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CONTENTS

December 2015 Volume 35 Number 12

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Editor
Tim Fryer
tfryer@findlay.co.uk

Technical Editor
Justin Cunningham
jcunningham@findlay.co.uk

Web Editor
Tom Austin-Morgan
taustin-morgan@findlay.co.uk

Group Editor
Graham Pitcher
gpitcher@findlay.co.uk

Art Editor
Martin Cherry

Technical Illustrator
Phil Holmes

Advertising Sales
01322 221144

Sales Director
Luke Webster
lwebster@findlay.co.uk

Sales Manager
Keith Murray
kmurray@findlay.co.uk

Deputy Sales Manager
Simon Bonell
sbonell@findlay.co.uk

Sales Executive
Paul Thompson
pthompson@findlay.co.uk

Production Manager
Heather Upton
hupton@findlay.co.uk

Circulation Manager
Chris Jones
cjones@findlay.co.uk

Publisher
Ed Tranter
etranter@findlay.co.uk

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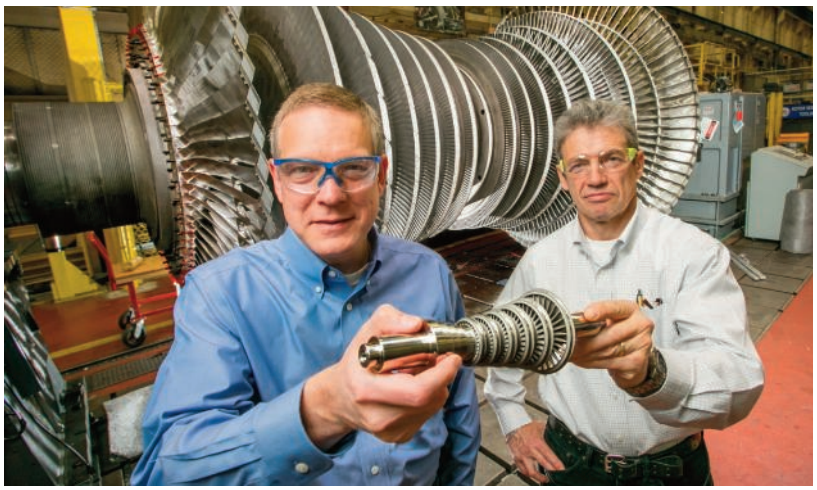
Energy is not ideal

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

Energy policy will affect all of us throughout our working and personal lives. How much it costs, its reliable supply and the effect it has on our immediate environment will all have a direct bearing. Certainly if the engineering and manufacturing industries are to flourish once more in the UK we need our energy supply to be reliable and competitive. And we are given the impression that when political parties are pitching for our approval at voting time, that they have a certain agenda based around their enthusiasm or otherwise for nuclear or wind or gas etc. But the interesting thing is that the amount of energy generated by fossil fuels remains much the same as it was in 1990. The same is true of nuclear generation and hydroelectricity. Only the renewables sector has grown, but still only represents about 15% of the UK's total generation. So it does make you wonder if manifesto promises make all that much difference. The latest proclamation from Energy Secretary Amber Rudd is that coal-fired stations will be phased out completely by 2025, to be replaced largely by the much cleaner gas generation, irrespective of the dependence this may then place on imports (potentially from countries we would rather not be dependent on) or even shale gas (recovered from parts of the UK that some don't want to be 'fracked'). Renewables have seemingly been put on the back burner until they can demonstrate that they can compete in an open market, which is either justifiable or short-sighted depending on your viewpoint. There are plenty of valid arguments for and against all strategies. However, it seems little changes when long term goals are no more than 'cheap talk' if there is little action in the here and now. Surely energy policy, which is so fundamental for the industrial sector, deserves more joined up thinking – a long term strategy set by a cross-party body. Energy strategy is, after all, just about finding pragmatic solutions, there is no need for political idealism.



Powering a potable dream

Scientists at GE Global Research are working with the US Department of Energy to develop a super efficient desalination machine that fits in the palm of the hand by shrinking a steam turbine originally designed to generate electricity.

If successful, the system could reduce the cost of water desalination by as much as 20% - enough, they claim, to break down the cost barrier that has prevented more desalination systems from being built.

The mini desalination system combines 3D printing with GE's knowledge of turbo-machinery and fluid dynamics. GE scientists Doug Hofer (left in picture) and Vitali Lissianski (right) used them to shrink a power generation steam turbine that would normally barely fit inside a school gym.

Hofer said: "In traditional steam turbines, steam condenses and turns to water. We thought maybe the same principle could be applied to water desalination."

The only difference would be in using flows through the turbine to freeze the brine, or salt water. Freezing the brine would separate the salt and water by turning salt into a solid and water to ice.

Awards launched

Two annual engineering awards are launching their 2016 campaigns, supported by the Engineering Council. Applications are now open for the 2016 Baroness Platt of Writtle Award and for the 2016 Hawley Award, with respective cash prizes of £1000 and £5000 for the winners.

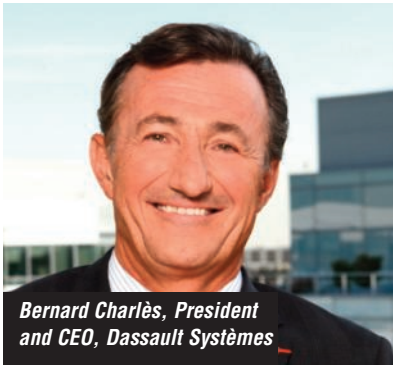
The Baroness Platt of Writtle IEng Award is in its fourth year in its present format and recognises the achievements of outstanding, newly registered Incorporated Engineers across all disciplines. The Hawley Award is presented for the most outstanding engineering innovation that delivers demonstrable benefit to the environment.

Disruptive Lab

Dassault Systèmes has launched the 3DEXPERIENCE Lab, its open innovation laboratory and start-up accelerator programme dedicated to nurturing and empowering disruptive projects and transforming society.

"Many promising entrepreneurs are looking at the world with fresh eyes yet are forced to innovate in isolation, without the benefits of a greater network to nurture, challenge, consolidate and validate their ideas," said Bernard Charlès, President and CEO, Dassault Systèmes.

During a one to two year programme, the startups will have access to the 3DEXPERIENCE platform, technical skills and mentoring to create digital experiences to optimise and validate their product and processes.



Bernard Charlès, President and CEO, Dassault Systèmes

First jet-powered, 3D printed UAV

Stratasys has teamed up with Aurora Flight Sciences to deliver, what is believed to be, the largest, fastest, and most complex 3D printed unmanned aerial vehicle (UAV) ever produced. The aircraft is built using lightweight Stratasys materials and can achieve speeds in excess of 150mph. 80% of the UAV, which has a wingspan of 3m and weighs 15kg, used 3D printing technology that cut the design and manufacturing time by 50%.

According to Dan Campbell, aerospace research engineer at Aurora Flight Sciences, the project achieved various targets: "A primary goal for us was to show the aerospace industry just how quickly you can go from designing to building to flying a 3D printed jet-powered aircraft."

"This is a perfect demonstration of the unique capabilities that additive manufacturing can bring to aerospace," said Scott Sevcik, business development manager, Vertical Solutions at Stratasys. "This meant using different 3D printing materials and technologies together on one aircraft to maximise the benefits of additive manufacturing and 3D print both lightweight and capable structural components."

As well as using Fused Deposition Modelling materials for the large structural elements of the build, Stratasys laser sintered the nylon fuel tank and the thrust vectoring exhaust nozzle was 3D printed in metal to withstand the extreme heat at the engine nozzle.

NEWS

First UK Robotics Week

The Engineering and Physical Sciences Research Council has announced the first UK Robotics Week, aimed at celebrating innovation in the UK's robotics industry.

The event will be held between 25 June and 1 July 2016 and will include the TAROS (Towards Autonomous Robotic Systems) Conference and the Hamlyn Symposium on Medical Robots. It will also feature the finals of a series of international academic challenges in which leading robotic research groups from around the world will come to the UK to demonstrate the latest robotic technology. including: the School Robot Challenge; Surgical Robot Challenge; Field Robotics Challenge; Autonomous Driving Challenge; and UAV Challenge.

Universities and Science Minister Jo Johnson said: "From driverless cars to tiny surgical robots, there is an array of exciting possibilities in robotics that can improve our lives. It's critical that we inspire the next generation of scientists and engineers to help develop these new technologies."

TECH BRIEF

Windchill boost for IoT developers

PTC's lifecycle management software, Windchill 11, will be equipped with a number of features to enable users to more easily develop smart connected products. It is hoped its latest release will be an enabling and uniting force in the Internet of Things movement,.

A critical part of Windchill 11 is the inclusion of the acquired Thingworx technology, which allows data from physical products, web-based resources, and enterprise software systems to deliver access, insight, and ultimately drive value from the acquired data.

"This is the first time a customer can give us their data and we can look for trends and patterns within it," said CEO Jim Heppelmann. "It will show that when the data is trending a certain way, for example, it will probably lead to 'this' or 'that' outcome. The algorithm learns, so it is something that is only going to improve over time."

Events

09 - 11 February 2016
Southern Manufacturing and Electronics 2016
Farnborough
Exhibition

24 - 25 February
Hazardex 2016
Runcorn
Hazardous areas event

31 March
DEVELOP3D LIVE 2016
Warwick Arts Centre
Exhibition

07 April
The Engineering Simulation Show 2016
The Roundhouse, Derby
Exhibition

21 April
Plastics, Prototyping & Metals Exhibition
Concorde Conference Centre, Runway Park, Manchester Airport
Exhibition

25 June - 01 July
UK Robotics Week 2016
Across the UK
Nationwide and industry wide robotics event

06 – 07 July
Manufacturing and Engineering North East
Metro Arena, Newcastle
Exhibition and conference

19 – 20 October
Engineering Design Show
Ricoh Arena, Coventry.
Conference, workshops and exhibition

28 - 29 September
TCT Show + Personalize
NEC, Birmingham
Additive manufacturing exhibition

For more event details go to www.eurekamagazine.co.uk

NEWS

Here is a selection of the latest products featured on the Eureka website. Just enter the reference number in the search box for the full story.

Standalone inductive sensor **109513**
Cost-efficient miniature motor **109924**
Simple solution for complex valve island applications **109591**
Siemens releases machine tool motors **109722**
Taking machinery protection to a new level **109870**
Three phase thyristor controller **109903**
Transducers with real-time Ethernet interfaces **109871**
Better engineering means higher productivity **109441**
Disc couplings enhance service in high torque applications **109209**
Latest version of FloTHERM features automated calibration **109965**

Eye-driven wheelchair winner

Patrick Joyce won £128,000 from Hackaday for his invention that helps quadriplegic wheelchair users like himself to control their wheelchairs independently.

Eyedrivomatic was developed by Joyce after he was diagnosed with motor neurone disease in 2008. It is a combination of 3D printed parts and off-the-shelf hardware and software that is thought to be a world first. It works by linking existing Eyegaze software, used to control computers using eye movement, to a controller that operates the joystick.

As most wheelchair users don't own their wheelchairs, permanent changes cannot be made, so Joyce had to make the system easy to attach and detach from the wheelchair.

Future technology on show

At the first Quantum Technology Showcase, an event organised to mark the first anniversary of the UK National Quantum Technology Hubs, 300 delegates heard how the £270million UK National Quantum Technologies Programme was drawing the country's research base together with industry, research funding bodies and other government agencies to accelerate the transition of new technologies from the laboratory to industry. Research teams from the universities and companies involved in the four Hubs, formed by a consortium of 17 universities led by the universities of Birmingham, Glasgow, Oxford and York, and funded by the EPSRC, demonstrated how the unique properties of the quantum realm are being used to advance technologies in measurement, security, computing, imaging and sensing.

Professor Philip Nelson, chief executive of the EPSRC, said: "This showcase is a really exciting event and there is clearly a huge amount of interest in what the UK National Quantum Technologies Programme can deliver. I am confident that it will keep the UK in the vanguard of many research areas and bring about world changing technologies."

CV joint for efficient vehicles

GKN Driveline has developed a range of lightweight constant velocity joint (CV joint) systems that are said to enable rear-wheel drive platforms to save more than 4kg of weight.

Karl Berger, GKN Driveline senior director of constant velocity joints, said: "For premium rear-wheel drive programmes seeking CO_2 emissions reductions, this system represents a step forward in weight, efficiency, performance and refinement for premium rear-wheel drive cars."

The VL3 CV joint is claimed to increase torque capacity by up to 27% with no increase in packaging size.

