can all affect pump performance. As pumps become digitally integrated into processes a properly selected PC pump can collect data to provide diagnostic tools for the entire system. For example, an unexpected pressure increase could signal a product change, a closed valve or a pipework obstruction. Additionally, an increase in measured flow could indicate narrowed pipework. As pipework becomes fouled, for example, the diameter decreases yet this can often remain undetected until problems arise. Using a comparison of theoretical flow vs actual flow at a given pump speed can provide an early diagnosis of the condition of pipework, enabling remedial action to be taken before issues occur.

SCALABLE SOLUTIONS FOR FUTURE DEMANDS

When selecting pump technology, it's equally important to consider existing technology infrastructures and industrial control systems and how your new technology will integrate into common supervisory platforms, such as SCADA.

The development of progressive cavity smart dosing pumps (SDPs) by SEEPEX caters to these future requirements. Used either as a standalone item or integrated into SCADA systems, these PC pumps maintain accurate flow using continuous real-time feedback and adjustment to overcome product and process changes that affect flow rates.

To simplify integration, the SDP has an intelligent VFD incorporating a PLC, special software and fieldbus communications. Input interfaces can be via a centralised system, a handheld HMI or by analogue and digital devices, which means that in addition to controlling the pump operation, data can be collected remotely and a picture of performance becomes clearer. Pump and system protection can also be managed using temperature and pressure sensors linked to the integral PLC.

The design of PC pumps is ideally suited to smart operation as the linear nature of the pump performance curve – flow rate vs pump speed – enables closed loop feedback. ''The signal from a flow meter on the pump discharge is used to automatically adjust the speed of the pump when required,'' explains Lesley.

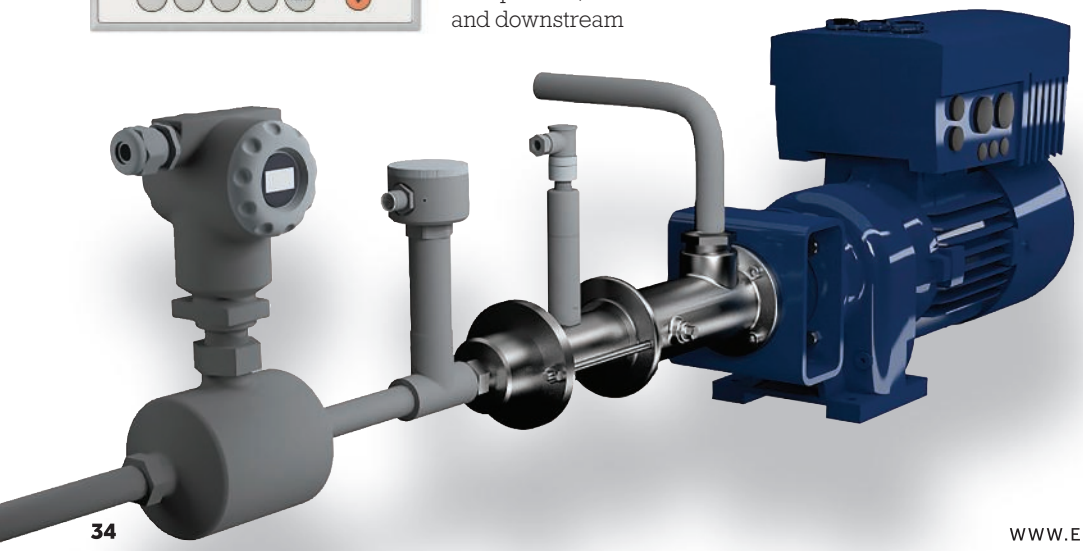
CONNECTING TO UNTOLD OPPORTUNITIES

Despite enormous advances, technology connecting information with the physical world has barely scratched the service. Yet, the fourth industrial revolution is rapidly pervading every part of our lives. Even a simple pump, tasked with distributing product from one source to another, becomes exponentially more valuable when connected. Data from one sensor can be combined with data from another and linked with cloud intelligence to make smarter, even autonomous, business decisions.

