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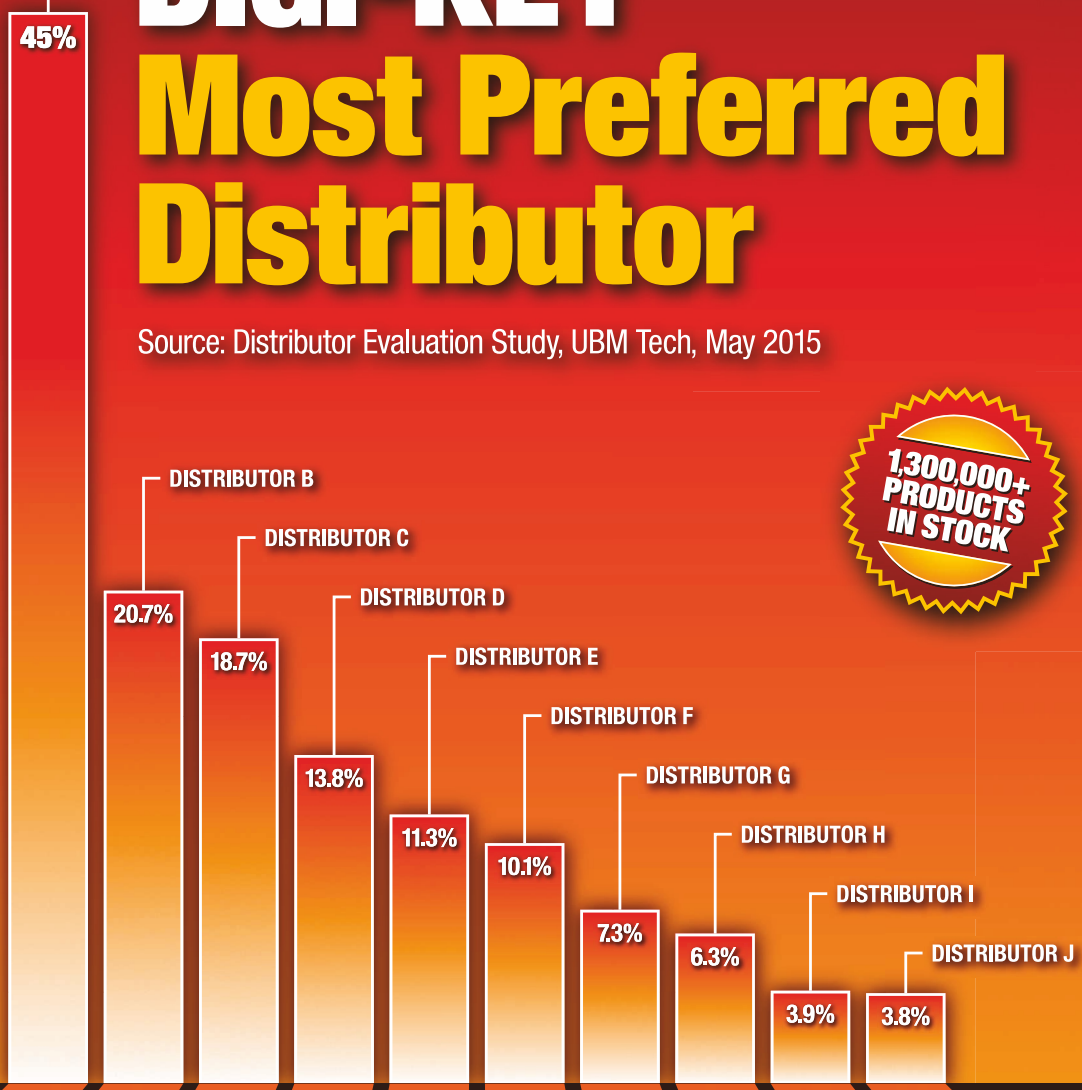

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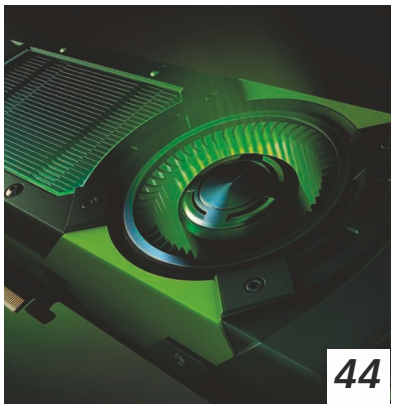