Solution to last month's Coffee Time Challenge

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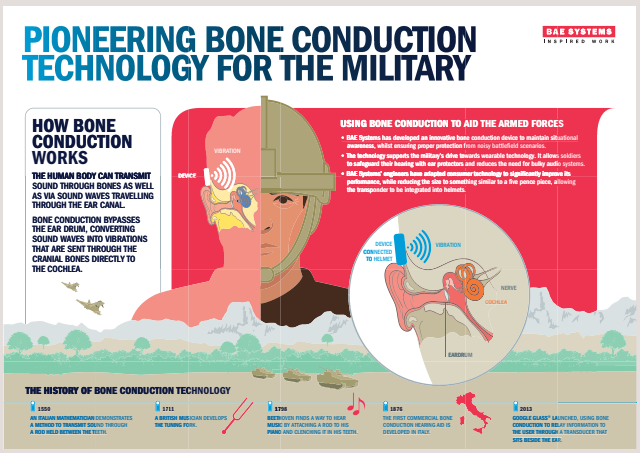
Last month we asked you to devise a way that soldiers could protect their ears while still being able to hear their battle instructions.

Our solution comes from BAE Systems, who have deployed an existing technology in an innovative fashion. Bone conduction technology, which already has applications in commercial hearing aids or headphones, is a method of using the human body's ability to transmit sound through bones, allowing sound to be 'heard' while by-passing the ear drum. It is a phenomenon that was identified nearly 500 years ago, and in 1798 (two years after his hearing started to decline) Beethoven apparently found a way to hear his music by attaching a rod to his piano and clenching it in his teeth.



The BAE Systems solution is substantially more refined than this and it has reduced the size of the transponder to the size of a five pence coin. The differentiator between the bone conductor and standard ear pieces is that soldier borne military tactical radios provide clear audio communications, but they inhibit the soldiers ability to naturally hear the environment around them. The bone conduction system integrated into military helmets provide clear comms and let the soldiers hear their environment simultaneously, enhancing their capability in the battlefield.

Mohammed Akhmad, Principal Scientist at BAE Systems, said: "We recognise that on the battlefield, auditory situational awareness is essential for armed forces personnel. With this system, the soldiers can safeguard their hearing with ear protectors whilst still clearly receiving military voice communications, to enable them to perform their roles efficiently and safely."

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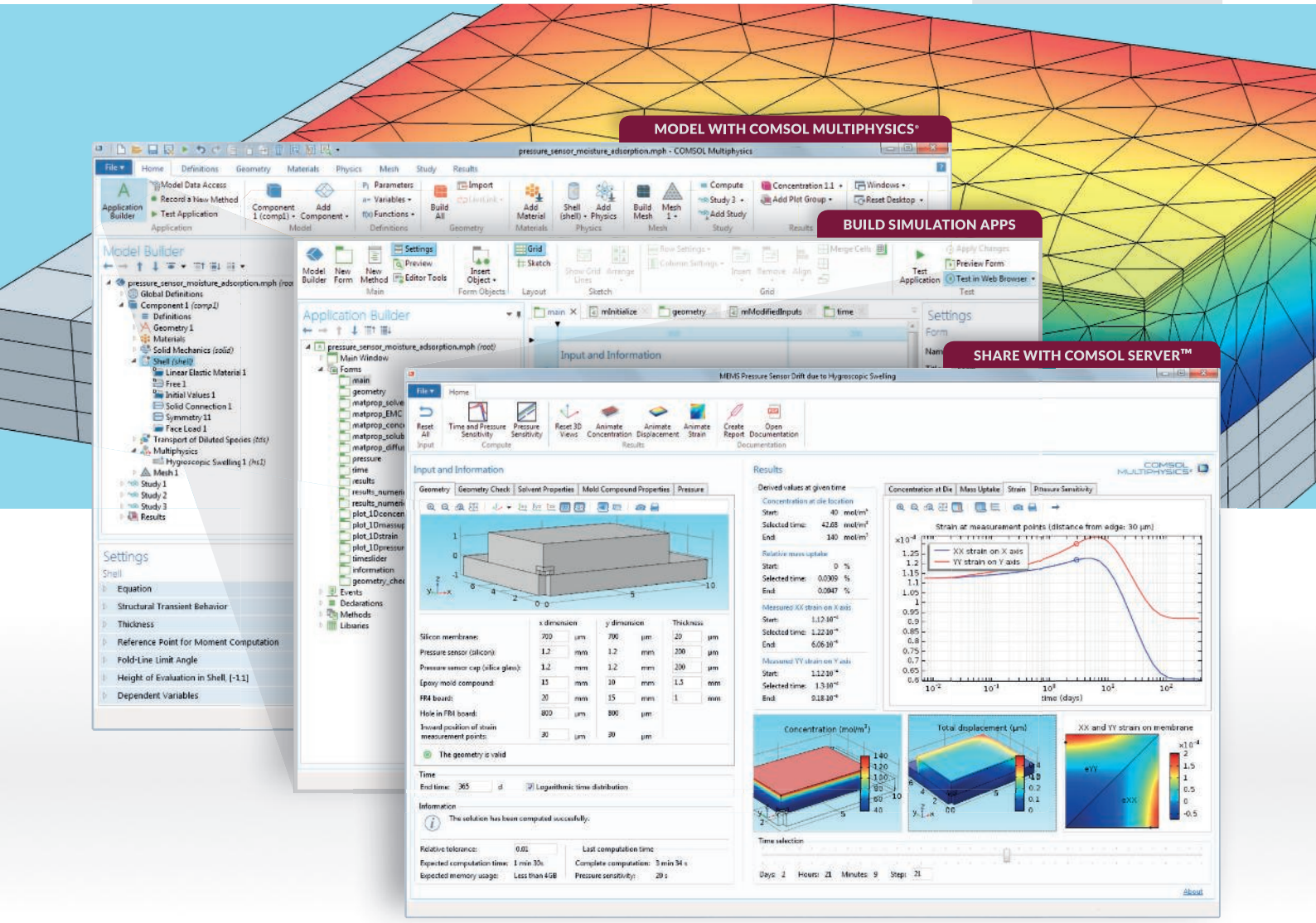

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Skills for breaking technologies

A gleaming new centre will spearhead the fight against skills shortages in advanced technologies. Tim Fryer reports.

Developing new technologies is only of any use if there is a generation of engineers coming through that know how to make the most of them. Sajid Javid, Secretary of State for Business, Innovation and Skills, said: "Last year Birmingham alone created more jobs than the whole of France. But all these companies that keep growing need skills – we recognise that in Government. We need advanced manufacturing. It is something as a country we are very good at, and we're getting better at, but we need that next generation to come through."

He was speaking at the opening of the Lloyds Bank Advanced Manufacturing Training Centre (AMTC) in Coventry, an additional string to the bow of the Manufacturing Technology Centre (MTC), which is in turn part of the successful High Value Manufacturing Catapult. The Centre intends to contribute to the training of around 1000 people in its first ten years, ncluding apprentices, engineers on conversion courses, graduates and students studying short courses. There will be an annual intake of around 50 for the full-time, three-year apprenticeship programme offered by the Centre.

Ken Young, technology director at the MTC, commented: "There is a skills shortage, but for us it is even worse than that. We are developing technologies that are the next generation for what we will do in manufacturing. Some of the things we are developing here like Net Shape and Additive Manufacturing, Industry 4.0, infomatics, the use of IT in manufacturing and intelligent automation - you can't go anywhere and get those skills. They just do not exist. So while we are developing those technologies, in parallel to that we realised we needed to have a centre over here developing the apprentices and also ultimately the graduates and post graduates that can get out in industry and make this stuff happen and start to make money out of it for the UK."

Changing the emphasis for the apprenticeship programme was therefore a priority for the AMTC. "The wrong thing to do would have been to do more of the same – churning out manufacturing apprentices," said Paul Rowlett, managing director of the Lloyds Bank AMTC. "We are in a privileged position as we have 90 members companies who know what technologies they are going to be using, who know what they want from the AMTC."

One of those companies is Bosch Rexroth who has fitted out one of the labs in the Centre with its automation equipment. The company's Andy Minturn said: "A lot of our younger engineers need practical experience. The design engineers – they need practical experience to know how things go together - for design for manufacture, for instance. All our research engineers need to have the necessary design skills to take products from cradle to grave, so the idea is that these guys get some of those skills here."

This exposure to manufacturing technology therefore is helping create more accomplished engineers. "I think it is vital," continued Minturn. "We have a lot of good people in our design department in their early 20s but they have very little practical experience. Being at the rough end, knowing how someone will use that part, is vital. The guys here are getting some of the design skills and the manufacturing skills – you can't have one without the other."

"The wrong thing to do would have been to do more of the same – churning out manufacturing apprentices," Paul Rowlett, managing director of the Lloyds Bank AMTC

Tim Hinton, MD of Mid Markets and SME Banking at Lloyds, said: "The UK economy is growing but if the shortage in manufacturing skills is not addressed, it will seriously hamper our future capabilities and poses a significant risk to our competitiveness and overseas trade. Our £5m contribution to help finance more apprenticeships at these impressive facilities is just one of the ways that we are supporting the manufacturing sector and closing the skills gap. We are confident that the MTC and AMTC will develop the next generation of world-leading engineers and help reassert the UK's engineering prowess."

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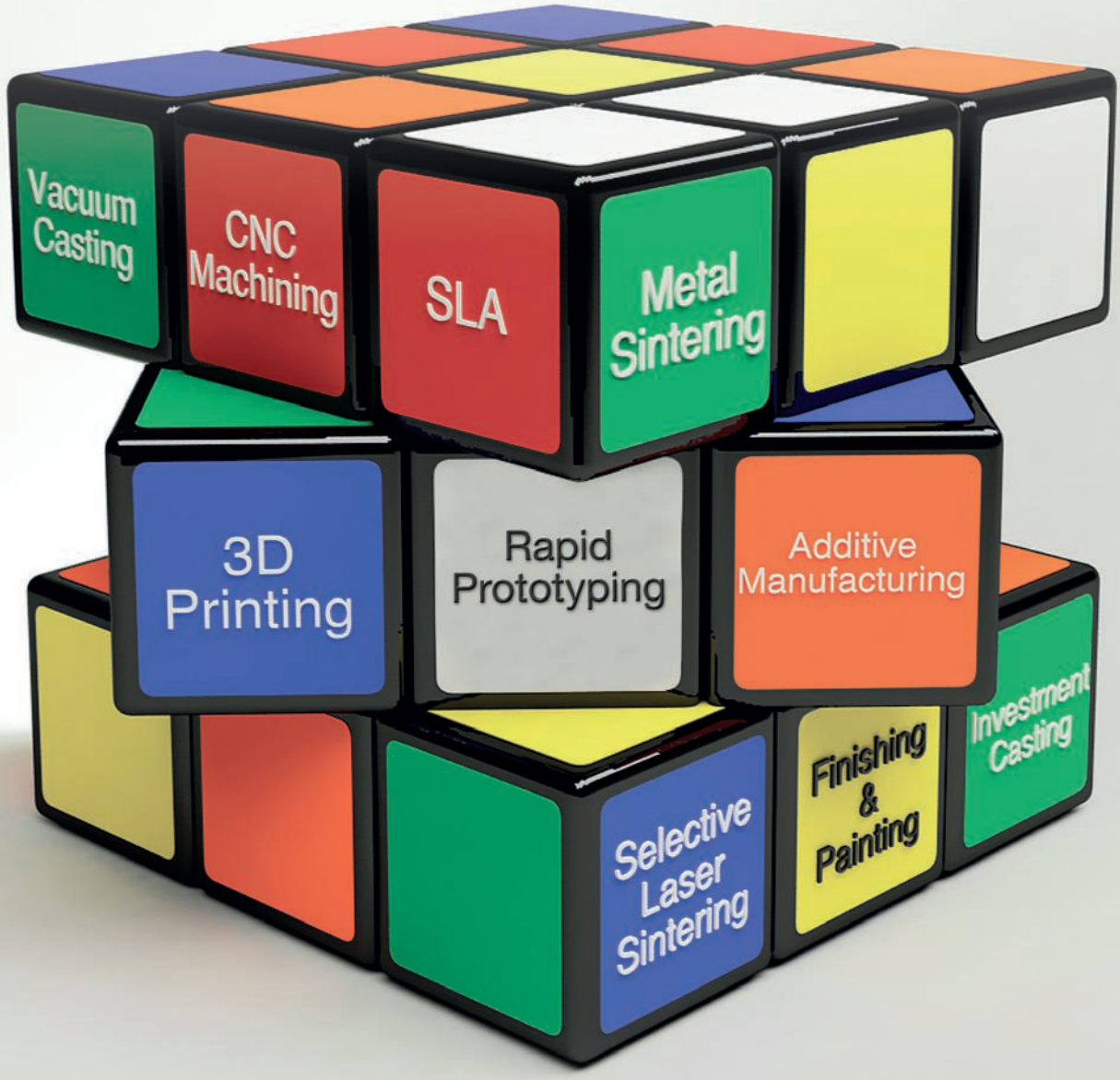

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Ready for lift off!

Bloodhound SSC went on display for the first time in London last month and it was no model. It was the actual car that will make the land speed record attempts. Justin Cunningham reports.

Eureka first covered the story when it was announced in 2008. It has been a long time coming and it could well run beyond 2017 before it goes for a peak performance record setting run. However, when the cover was pulled off the car in London's Docklands last month, there were gasps and applause from the world's media. Suddenly the Bloodhound project has turned from being about education and excitement, in to something very real.