Rather than just connecting for connectivity's sake, many industrial businesses see connected devices as a transformational opportunity. As a recent report from KPMG concludes, 'the real value of 4.0 comes not from component technologies or capabilities, but rather from smarter processes that integrate automation, data, analytics, manufacturing and products in a way that delivers unique competitive advantages and unlocks new business models'.

''The reality is that data connectivity and Industry 4.0 permeate every aspect of every business, large and small,'' adds Lesley. ''With scalable options, there's the potential to revolutionise how we work and cut machine downtime by providing continuous feedback on performance.''

Intelligent data generated by sensors is the basis for 'smarter' machines



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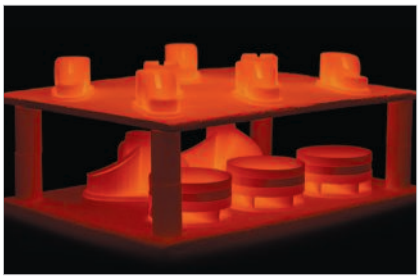

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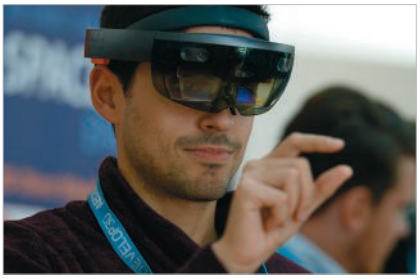

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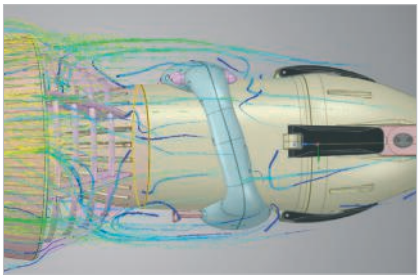

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PROTECTING YOUR PRODUCTS

Intellectual Property (IP) is a common subject on business management courses but for designers and engineers, IP education is far from comprehensive. Robert Games, MD of Albright IP explains why IP should be at the forefront of designers' minds.

Ideally you should always be thinking about IP as you go about your work, especially when you realise that you have a product or design that is worth developing. Once you've had your 'eureka' moment you should limit who you talk to about your idea, use confidentiality agreements and undertake some basic internet searches to see if any similar products are already on the market. Searching the free patent databases may help you to develop the idea, but may also uncover competitor patents that could pose a risk to your project.

The IP disclosure rules mean that if you publicly disclose your design you won't be able to get a valid patent and your options for protection will be extremely limited. Next, talk to an IP attorney about how to best protect your idea. Remember, IP protection can be applied for while you are still finalising your product and before the final design is completed.

BUILD VALUE

More than protection, IP can help you secure funding to develop your design or idea. While the innovative design and functionality of your product will make it desirable and marketable, the IP makes it valuable.

If you protect the work you do by registering your brand as a Trademark, your designs through Registered Designs and your technical developments as patents, then you're creating a value proposition in your product and business.

In the UK, trademarks can be protected indefinitely; designs can be protected through registration for up to 25 years and patents offer protection for up to 20 years. This IP value could last for the lifetime of the business, or certainly the lifetime of the product that you're trying to promote. Through the Patent Box tax relief system, a patent can also give you significant corporation tax savings.

WHY PATENT ATTORNEYS?

The legal process of obtaining patents is relatively complex and it is essential to get it right first time. If your first attempt at a patent application falls short, you have essentially disclosed your product to the competition without protection.

Patent applications need to include plenty of descriptive wording at the beginning that can be drawn upon later for amendments. You may want to split your application into two applications to cover different aspects of the invention, which may open-up different commercial opportunities. A patent attorney will be experienced at crafting the patent wording and will have a good idea of what may come in handy later.