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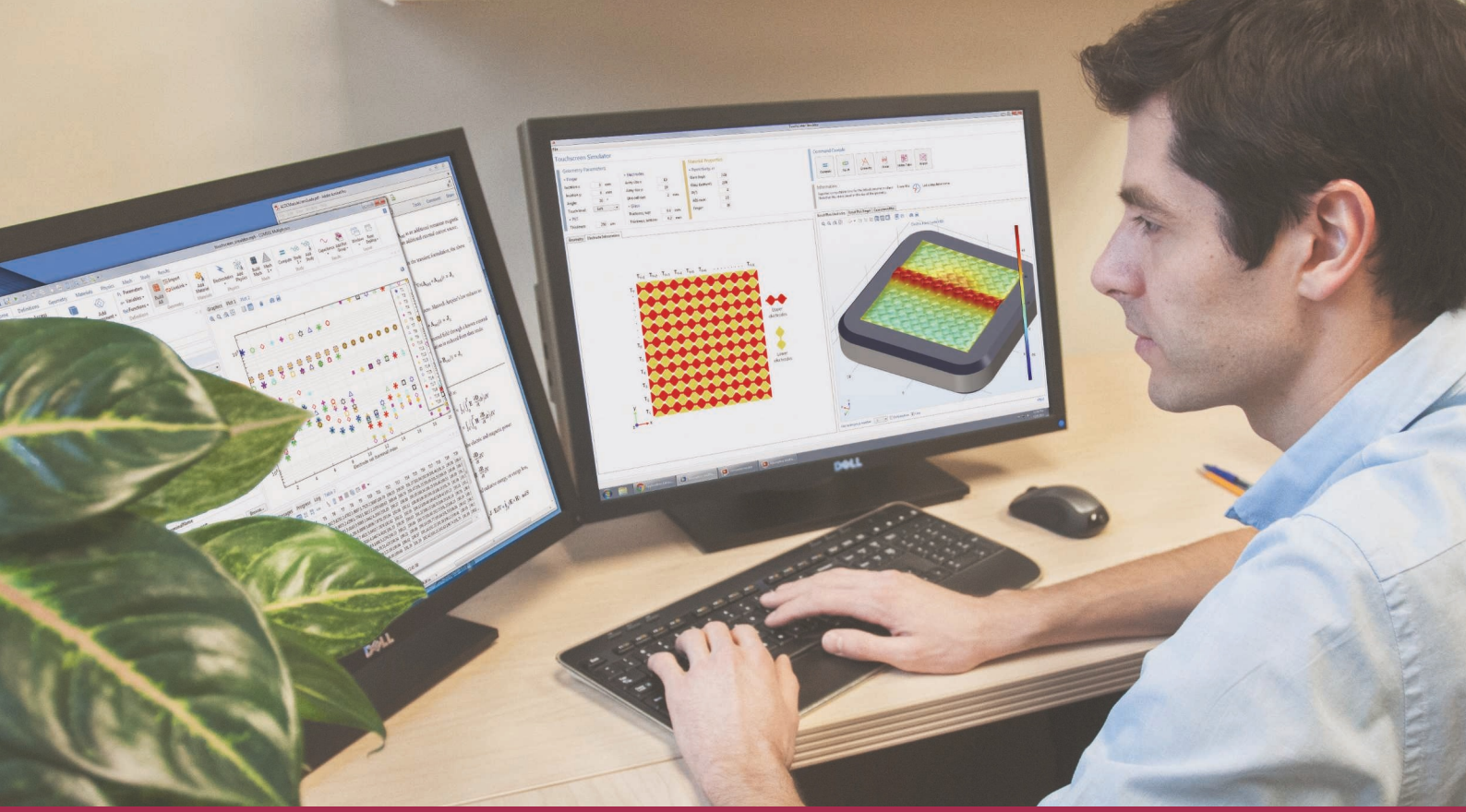

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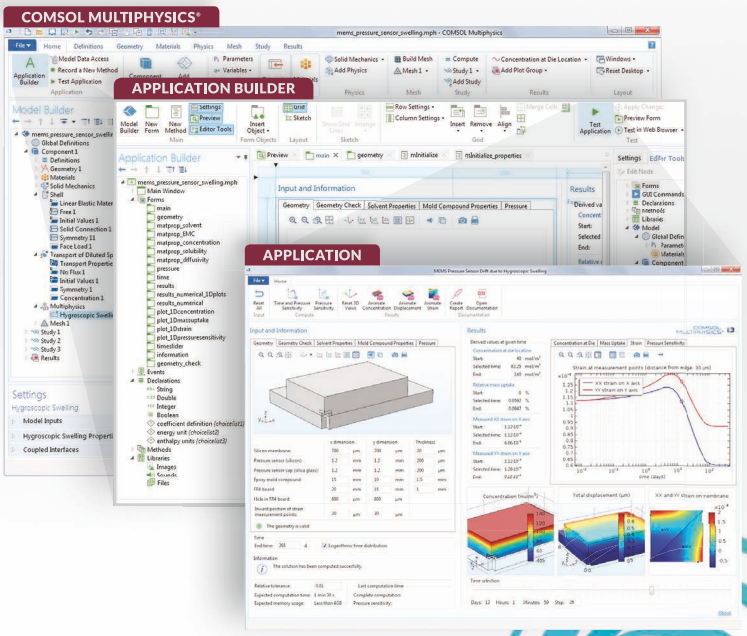

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Reality becomes necessity

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

Virtual reality is now creating a real life stir. Is this down to those with vested interests creating that stir – in the same way that social media has been foisted on a largely unenthusiastic engineering sector – or is it really the next big step up in engineering design? In my interview with Gian Paulo Bassi this month (see p18), he sees that while there is a blurred distinction between what is augmented reality and what is virtual reality, it is something that is starting to excite his CAD-using customers. For example, Bombardier, while sadly losing hundreds of real engineers at its Belfast plant, is using the technology in the development of trains, vehicles and aeroplanes. By having virtual hands probing wiring, using welding guns to assess access during manufacture, or just testing the ergonomics of a passenger moving into and about a vehicle, the company claims it could save 70% of prototyping costs.