The project has been beset by delays with original runs earmarked for 2011/12. Now, however, it is nearly 95% complete with just a few devilish details to be finalised.

It has to be said, the schedule was always ambitious. Taking a car to 1000mph has '10 year project' written all over it. The initial hope of doing in just four or five was probably as much about keeping sponsors excited, and involved, as it was anything else.

"It has been a massive effort to get it to this stage," said Sir Richard Noble, project director of Bloodhound SSC. "Normally you'd need an organisation of 300 or 400 people to do this... we peaked out at about 80."

Bloodhound SSC has done what few in the engineering realm have been able to mimic: get the widespread backing of British industry, Government and the general public. It stands as one of the very few projects to become a household name.

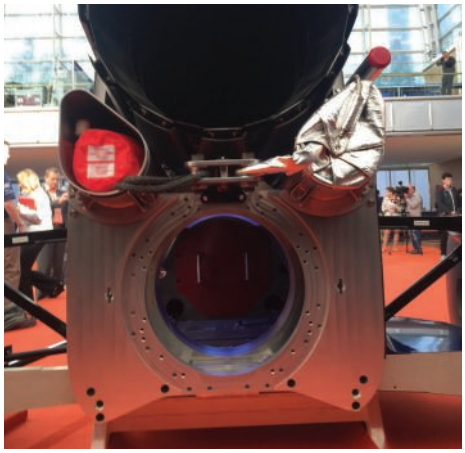
"This has only been possible because we've got 340 British companies and 6000 schools involved, so it has been a huge engineering and educational effort all around," he continued. "Having big names like Rolls Royce and JLR is great as that gives it the UK prestige and great kudos. But, none of this would have been possible without everyone coming together and getting involved."

Bloodhound doesn't just want to set a new land speed record, it wants to smash it. And it has put so much resource in to the project that if it does set a new record, it will stand for decades, as it will take a phenomenal effort to beat it.

While there are a number of other land speed record cars making attempts in the next few years, few are setting the bar quite so high (in excess of 1000mph), and none have forged such a long running engineering team that have intimate knowledge of the challenge.

Nothing's changed, everything's changed

Reviewing images and models of Bloodhound from when it was first announced in 2008, the car appears to be essentially unchanged – at



least in terms of external geometry. But the 'rough' exterior initially set out has been subtly changed and tweaked as analysis has progressed.

Mark Chapman, chief engineer of Bloodhound SSC, said: "We think this looks really different," referring to the actual car on display. "You get so use to seeing the show car, which is a full sized plastic mock up. But this has got weight. It's got a real presence."

Design of the car has been driven largely through computational fluid dynamics (CFD). The need for optimisation, and scope for improvement, has been come from work carried out at Swansea University. There, the team has developed techniques to bring about small but important changes using CFD and computational optimisation, to geometrically parameterise the car in an optimiser that has been coupled to a CFD solver.

Dr Ben Evans, a CFD engineer for Bloodhound and senior lecturer at Swansea University, said: "The harder you hit it with the hammer, the more likely you are to find a better geometry.

"With a CFD driven aerodynamic design like this, we've tended to see the fidelity of the modelling increase as we've gone through the design process. Early on in the concept stage we got relatively crude models that we put together pretty quickly. So we want to see if we change something on the car, did the drag go up or down.

"When you get to the point when you are on the final design, and you really need to know accurate predictions of pressure distributions over the entire surface then you need high fidelity models. It might take days and days of run time on a super computer to get the result. That is then optimised, but it is still not optimal."

Devil in the details

The reality is that Bloodhound is a very different car from that which was first outlined. Numerous changes have been made in and around the car, some subtle, others more obvious, and these are not just related to aerodynamic performance, but also its numerous internal systems.

"What I didn't think would be a challenge is making it go in a straight line," said Chapman. "I thought we'd put a fin on the back and that would be that. But, if the fin is too big it makes the car too stable, so if there is a side wind the car will pivot. So, we have to get the fin big enough that the car goes in a straight line, but not so big that if there is a side wind it will take you off track."

It means that the car's design has to walk a very delicate line on the edge of stability. "It is designed to be unstable but controllable," explained Chapman. "It is a 3% margin, and that is where we sit."

In addition the use of two engine systems also caused issues. Originally the EJ200 Turbojet engine was at the bottom and the three rocket engines at the top. This configuration kept the Centre of Gravity (CG) low, and in an ideal position. However, it meant that when the rocket was turned on and began producing up to 122kN, it would make the car's nose pitch into the ground. So, canards were added to generate lift to counteract this force.

However, once risk began to be assessed, it was an area that could cause serious problems. In the event of hydraulic failure the canards would be locked in place, so after the rocket suddenly stopped the nose, the canard generating four tonnes of lift, would instantly lift the car in to air and cause it to flip up.

"That was a big 'errrr' moment," said Chapman. "The jet engine weighs about a tonne, and the rocket 140 to 150kg. We decided we needed to swap them over to make the system fail safe. We did worry that this would raise the CG, and make it really high. But, with the oxidiser the two engines end up about the same weight, and it goes across the CG, so it doesn't affect it nearly as much as we thought."

The 3% is the margin between CG and the Centre of Pressure (CP),

The rocket

In order to accelerate the car to 1000mph, Nammo hybrid rockets will provide a thrust of 30kN each. This will be combined with the thrust from the EJ200 jet will generate a total of about 212kN.

The design of the Nammo rocket is still being finalised, but it is likely to have a cluster of four or five rocket motors rather than a single large combustion chamber.

Mark Chapman, chief engineer of Bloodhound SSC, said: "The beauty of the hybrid rocket is that we have got a solid fuel grain with the test peroxide oxidiser and you can actually throttle the rocket by varying the flow rate of the oxidiser and that changes the thrust parameters."

both are in optimised positions relative to each other, and moving either significantly effects aerodynamic performance, the balance and stability of the whole car.

The trouble with supersonics

Having to deal with shockwaves on the car is the one thing that makes Bloodhound as much of an aerospace project as it does a motorsport one. Three distinct shockwave systems appear on the car, the first of which is the traditional bow shock.

The second appears just above the head of driver Andy Green on the top of the driver canopy. While the fuselage and cockpit geometry may appear unchanged from early designs, it has been precisely modified and optimised to create the shockwave in just the right place. The angle of the cockpit canopy is such that the shockwave forms at the exact position needed to decelerate the air to around 600mph as it enters the turbojet compressor stage.

Then, finally, and perhaps most challenging is the shockwave at the back of the car, around the rear wheels. Key to designing any supersonic vehicle – or indeed aircraft – is the need to minimise the cross-sectional area. Unfortunately, at the back there are two large solid aluminium wheels that protrude out with accompanying suspension system. "You always have these battles with the people designing the internal structures and mechanical engineers," said Dr Evans. "We need to minimise the cross-sectional area but they might say that's impossible given the load. This is where we need to find interesting and novel solutions. The whole geometry system with the delta strut, the width of the wheel away from the car, the angle of these suspension struts is all driven by aerodynamic optimisation and that is largely done computationally, using techniques developed by Swansea University."

The delta struts are crucial. As the shockwave forms, high pressure tries to get under the car and pick it up. The delta struts create the shockwave on top of the struts, so instead of picking the car up, it presses it down.

Going the extra mile

While there are very few physical parts still to make, there is an awful lot of shakedown testing to be done. The car has been hugely reliant on computer aided design technology and simulation software, and getting virtual predictions to match physical outcomes can be a tricky business. A small unforeseen variable in the South African desert could drastically alter predictions.

"The challenge now is to get the car back to Bristol and then begin runway testing in Newquay in spring of next year, before heading to South Africa in the later summer," said Chapman. "And from this to that, there is still a hell of a lot of work to do."

Chapman has been on the project from the outset, and perhaps knows the car better than anyone. So is he confident? "A 1000mph? We need some more data," he said. "So, next year we'll take the car to 800mph in the desert." This would give the team the land speed record, but also the data needed to take the car to its ultimate limit.

"From 800mph to 1000mph is a big leap," said Chapman. "The drag force goes up with the square of the speed, power requirement goes up by the cube of the speed. So there is a huge step change. Will it get to 1000mph? I hope so. To date, we haven't found a technical reason why it shouldn't, so we're confident. But there are many unknowns."

Fact File

- The existing land speed record was set by Andy Green on October 15 1997. In the Black Rock Desert in the USA he drove the ThrustSSC at 763mph.
- Black Rock Desert is in poor condition after years of other uses and lack of rain, so the record bid has been shifted to Hakskeen Pan in South Africa.
- Design Speed of BloodhoundSSC is 1050mph – Mach 1.4
- Our original headline was 'Faster than a speeding bullet', but it turns out that speeding bullets travels at about 1700mph.

Space *to* expand

Dr Helen Meese has spent the last year analysing opportunities in the Space Industry. Here she tells Tim Fryer what she found out.

As Head of Engineering in Society at the Institute of Mechanical Engineers, Dr Helen Meese looks at different areas of engineering with a view to developing policies that could benefit the IMechE's 112,000 members. With the Government's recently stated intention to capture 10% of a global market that is estimated to have reached £400bn by 2030, space has become a developing sector of considerable interest.

"The UK has been a global leader in major aspects of space and satellite systems over the last 40 years," said Meese. "Many consider it to be one of the most innovative and cost effective space sectors of any nation in the world." In fact it supports 106,000 jobs, 34,500 of which are direct employed, and about 72,000 which are indirect jobs through supply chain. The Government's long term plan, outlined in the Space Innovation and Growth Strategy (IGS), aims to almost double employment in the sector.

In total, nearly £144 million is spent on UK satellite manufacture, and service providers each year, and that's split among about 400 businesses, of which half of those are SMEs. And of its £0.7 billion turnover last year, Airbus Defence and Space flowed down about 60% of that money down into the supply chain.

However it is at the other end of the market, where satellites are the size of a loaf of bread rather than a small bakery, where much of the interest lies. Meese commented: "The satellite market is now ripe for disruption, and certainly by emerging technologies. And it's becoming more accessible to, and affordable for, small businesses and start-ups who want to fly their own missions.

"Failure, of course, can't be easily rectified once it's up in space. The cost of getting hardware into space is around £2000 per kilogram and that's almost as costly as the satellite itself. However, innovative approaches to design, exploiting cost technologies, standardisation of launch vehicle integration, and increased availability of piggybacking launches, are enabling greater access to space and creating new uses for satellite data. This new approach is dependent on an iterative development programme, and it's often referred to as agile space, or flexible space."

A key enabler to this 'flexible space' are the CubeSats, or nano sats, that can weigh just a few kilograms. Meese said: "Despite their diminutive size they have the ability to collect and retrieve, store and process data pretty much on the same scale as large satellites - and that can be up to about a terabyte of data per day."

Despite the opportunities offered by this latest technology, Meese has uncovered some significant barriers that stand in the way of progress, particularly for the small satellite sector. "This includes things like regulation and licensing, private and public investment, and education. If the UK is going to achieve the IGS goals, then these barriers must be addressed. And at the Institution of Mechanical Engineers, we believe that greater engagement between the UK satellite industry stakeholders is key to ensure the success of the industry in the future."

The report, in which Meese collects the findings of her year-long analysis and which will be published this month, indicates a lack of private financing and venture capital. This is in part due to the risk of costly missions, uncertainties as to the future restrictions on satellite data, and a lack of understanding by wider industry on the high value returns from satellite build and operation.

"Additionally, developing nations are luring small satellites businesses away with the opportunity to create new technology without the financial and regulatory burdens levied in the UK," claimed Meese. "The UK Outer Space Act, which covers the launch and operation liability laws for satellite operators is now 30 years old, and it doesn't include these new technologies that are being developed. It must be revised to acknowledge this technical advancement and the changing nature of space usage. And despite providing £52 billion per year to the UK economy, radio frequency spectrum, which is used in satellite communication, is becoming a scarce resource for all satellite use operators. There is an immediate need for frequency sharing to be implemented, and to ensure that parity between existing, incumbent operators and the newer, smaller, short-term ones."

Meese also called for the UK to change its insurance obligations. The UK is the only launching nation to require satellite operators to pay for third-party liability. She believes growth can only be stimulated in the CubeSat and small sat market, if this TPL insurance is ended and a more appropriate solution, based on up-to-date knowledge of large and small satellite operations is found.

One of the issues that the space market shares with many other sectors in science and engineering is the well publicised lack of qualified engineers ready to fill those 100,000 jobs that are created. "The speed at which the small satellite sector is growing is has put an increased strain on the recruitment pipeline," said Meese "Whilst the UK space sector continues to grow, the domestic supply is limited, and an increasing number of degree qualified engineers and technicians are being recruited from overseas. Growth amongst universities and start-ups and SMEs is therefore required if the space industry, and ultimately, the satellite industry, is going to maintain its global standing."

"The UK CubeSat market is growing rapidly, and offers the UK satellite industry some fantastic opportunities."

CV

Dr Helen Meese is Head of Engineering in Society at the Institution of Mechanical Engineers. She manages its programme on innovative and emerging technologies and their impact on UK and global communities. Through reports and policy making she engages with the general public, government and the media to raise the profile of engineering both in the UK and internationally.