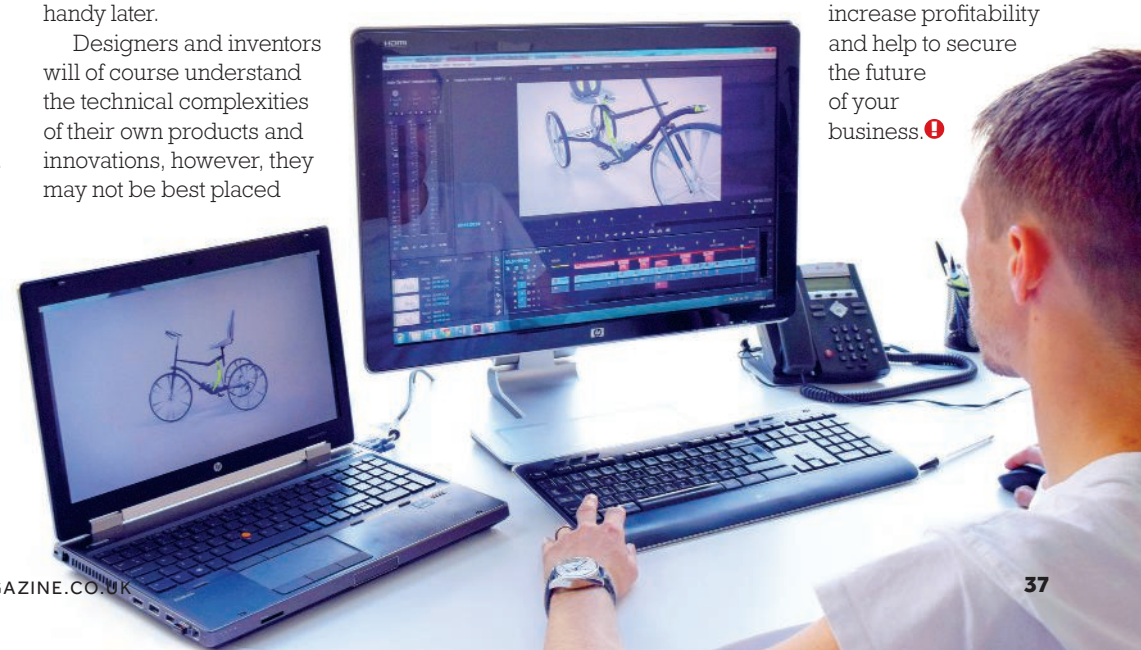
Designers and inventors will of course understand the technical complexities of their own products and innovations, however, they may not be best placed to phrase these technical features in the kind of language expected by patent examiners. Being too close to a project can colour the way you write and often the starting point may not be where you expected.

Patent offices apply rigid and highly specific rules to decide whether an application is allowable, and it can be difficult to foresee and understand their objections if you are not familiar with these rules. An experienced patent attorney will know what to expect and will be able to draft your application with the examination in mind, giving you the best possible chance of obtaining a granted patent.

Put simply, if you get a good idea, talk to a patent and trademark attorney to discuss how you should approach your IP. Most attorneys will provide an initial consultation for free, which could help steer you in the right direction. Remember, IP is a long-term investment, which should create and maintain value in your business, reduce trading risk, increase profitability and help to secure the future of your business.

ABOUT THE AUTHOR

Robert Games, MD of Albright IP.



A BETTER BRUSH

Show me that smile! Show me those pearly whites! For many of us, keeping our teeth clean is a routine that happens twice a day without really ever thinking about it. The trouble is, for many others, brushing teeth is a hassle. It's time consuming, meaning if you are running late or feeling particularly tired, you may feel more inclined to rush, spending 20 or 30 seconds brushing rather than the recommended three minutes.