She is an Electro-Mechanical Power Engineer with over 19 year of experience in both academia and industry. Her academic career was spent at Loughborough University researching turbocharger performance characteristics and developing electrical defence systems for armoured vehicles. Her industrial career was predominantly in the defence industry working for Babcock International and GE Energy, where she managed projects on euro-fighter typhoon, submarine systems and naval vessels.

Multi-coloured **paper maker**

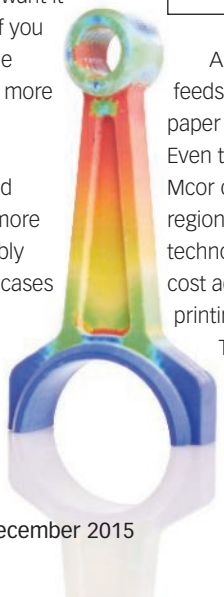
Additive manufacturing technologies, while still evolving rapidly, do not always tick all of the boxes. A part needs to be produced in timely fashion, at the right price point, able to fulfil functional requirements, be made of certain materials....and what about colour? Tim Fryer looked at a 3D printing platform aiming to tackle all of these challenges

Opening a bottle of Coke with a bottle opener made on Mcor's IRIS HD printer immediately dispels the over-riding negative assumption that people would have about products made on the platform. They are solid. So solid in fact that you could print a hammer and use it to go about its nail-hammering business. The reason this is surprising is that both hammer and bottle opener are made of paper, as are all the products made on the machine.

"There's a bit of snobbery in the trade of printing," claimed Dr Conor MacCormack, CEO of Mcor. "I showed a part [at a conference] and we talked about the colour and people were very impressed, blown away in fact. At the end I said, well, what do you think that made of? Nobody gets it right. Undoubtedly there is a bit of a negative connotation with paper, that's why one of our challenges is to get parts into people's hands."

Paper is porous, in fact it is around 70% air. If different properties are required the model can therefore dipped in a resin or other liquid and when it cures it will take on the properties of that liquid. "There's lots of opportunities," claimed MacCormack. "If you want it waterproof, you can make it waterproof. If you want it really hard, you can make it hard. If you want it flexible, you can have flexible parts. It is all paper but there's a lot more use cases to it than people initially imagine."

This opens the door for unlimited prototyping solutions, but also for more functional applications. While possibly paper-based parts will still in some cases be unsuitable as actual end-use components, they may be useful for other purposes, like tooling and jigs.



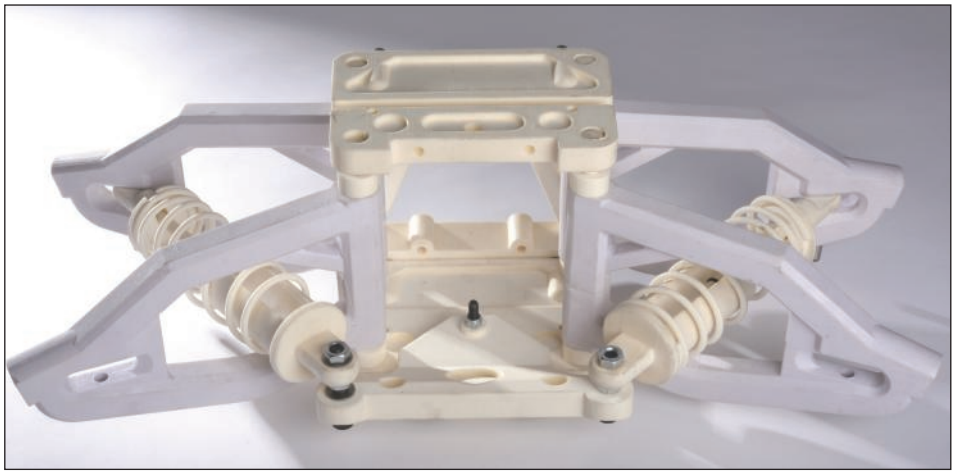
The 3D selfie

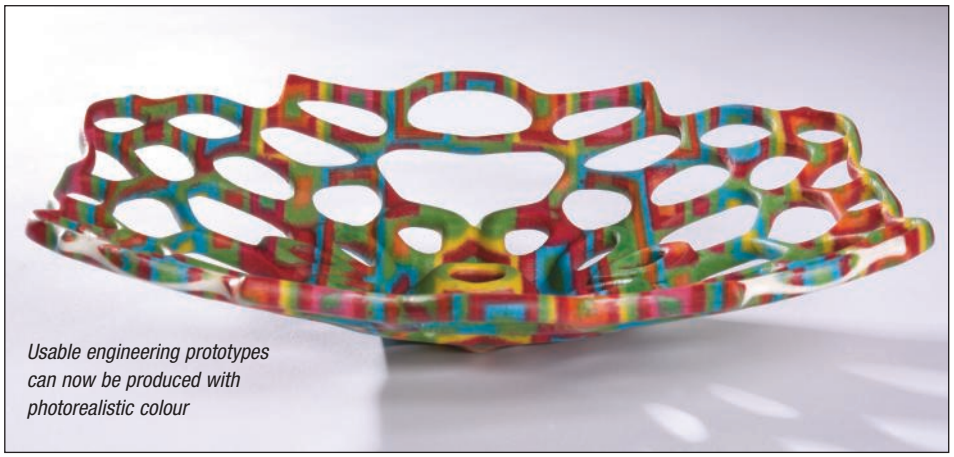
"The advantage of having a 3D printer with true colour representation is that you can print anything you scan," claimed Conor MacCormack (scanned, printed and pictured above). The new IRIS HD 3D printer features photorealistic 5760 x 1440 x 508 dpi bitmap colour. All you need is a 3D scanner with similar colour capture capabilities and resolution. Physical resolution for the x, y and z axis is 12u, 12u and 100u respectively.

And paper, of course, is cheap. The feedstock can be the same block of 80GSM paper that is used in a standard office printer. Even taking into account the adhesives and inks, Mcor claims that typical material costs are in the region of 10 – 20% those of other 3D printing technologies. According to MacCormack, the cost advantages of the IRIS system – Mcor's 3D printing platform – is one its two main 'USPs'.

The other one is colour.

The problem most people have with printing in colour is that it requires blending materials that are primary colours. While all colours can be arrived at, it is a slow and inaccurate process. MacCormack said: "If you type 'full colour 3D printing' into Google you will get loads of people who say they can do it, but actually it is impossible for them. There's only two companies that can colour print properly, and both are kind of based on the jetting ink. One jet adds the powder and binds the powder together [3D Systems], and then we jet ink on the paper. That's how we get a higher resolution, because we're printing on the paper,





Usable engineering prototypes can now be produced with photorealistic colour

and that's what ink was developed for."

Selective Deposition Lamination (SDL) is how Mcor label the technology. In simplistic terms the way it works is by feeding through sheets of paper one at a time. Each sheet is cut out using the tungsten carbide blade to a depth of 150 um – as each sheet is typically 100um then it will only cut through the uppermost sheet. The ink which penetrates the paper is jetted within the adhesive, which is put down in high concentrations on the areas that are to form the model and only minimal amounts on the waste. This way the waste material very easily can be crumbled away just using fingertips.

Ink is jetted out to the cut border, i.e. what will become the visible surface. The improved algorithms in the latest versions have not only increased colour resolution, they have also allowed this coloured border to be made thinner, hence the saving in ink costs. Over a million different colours can be used.

Mcor's SliceIT control software for its 3D printers reads the digital data and slices the computer model into printable layers equivalent in thickness to the paper. The software enables the user to position the model, or several models, within the 3D printer's build chamber. It will also take in any colour information from the source files. "For example, in SolidWorks if you did an FEA analysis and you look at stress," said MacCormack, "you just right click your stress plot, then save that as a VRML file and read that straight into SliceIT. All the geometry and the colour are brought in, so the model will show the stresses." [See picture on p19]

Additive manufacturing, for all its hype is still an untapped resource in some parts of the market according to MacCormack. "I think creative people want something that you press a button and it runs. They want high quality to match their expectation level and I think that's the reason why they haven't got into it as much. Creativity is what's important to a designer. And I think sometimes when they look at what comes out of a desktop 3D printer, they go 'it's awful'. So I think that there is a disconnect between creative people and what the output is."

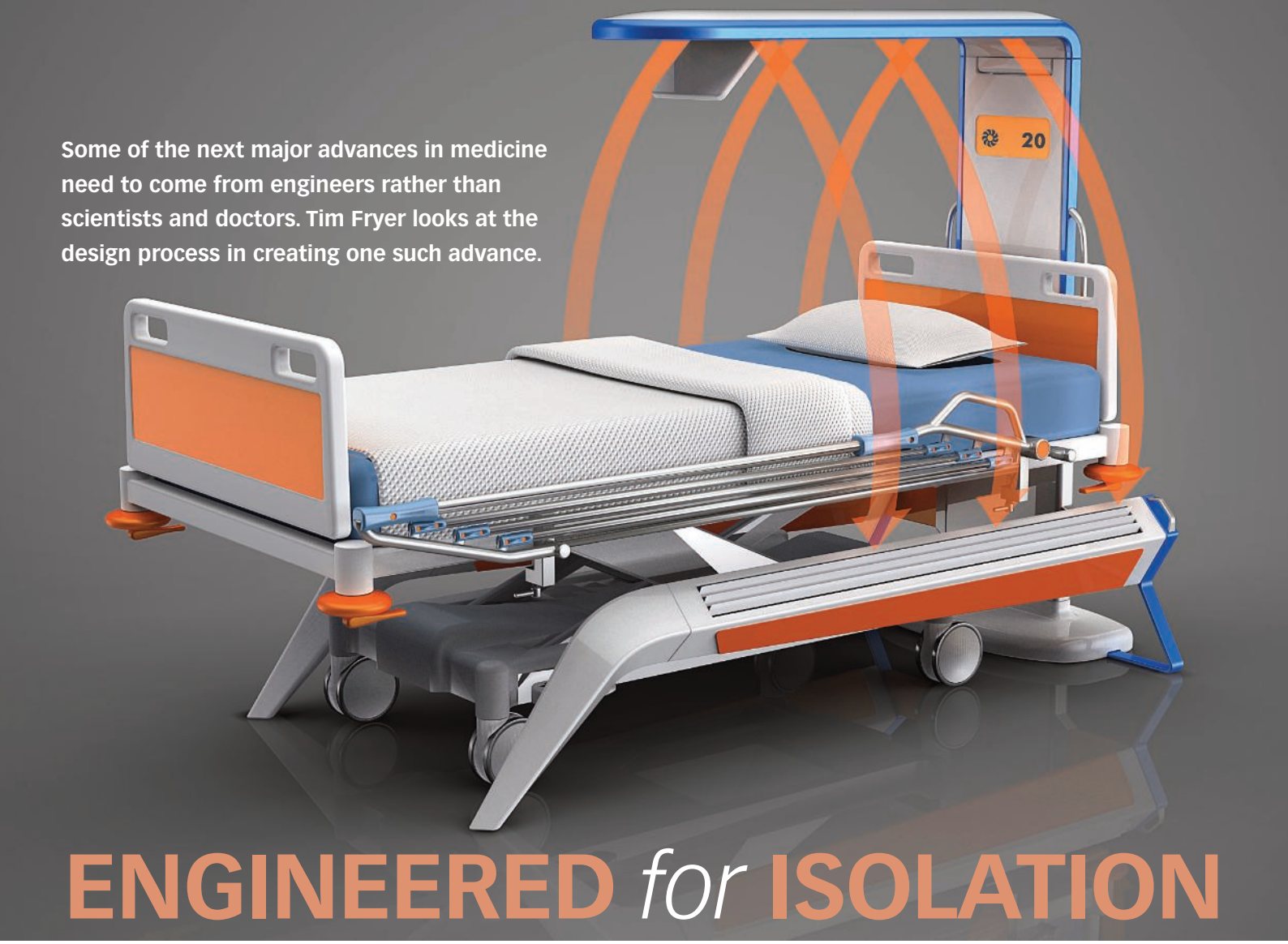
Mcor believes that its technology, particularly now that it has been enhanced by the software algorithms to improve colour print sharpness and new cutting blade to improve resolution, can overcome these disappointing outputs, without the high expense of the high end machines

mcortechnologies.com

IRIS HD

Earlier this year the company introduced the IRIS HD that offers sharpened details and a further 20% reduction in operating costs. Built on new algorithms and a newly designed carbide cutting tip, the IRIS HD makes full-colour detail and text on 3D printed models crisper to deliver a photorealistic appearance around the full geometry of the model and better communication of granular information.

The cost reductions come from the increased life of the cutting tip and the reduced cost of ink. Dr. Conor MacCormack claimed: "Our SDL [Selective Deposition Lamination] paper-based 3D printing technology has always offered the industry's highest-resolution colour at the lowest operating costs. Now, with IRIS HD, we're providing even greater access to truly photorealistic colour 3D printing."



Some of the next major advances in medicine need to come from engineers rather than scientists and doctors. Tim Fryer looks at the design process in creating one such advance.

ENGINEERED *for* ISOLATION

According to the adage, engineers save more lives than doctors. In terms of sanitation alone this is probably historically true, but increasingly doctors and engineers are working together to come up with potentially life-saving solutions. Which is just as well because, according to the World Health Organisation, we are in trouble. The rise of antimicrobial resistance (AMR), it says, is a global health crisis

The UK's Chief Medical Officer Professor Dame Sally Davies said: "We have reached a critical point and must act now on a global scale to slow down antimicrobial resistance" Drug-resistant infections could kill an extra 10 million people across the world every year by 2050 if they are not tackled.

So while engineers may have created an infrastructure to improve hygiene and doctors are at the cutting edge of the medical science, further steps need to be taken if we are to prevent these apocalyptic predictions coming true.

Michael Phillips, design development director for Renfrew Group, believes the first step is to increase funding. At the moment the pharmaceutical sector globally contributes $0.4 billion to an innovation fund to promote the discovery of new antibiotics. Phillips said: "I propose that a proportion of this $400million or maybe even an additional sum is directed toward engineering and technology innovation to address new methods of infection control."

So what is it that requires this innovation? One particular cause for public concern in recent years has been the health of the hospital environment. For example, C diff and Norovirus, which can amongst other symptoms induce severe projectile vomiting, resulting in spores being projected up to 8m away. And this is without considering AMRs. Are closing the curtains round the bed enough of a comfort if it is you or your relative in the neighbouring bed?

In the UK, it is estimated that Healthcare Associated Infections (HCAIs) affect some 100,000 patients a year and is responsible for the deaths of around 5000 patients annually in the UK.

The recommendation is that someone showing signs of an HCAI should be isolated immediately to a sideroom, with its own basin and toilet, but an NHS survey indicated a shortfall of 37,000 such rooms.

Phillips commented: "600 NHS frontline staff, were asked if they were given a 'Technology Magic Wand' - what would they want to best help combat infection in hospitals? We assisted the steering committee with the process of visualising and assessing the early ideas and developed concept for 10 technologies. Several were brought together in the form of a portable isolation facility for use on the ward – the Temporary Side Room [TSR]."

Solutions investigated included tent like structures with clear plastic walls and roof; fabric and mesh. "The target was to improve upon current cross infection rates by as much as

possible, whilst being practical to manufacture and install and must be comfortable to live in," said Phillips. "It must not look intimidating or feel claustrophobic."

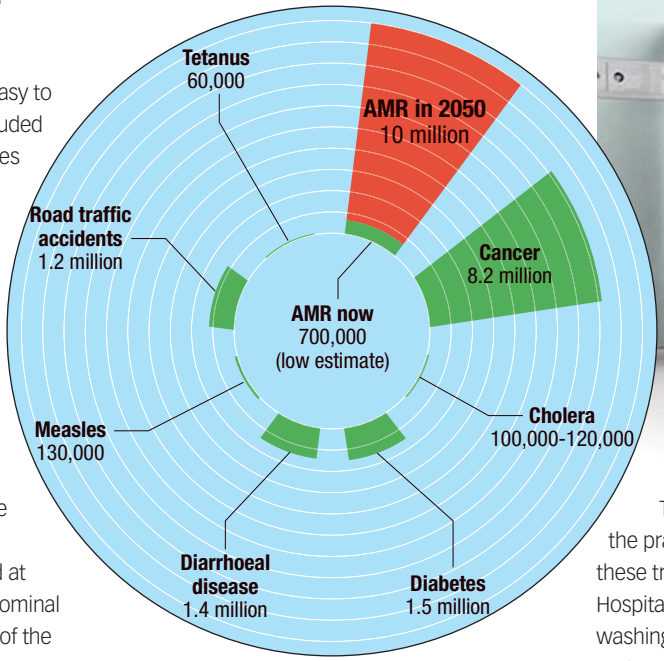
The requirements were that it must be practical, fast to erect and dismantle and easy to clean with no dirt traps. Other features included a non-touch doorway, hand washing facilities and built-in water supply for a minimum of one day's washing with non-touch towel dispenser as well as a 2-sided consumables locker and a deliveries hatch.

A non-touch doorway or preferably a doorway that could be open most of the time, with controlled air flow, would allow good observation and easy access for adequate nursing attention.

"We used tools such as CFD, in this case from Ansys, as well as quick rigs filled with smoke and so on," said Phillips. "We looked at how to make a doorway that produced a nominal negative pressure, to try to retain as much of the airbourne pathogen as possible."

Working with the NHS nationally, the National Innovation Centre and the Department of Health, as well as widely with industry, Renfrew created designs and prototypes for a TSR that could be erected and dismantled within an hour, in-situ without disturbing the infrastructure. Prototypes were tested at Health Protection Agency (HPA) Porton Down with markers and live bacteria.

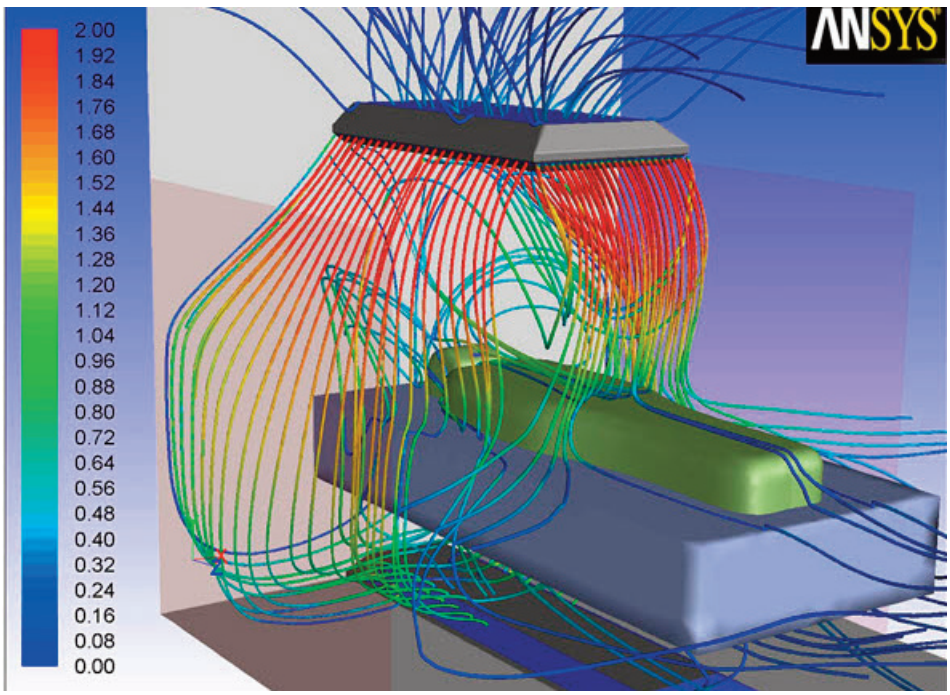
(Right) Design for the Temporary Side Room. (Below) Prediction for AMR deaths in 2050



Ten units were made for trials to explore the practical use in a clinical environment, and these trials were run at University College London Hospital. It turned out that the key thing was hand washing. Phillips added: "So we engineered a system that would deliver 50 to 70 handwashes, timed to perfection by the RCN with illuminated prompts., with its own water supply and contained waste."

Vital to a comfortable environment is a breathable roof. This provides a surface, close to the head when standing, that does not reflect heat or importantly sound. A solid or impermeable roof makes an uncomfortable space where heat and sound is reflected back. A good acoustic profile provides a comfortable, non claustrophobic atmosphere. A 50 micron mesh was found to provide a balance between keeping the majority of particles in, whilst making the difference between a pleasant and an unacceptable living space.

Phillips said: "Designers have a responsibility to understand and translate these less tangible but absolutely critical aspects of a product's design. The trials revealed that of the patients in the same ward, those who were not in a TSR, frequently actually requested to be in one."



Computation Fluid Dynamics predicted a very low percentage of escaped particles (in the range 2 to 300 microns) would be possible

But were the walls needed?

During the process of designing the TSR, the question was asked, could this infection control capability be achieved without solid walls? A portable air curtain could provide a degree of infectious particle containment in an easy to move and install package, and claustrophobia of the

patient would be minimised. So Renfrew started to work on a design.

CFD was again the main tool in the design team's armoury at this stage as Phillips explained: "By entraining downward airflow from overhead air blades, and evacuating at a higher volume (slower speed) under the bed, we could remove the particles. Gravity generally overcomes the weak lift provided by convection currents. The CFD predicted a very low percentage of escaped particles (in the range 2 to 300 microns) would be possible."

A quiet air stream is output from the overhead unit, directed to pass around the bed, enveloping the patient bed area, and extracted under the bed. The air is cleaned via UV and other systems under development, and either exhausted outside the ward or building or recirculated.

Despite the critical role played by CFD, old fashioned hands-on engineering still has its place. Phillips said: "At RG we like to build things quickly and see what happens. We reckon often more can be learned, faster and possibly cheaper, by building quick card and tape mock ups with and having a play. The variables can be the same as with CFD, probably modified more rapidly, and the benefit of observing something not predicted can be very valuable."

A finished representative model was then produced to make first assessments for acceptability with patients and nursing staff in perception studies. "Patient perception is all important," said Phillips. "Creating a positive environment from a potentially negative one can make innovations acceptable. Our approach is where possible to make a product desirable, especially in circumstances where the environment might otherwise be seen in a negative or frightening light. By trying to evoke something of the quality of business class interiors, with built in entertainment, patient info system, personal lighting in a stylish design, with airflow designed to be gentle and quiet, the air curtain can be accepted much more readily by patients."

But given the rise of the HCAIs, such outbreaks as the recent Ebola, and our seeming inability to be prepared for them, are developments in containment such as the TSR and the overbed airflow enough? Phillips responded: "Urgency creates action. So in a sense, yes, panic, we should do something about it. AMR is leading to a potentially disastrous situation - it's not an exaggeration. So it is time for action and it can't be on the shoulders of engineers alone. But I think working together, although it sounds trite, true collaboration brings good results."

This article is based on Mike Phillips' presentation at the Engineering Design Show 2015.

www.renfrewgroup.com

Keeping EMC **under control**

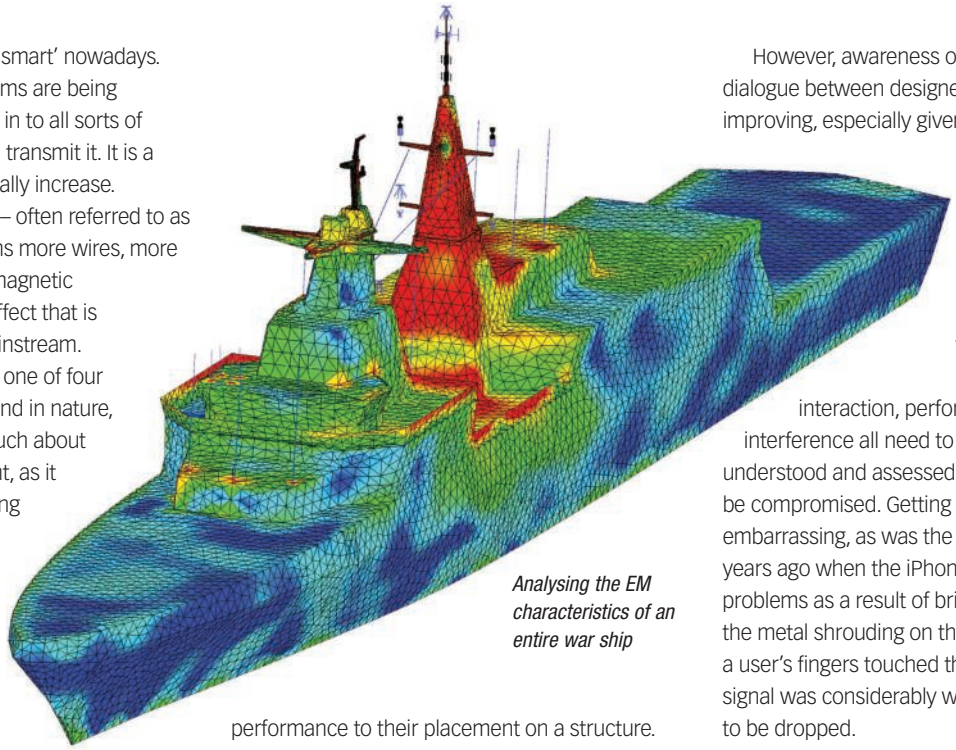
The black art of managing electromagnetism is becoming of increasing importance as products take on more electronic systems. Justin Cunningham looks at the latest tool in understanding the phenomenon.

Everything needs to be 'smart' nowadays. Clever electronic systems are being increasingly integrated in to all sorts of products to harvest data and transmit it. It is a trend that is set to exponentially increase.

This rise of the machines – often referred to as the Internet of Things – means more wires, more antennas, and more electromagnetic compatibility issues, a side effect that is seldom discussed by the mainstream.