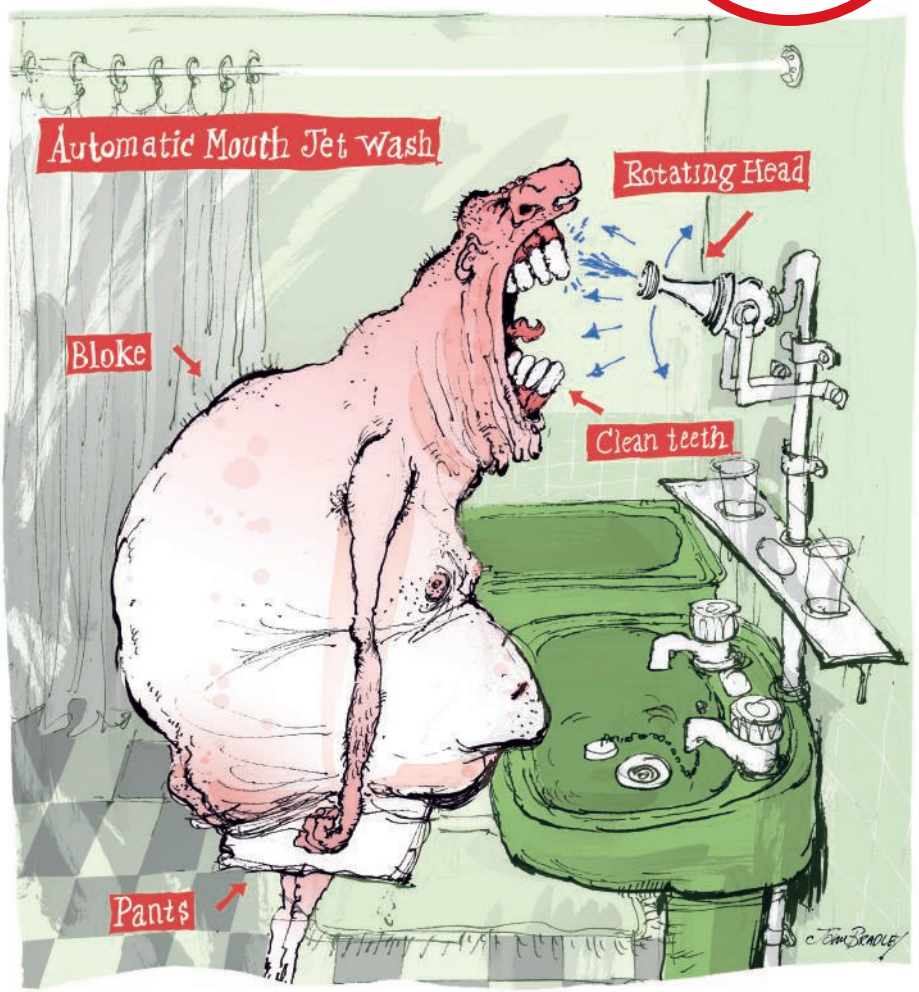
Although electric tooth brushes have improved things, they are still not quite ideal and leave a great deal of room for variability in where exactly you place the brush. For example, while you might concentrate on the front teeth for maximum white dazzle, the rear molars might not get the same attention.

As such, it's estimated that up to 90% of all dental and gum disease is caused by incorrect brushing.

THE CHALLENGE

The challenge this month is to therefore come up with an alternative to the toothbrush. Think about how all the teeth can be cleaned in a much more uniform manner, rather than relying on your own wits when you might not be 100% compos mentis first thing in the morning or last thing at night. Many dental problems are actually a result of people not brushing correctly, such as too hard, too soft or using longer slower strokes rather than shorter faster ones.

The other problem we'd like you to overcome is the need to hold a device in the hands. Many people would prefer to go hands free when it comes to cleaning their teeth, so think about how that might be achieved.



The idea we have in mind will be revealed in the **March** issue of Eureka! Until then see what you can come up with. Submit ideas by leaving a comment on the **Coffee Time Challenge** section of the Eureka! website or emailing the editor: **justin.cunningham@markallengroup.com**

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