Electromagnetism (EM) is one of four fundamental interactions found in nature, and its management is as much about getting it to do what you want, as it about mitigating and managing unwanted side effects.

This growing need has been reflected in the fact that simulation software and product design consultant company Altair acquired EM Software and Systems last year to enable FEKO, its comprehensive electromagnetic simulation software tool, to be added to its extensive Altair HyperWorks suite of multi-physical simulation solvers.



Analysing the EM characteristics of an entire war ship

Vice president of electromagnetic solutions at Altair, Dr Ulrich Jakobus, explained: "The cross-sector, cross-industry increase in electro-dynamic systems means we need to better understand and engineer systems that produce electromagnetic radiation so we can maximise functionality and minimise any undesirable effects."

FEKO is a state of the art solver specifically configured to assess a broad spectrum of high frequencies. It uses various frequency time domain techniques and hybrid solvers to analyse a whole spectrum of electromagnetic problems.

The industry sectors are diverse and cover everything from automotive to aerospace, communications to medical. The key applications are antenna problems, from their design and performance to their placement on a structure.

Like much of the Hyperworks portfolio, FEKO can be used to tackle problems on products large and small, from mobile phones to warships. However, FEKO is perhaps most prolific in its use to design and place antenna on structures, assess their interaction with surrounding wiring and materials, as well as understand any effect from the surrounding environment and on personal.

Antenna placement

Design engineers are notoriously preoccupied with packaging, neatly placing as many components and systems in as small an area as possible. However, this often creates problems and headaches when it comes to electromagnetic interference.

"Typically the design engineers tell you, 'this is the space you have to put an antenna'," said Dr Marcus Schick, director of electromagnetic solutions at Altair. "Then you find the EM engineer has a problem: how to get good reception with the given parameters that you have?"

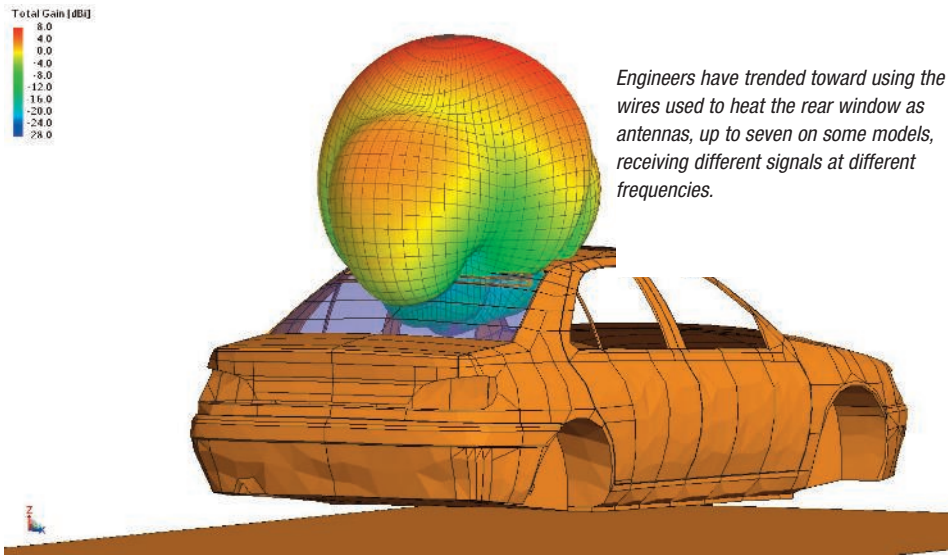
However, awareness of the need to improve dialogue between designers and EM engineers is improving, especially given the trend of integrated antennas. For example, an average mobile phone can have half a dozen antennas and cars more than 20, yet it is often difficult to even find a single one.

Placement, interaction, performance and interference all need to be thoroughly understood and assessed if functionality is not to be compromised. Getting it wrong can be embarrassing, as was the case for Apple several years ago when the iPhone 4 suffered reception problems as a result of bridging the antenna with the metal shrouding on the phones edges. When a user's fingers touched the metal shrouding, the signal was considerably weakened causing calls to be dropped.

"We want to analyse what the antenna is doing, but also what will happen when you put it on a structure," said Debbie Fellows an EM application engineer at Altair. "What are the interactions going to be? Will that affect performance? And alongside that, you always have unwanted performance, so it helps to really understand electromagnetic compatibility issues."

The automotive industry is a case in point. Over the last five years engineers have trended toward using the wires used to heat the rear window as antennas, up to seven on some models, receiving different signals at different frequencies. In addition cars now have more sensors and wiring than ever before, all emitting electromagnetic radiation that has the potential to cause problems if not properly managed.

The biggest megatrend for the industry, however, is electrification. This may be hybrid cars or all electric, but both create substantial new electromagnetic signatures. Electromagnetic compatibility (EMC) can be used to improve the



Engineers have trended toward using the wires used to heat the rear window as antennas, up to seven on some models, receiving different signals at different frequencies.

design of the electric systems and equipment, optimise how they interact with the rest of the structure and materials, and reduce the overall cost of the project.

Dr Salah Benhassine, a specialist in EMC numerical simulation at PSA Peugeot Citroen Automobiles, has been tasked to look specifically at this problem. He explained: "We model hybrid cars and their EMC emission. We have to model the whole structure of the car, the metallic pieces, and also we have to take in to account the antenna on the roof or integrated into the windscreen. Then we have to describe the hybrid system that takes in to account cable harnesses... and the affect on people. We might find radiation from equipment that could affect the antenna, especially when you have higher power."

To shield or not to shield?

In the Peugeot systems given as an example, the front wheels use electric motors and inverter. In the rear of the car there is a 48v battery, a DC/DC converter, and some grounding on the chassis.

It was clear there would be some issues and so analysis was run to see if cables needed to be shielded or unshielded. While shielded cables would reduce any EMC, for every car this would add both cost and weight. The alternative solution was to use filtering instead.

"We had to model the whole vehicle and whole cable harness, and then look at the distinction between shielded and non-shielded," said Dr Benhassine. "We wanted to see what happens if we group the cables together or if we separate them. We introduced some filtering and we could see the behaviour that had on the antenna. "It shows we could reduce the levels if we used only a filter on the 12v cable instead of putting shielding on the whole cable, probably 5 or 6m. This simple filter reduced noise by 40dB across the whole system. Using EM simulation, we can highlight worst or best configuration, optimise the routing of the cables, optimise grounding, and also give good filtering according to the frequency."

Cable coupling can also create undesirable electromagnetic effects. In general, cable harnesses are often placed in multiple bundles that get threaded through in all kinds of arbitrary places, as they run through vehicles. This is often without huge thought about how they are implemented. FEKO features a cable analysis tool that assesses the electrical fields coming in to cables, what happens with the energy along them, and ultimately the affect this has on other electrical sensors and systems.

"Cable coupling is important when it comes to EM," concludes Dr Jakobus. "But we are interested in using it with other solvers in Altair in the multi-physical analysis such as thermal or vibration analysis. Take a car, for example, that has a radar on the bumper to measure the distance to the car in front as part of an adaptive cruise control system. We need to know how that interacts with the vibration from the road. We don't want a pot hole to make the radar give false or inaccurate readings. So we need to assess this interaction, the multi-domain, multi-physical, system."

www.altairengineering.co.uk

Understanding the thermal issue

CTLaserGLASS sensors are specifically aimed at measuring glass surface temperature

A variety of thermal measurement sensors have recently come to market that promise to improve upon current options, alleviate problems and open up opportunities. Justin Cunningham reports.

Temperature is a key measurement parameter in controlling the quality of glass or glass products. Conventional thermal imagers with spectral wavelengths of 8-14µm do not measure accurately the temperature of the glass.

The thermoIMAGER G7 from Micro-Epsilon is a thermal imaging camera specifically designed for measurements on glass object. With a spectral range of 7.9µm, the thermoIMAGER G7 accurately measures the temperature of glass.

At longer wavelengths, glass allows transmission of temperature from objects behind or near to the glass, which gives inaccurate measurements, normally lower than the true temperature. However, using the G7 camera at a wavelength of 7.9µm eliminates any transmission from other objects, resulting in very accurate glass temperature measurement.

Chris Jones, managing director at Micro-Epsilon UK said: "When measuring at 7.9µm, the glass object becomes a solid body and only emits its own temperature. This results in very accurate temperature measurements, even on very thin glass or thin walled objects such as glass tubes, bottles and substrates."

Even if the glass has a protective (reflective) coating applied to it, an additional reference pyrometer can be set up to provide an adjustment factor to the camera, which corrects for this reduction in transmission of infrared temperature from the glass – a unique feature of the thermoIMAGER software supplied as standard with the G7.

Powered and operated via a USB 2.0 interface, the G7 provides temperature images and profiles of a target area. This plug-and-play unit enables the real time capture at 80Hz full frame rate and storage of images or video of an event for slow motion play back or snapshots at a later date – a key feature in many quality, inspection, R&D and failure diagnostics work.

An alternative method of measuring the temperature of glass and glass products is to use a high precision infrared temperature sensor. Micro-Epsilon also has a thermoMETER CT family of infrared temperature sensors that include the CTLaserGLASS, a non-contact infrared thermometer specifically designed to measure the temperature of glass surfaces.

The CTLaserGLASS uses a 5.0µm wavelength detector to accurately measure temperatures from 100°C up to 1650°C. The average measuring wavelength of 5.0µm provides a low depth of penetration and enables reflection effects to occur for the infrared measurement of glass. Using shorter wavelengths than this would mean the sensor would measure through the glass rather than measuring the true temperature of the glass itself.

In container glass production, for example, the operator must obtain the temperature of the glass gob (molten glass that is poured into a blow mould) to observe the ratio between glass viscosity and gob weight. The mould temperature measurement is therefore critical for balancing the

High temperature ratio pyrometers from Fluke

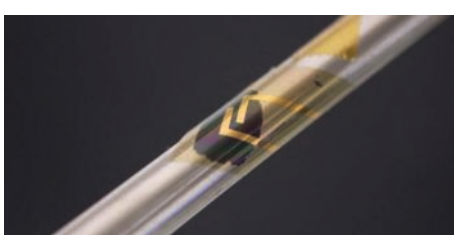
cooling levels of mould shells. In the production of flat glass, automotive glass and construction glass, homogeneity of the complete glass panel is important, particularly when it comes to bending, annealing and tempering zones.

The double laser aiming of the thermoMETER CTLaserGLASS marks the real spot location and spot size up from 1mm at any distance. The 70:1 (or 45:1) optics with selectable focus, provide a very small spot size of just 1mm.

ThermoMETER CTLaserGLASS has a stainless steel sensor head and can be used in ambient temperatures of up to 85°C without cooling and to protect the laser aiming optics, has an automatic laser switch off at 50°C. Cooling and protection accessories are also available for harsh environmental conditions. For example, a water-cooled version is available for ambient temperatures of up to 175°C.

The thermoMETER CT series operates with specific wavelengths and are ideal for measuring the temperature of virtually all materials. These include metals, glass, ceramics and composites, from -50°C to +2,200°C, using laser sighting to easily locate the target to be measured and also define measurement spot size.

The thermoMETER CTLaser M3, for example, has a start temperature of 50°C and so fulfils the demands of end users who need to measure the temperature of metals, ceramics and composites, while processing at room temperature. The short wavelength also enables measurements to be taken through glass or transparent plastic windows, a common task in the latest laser welding or lighting systems.



In applications where the emissivity of a target is unclear or varies, the thermoMETER CTRatioM1 offers an alternative solution where the ratio between two different short wavelength detectors is compared.

The ratiometric principle, sometimes referred to as a '2-colour pyrometer', minimises measurement errors caused by objects in the optical path blocking the path. For example, scale build-up on hot and molten metals, steam or smoke, which block up to 90% of the measurement spot do not affect the measurement accuracy. The CTRatioM1 measures temperatures from 700°C to 1800°C and the use of glass fibre optic cables means the sensor can withstand ambient temperatures up to 250°C without the need for additional cooling.

Another temperature sensor has recently come to light from the University of Tokyo. There, researchers have produced a flexible, lightweight sensor (*pictured below left*) that is said to respond rapidly to changes in body temperature. The sensor's resistance is said to change by up to 100,000 times over a range of 5°C, allowing accurate temperature measurement without additional complicated display circuitry.

The sensor is composed of graphite and a semicrystalline acrylate polymer formed of two monomers. The temperature at which the sensor is most precise can be selected by altering the proportions of the two monomers. The research group measured temperatures between 25 and 50°C, with response times of less than 100ms and a temperature sensitivity of 0.02°C. The device was also found to be stable, providing repeated readings up to 1800 times.

"By printing an array of these sensors, it is possible to measure surface temperature over a large area," said Professor Takao Someya from the University's Graduate School of Engineering. "Because the huge response of the sensor to temperature change allows us to simplify the circuitry, we could print our sensors onto adhesive plasters that could then monitor body temperature."

Other possible applications include wearable electronics, where the sensor could be applied beneath fabric to measure temperature during sporting and other activities.

Another product of similar ilk to come to market is from Fluke Process Instruments. It has introduced the Endurance Series of high-temperature ratio pyrometers. These instruments are said to enable continuous visual process monitoring and are designed to meet the demands of harsh industrial environments, including primary and secondary metals manufacturing, carbon processing and silicon production.

The Endurance Series pyrometers provide a robust solution for manufacturers seeking to improve product quality and uniformity, reduce reject rates, maximise throughput, and minimise energy costs. They offer optical resolution of up to 150:1, for viewing critical process operations. Multiple lens, sighting and focus options are available for different mounting distance and sighting needs. The units feature galvanically-isolated inputs/outputs, as well as an IP65 rated stainless steel housing able to withstand ambient temperatures up to 65°C or up to 315°C using cooling accessories.

The pyrometers are also said to be versatile and easy to install. The sensors operate with either PoE or DC power, and interface to various bus systems. A rear-panel user interface is claimed to simplify navigation. PC-based Endurance setup and monitoring software is provided for configuration and deployment, and a built-in web server enables archiving of historical data for traceability and process troubleshooting.

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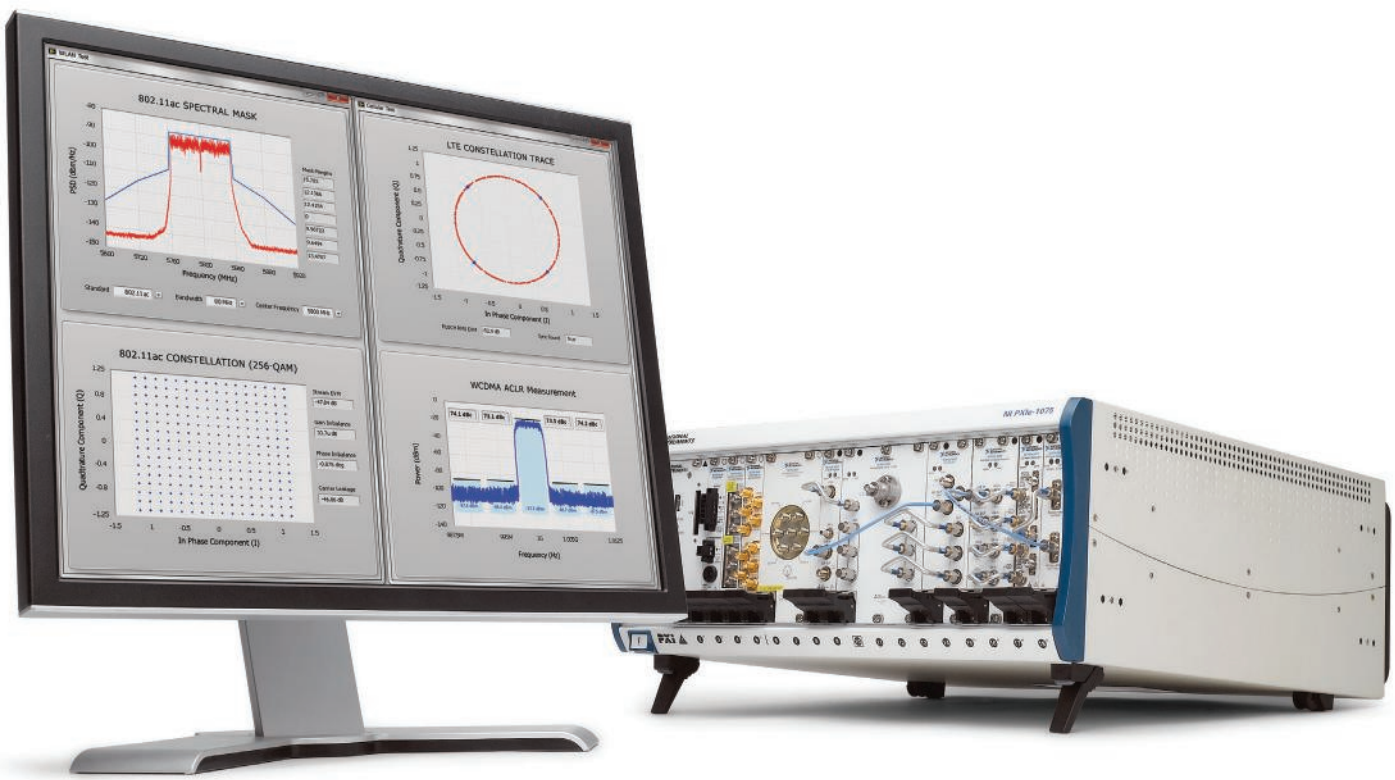

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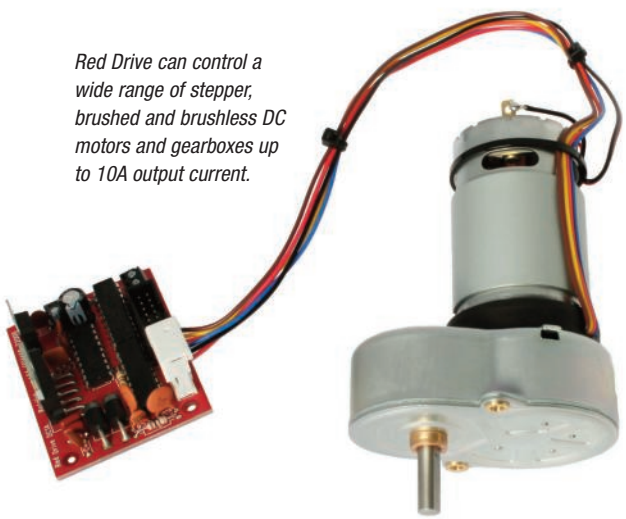
NATIONAL INSTRUMENTS

Sailing by servo

'Sail by wire' would improve control and reduce weight in large racing yachts – but designing such a system is not easy. Eureka looks at how it can be done.

As in any professional sport, gaining a competitive edge by taking advantage of the latest technology can make a significant difference - and racing yachts are no exception. A good example of this is an innovative 'sail-by-wire' solution which engages and disengages the numerous winches required to position the sails on a racing yacht. Developed by Somerset based competitive sailing specialist Stayinphase, the system uses motors and gearboxes supplied by transmission and control company Rotalink. The idea was to see if a 'wired' control system could transmit signals to the servos positioned next to the clutches to engage and therefore eliminate the need for bulkier, heavier mechanical linkages.

Modern racing yachts use hand-operated cranks to drive several winches positioned throughout the hull to raise and lower sails.

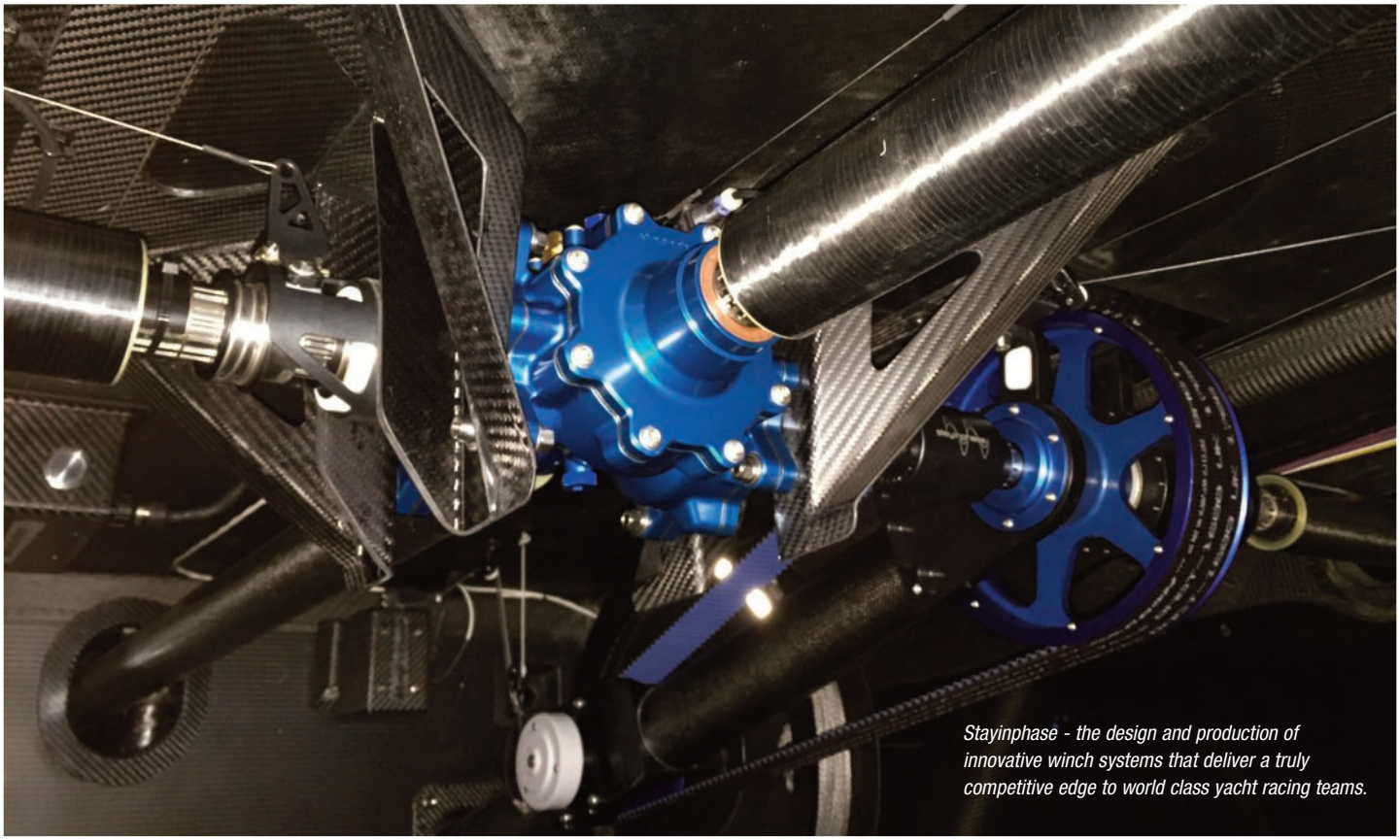


Red Drive can control a wide range of stepper, brushed and brushless DC motors and gearboxes up to 10A output current.

Disengaging all but the winch needed in a given manoeuvre lightens the load and crucially, letting sails rise (or lower) faster, improves performance. Higher spec, 'racing grade' clutches make this possible, although running mechanical linkages to them from the crank station requires extra pulleys, extra cable. Though races can last for hours, every second makes a difference and in a sport where shaving kilograms is as important as shaving seconds, less weight = improved performance.

For the 'sail-by-wire' idea to be viable Stayinphase realised that compact and powerful servos were needed along with the associated control and software. As a result they contacted Rotalink to explore the possibilities of developing the control system using their brushed DC gearmotors and Red Drive programmable drive board.

Making the gearmotors move between two points to engage and disengage the clutches was simple enough. Less simple was reacting to the movements of the other winches, disengaging only when they reached a certain position. More complex still was designing a program that allowed the exact



Stayinphase - the design and production of innovative winch systems that deliver a truly competitive edge to world class yacht racing teams.

points the gearmotors moved between to be set using just the switches that were to trigger them, rather than by reprogramming the drive board.

The numerous inputs and outputs of the Rotalink's Red Drive allowed it to utilise Hall Effect and infrared sensors to monitor the winches. In addition, its EEPROM memory allowed the gearmotors to be positioned and these positions were 'memorised' using just three switches, as opposed to using a laptop. The program to enable this was complex, but came together quickly aided by the intuitive flow chart based programming of the Red Drive software.

The geared motors themselves were also well suited for this demanding application. The humble brushed DC motor is not the obvious choice for a high-performance racing yacht, but the fact the servos only had to operate intermittently made its relatively short lifespan irrelevant. Also, the benefit of packing a lot of power and torque into a small space was important for this application. Rotalink's compact 210 hybrid planetary-spur ovoid gearbox allowed this power to be fully utilised. It offered a smaller footprint of 45mm x 35mm, a weight that is 100g lighter than an equivalent inline planetary gearbox and with the added benefit of an absolute encoder mounted on its output shaft. This compact, yet powerful gearbox/encoder combination provided significant advantages over using an inline planetary gearmotor and a conventional servo motor.

Encoder key to success

The absolute encoder was the final element that enabled the success of the sail-by-wire approach. A design unique to Rotalink, it serves as the digital equivalent to a potentiometer. Compared to an analogue component it offers reduced size, greater lifespan and the option to report its position via 10-bit SSI as well as a more conventional 0V to 5V analogue signal. This makes it resistant to the effects of electromagnetic resistance and, critically in a battery-powered application like Stayinphase's project, prevents its true position from being distorted by a drop in voltage as would be the case with a potentiometer.

The installation and testing process was helped by the engineering support provided by Rotalink to Stayinphase, with final on-site tweaks facilitated by the simplicity and functionality of the Red Drive programmable drive board. The system proved to be a success, seeing use in the 2014 Rolex Middle Sea Race staged off the island of Majorca.

Commenting on this application, CEO at Stayinphase, Jon Williams said: "We worked extensively with the team at Rotalink on this complex project; they took the time to fully understand the demands of our application and delivered a suitable product first time which considerably reduced our time scales. They provided excellent engineering support during the design and fit stages and have given us technical data and training to support the ongoing service we give our customers."

The specialised and complex Stayinphase racing yacht winch control solution is an example of how Rotalink's compact range of servos and motors supported by innovative gearboxes and encoders can benefit industry, particularly in applications where motorised valves are used.

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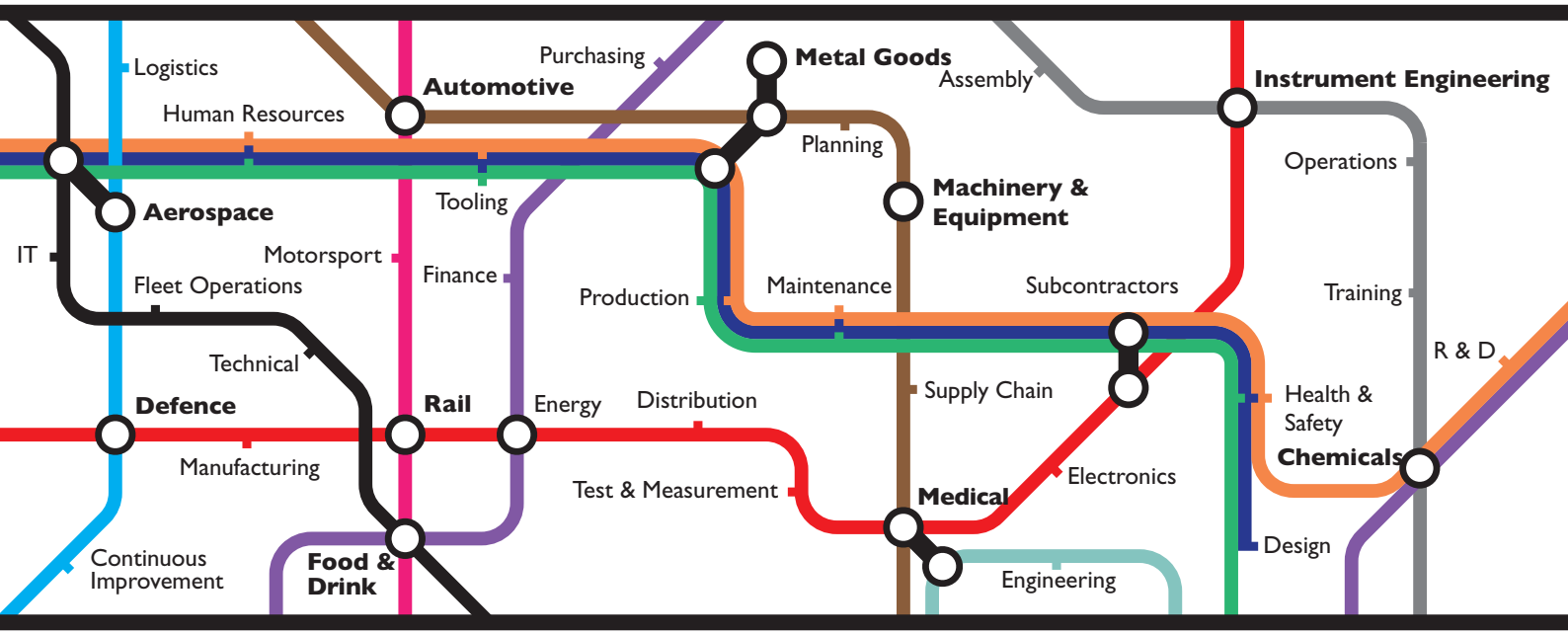

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Exploiting a UK patented invention

In our IP survey earlier this year we asked whether you believed your company is effectively exploiting its IP. Nearly 50% of respondents disagreed. In response to this feedback Charlotte Musgrave takes look at the different ways a patent can be exploited.

Your UK patent gives you the legal right to stop others from making, using, selling or importing your patented invention in the UK, even if those others conceived of the patented invention independently. You can use this right to keep your competitors out of the UK market for the patented product, giving yourself a monopoly position as defined by the scope of the patent claims. In this scenario your competitors would need either to withdraw from the market entirely, or perhaps offer an alternative or even inferior product or process, either way gaining you a competitive advantage.

Using your patent in this way is beneficial if for example you wish to manufacture a patented product yourself, or you wish to subcontract the manufacture to a third party and take the income from selling the product yourself. Another approach might be to use your patent to enter into a joint venture with a third party manufacturer where you would contribute the patent right and they would contribute the manufacturing facility and expertise.

Defending your patent rights

Your patented product and any related commercial literature should be marked with the patent number to make third parties aware of your patent.

Sometimes, the very existence of your patent may be enough to dissuade would-be competitors, and in other cases some degree of negotiation or mediation may be required to preserve your monopoly. In the worst case, it might be necessary to take legal action against the competitor through the courts, or in some cases the UK Intellectual Property Office. If your infringement action is successful, the courts are able to force the infringer to pay compensation for the infringement of the patent, usually running from the date of publication of the application which matured into the patent, to issue an injunction to prevent further infringement, and to award you a proportion of your costs. Where significant and unrecoverable damage to your business is likely as a result of the infringement, an injunction before trial can be obtained under particular circumstances, although this is uncommon. Various other minor legal remedies may also be available. Where infringing articles are being imported into the UK, then it is useful to note that customs officers are able (on request) to confiscate goods which appear to infringe a patent.

Exclusive and non-exclusive patent licencing

An alternative way of exploiting a patent is to encourage other parties to use the patented invention – for a price. You can offer licences to other parties in return for royalties, which will allow them to use the patented invention under the terms set out in the license agreement.

An exclusive licence provides the licensee with a monopoly for the patented invention – excluding even you as the patent holder. You may wish to offer this type of licence if you do not wish to work the patent yourself, and if maximum profit would be derived by offering exclusivity to a single company.

In contrast, a non-exclusive licence opens up the market for the patented invention to several companies, including you as the patent owner. This approach enables you to fully capitalise on a large market which you would not be able to fully exploit yourself.

A licence may be limited by, for example, geographical area, field of use or duration, and may include or exclude the right to sub-license. In this way you are able to limit each licensee to the scope of right they actually require and maintain overall control of the exploitation of your patent. The amount of revenue derivable from the patent will depend on numerous factors, including the nature and value of the patented product or process, the strength of the patent, the breadth of the monopoly provided by the patent claims, the scope of the acts permitted by the licence, and whether it is exclusive or non-exclusive.

Patent acquisition

A patent is a form of property, and has a value dependent on its strength and the commercial significance of the monopoly it provides. The commercial significance may be judged on the basis of the benefit derived by having a monopoly position, or the amount of licensing income actually or potentially derived from the patent. A patent can be used as leverage in commercial negotiations and clearly forms an important asset of a company, which can be realised by way of sale of the patent (either on its own or along with the company) in return for a one-time payment, by way of a mortgage of the patent to raise capital, or by way of attracting investment in the company.

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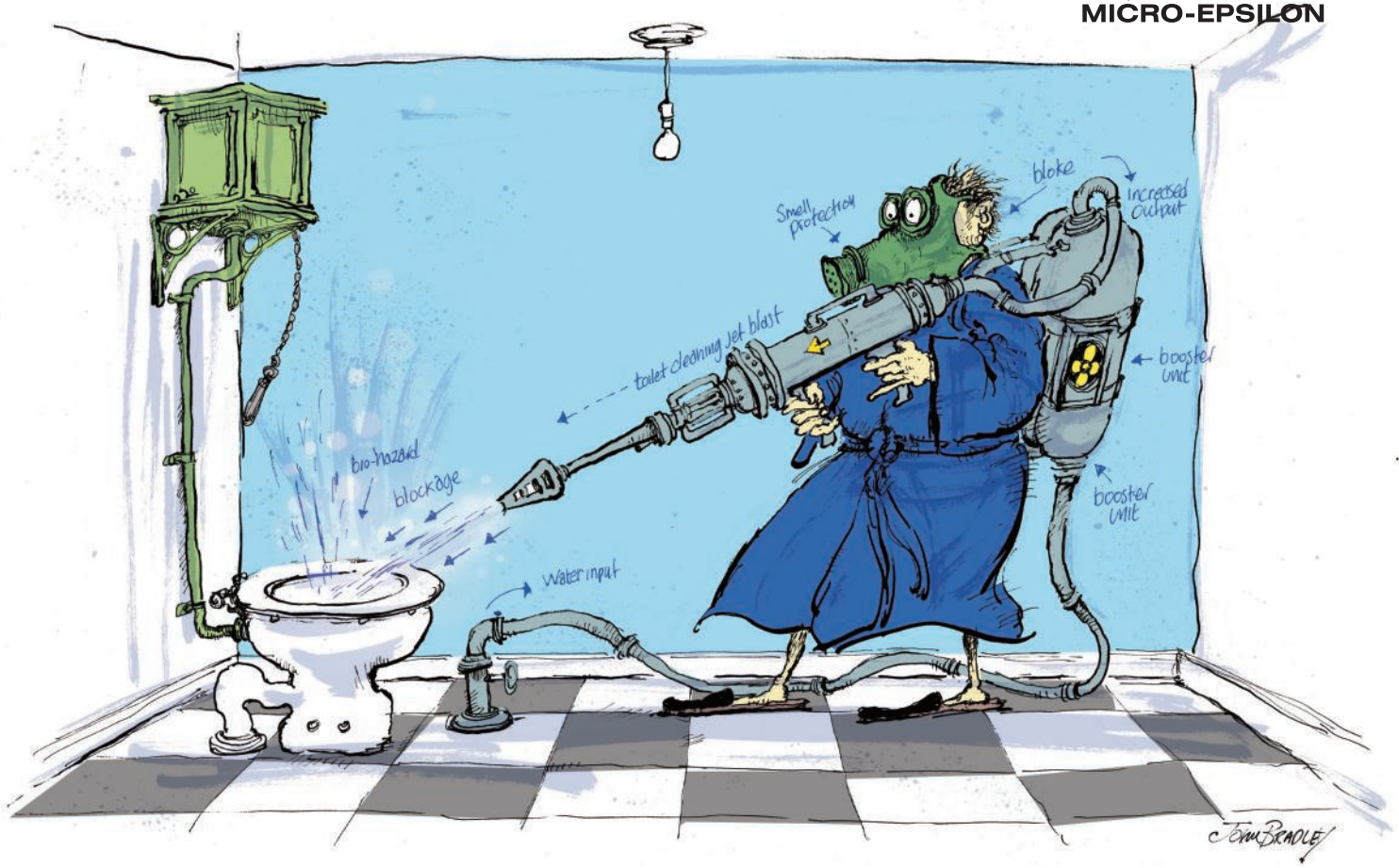
Toilet troubles?



Some things are so fundamental that radical design overhaul is not necessary. A garden fork might be made with a stronger steel but fundamentally it is a garden fork. A spoon is a spoon. A wastepaper basket is a wastepaper basket.....

What about the humble loo brush? It is a brush that sits in the back corner of the bathroom – or the cloakroom if you live in Surrey. It can be accused of being underused by certain family members, usually on a gender-defined basis. And it can be, well, ...unappealing. For a cleaning device it can become fairly unclean. Clogged. Dirty. Smelly. Unhygienic.

The challenge

So our challenge to you this month is to reappraise the toilet brush in terms of form and function and try and come up with a better solution. Something that is hygienic and functional to replace the standard existing design. Or perhaps it is time to have a look at the design of the toilet itself? Do we have materials and mechanisms that weren't available when the first flush toilets were designed in Elizabethan England – not, contrary to common misconception, by Thomas Crapper three centuries later.

As ever, we welcome ingenious or entertaining solutions, without going too far down the toilet humour route! Just email the editor at tfryer@findlay.co.uk or go to the Coffee Time Challenge section of the website and leave your idea as a comment.

Our solution to last month's Challenge, how to provide hearing for soldiers while explosions are going on all around, can be found on page 8 of this issue.

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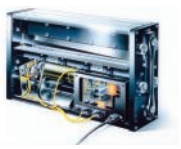

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Perform electromagnetic field simulations and quickly make geometric modifications to examine their impact on the design without worrying about exporting model data and dealing with compatibility issues. The property management pages and study setup use the same look and feel of SOLIDWORKS interface, making it intuitive to existing users.

MagNet for SOLIDWORKS' solution approach is based on the highly accurate finite element method for simulating static, frequency dependent or time varying electromagnetic fields. Read more about the complete feature set.

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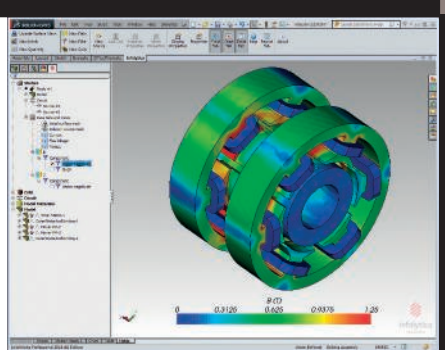

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