AMD is likely to be a leading company when it comes to providing the hardware foundations for virtual reality. It has just announced it is to partner with Associated Press on a Virtual Press room, where people can cheer in processions, shout at politicians or even enter war zones. Will this bring the sharper edges of reality into our cosseted lives, or will it trivialise the reality of other people's – turning a devastating incident into a meaty episode of Eastenders? I don't know. But it does seem that genuinely useful applications exist within the engineering sector. Big engineering enterprises are willing to use it and suppliers have the technology ready to start integrating it into the design flow. It could be that 2016 is the year virtual reality becomes a reality.

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Hydraulic clamping saves time and space

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

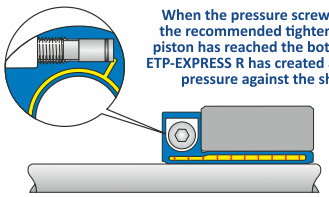
Everyone in every industry needs to save time and space while improving performance. Given this, the traditional mechanical clamping bush suffers a number of key disadvantages.

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

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

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

ETP's hydraulic bushes allow quick, easy and precise screw mounting in a multitude of applications by virtue of using a single screw for mounting and dismounting of the hub, thus ensuring an extremely quick and easy service interval time due to easy adjustment of the hub. This is achieved by the application of the principle of pressure propagation in liquids.



When the pressure screw is tightened to the recommended tightening torque, the piston has reached the bottom of the bore. ETP-EXPRESS R has created a uniform surface pressure against the shaft and hub

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

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

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ETP-Express, which has only one screw for pressurising and is therefore suitable when there is a need for the fast and accurate repositioning of the hub.

ETP-POWER, a hydraulic connection that consists of a double-walled hardened steel sleeve filled with a specially-developed pressure medium and a flange for higher torques and stresses

ETP-TECHNO, whose outer and inner diameter and the side of the flange towards the hub are accurately machined for excellent concentricity.

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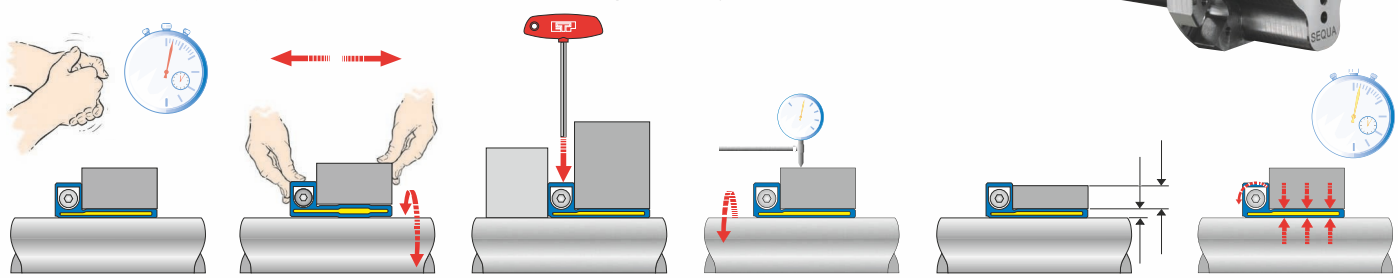

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NEWS

Ready for lift off? Not quite...

The Bloodhound land speed record project (see *Eureka*, Dec 2015) has suffered further delay due to financial problems. Test runs in Newquay have been pushed back to late 2016 while the record attempts in Hakskeenpan, South Africa – originally planned to be carried out this year - are now moved back to 2017.

"We are working on a considerable number of major sponsorship deals but these are taking time to come to fruition so we have had to slow our rate of development," said the project director, Richard Noble. "The hardest parts are behind us: the Bloodhound SSC car is 95% complete and we have prepared the best land speed racing track in history."

Skills gap increases graduate demand

UK job site, CV-Library, has revealed that the engineering sector is facing a bigger struggle than any other sector to recruit in the face of the impending skills gap, as experienced engineers retire and universities struggle to maintain the uptake required to replace them.

The job board analysed the number of graduate jobs posted on its site during January 2016 and discovered 1204 engineering jobs for graduates, more than any other sector.

Managing director of CV-Library, Lee Biggins (pictured) said: "Engineering businesses can't face this problem alone; it's a much broader issue which requires further Government intervention. More needs to be done in early education to entice our future generations into sectors such as engineering, otherwise the threat of skills shortages in years to come will quickly become a reality."

According to the research, degrees in civil, mechanical and structural engineering were the most sought after within engineering graduate positions. Growing numbers suggest more employers are taking the skills shortage into their own hands and training new recruits on the job.

Solar cells help purify water

Swedish researchers from Lund University have developed a solar powered water purification plant. With the help of Nobel Peace Prize recipient Muhammad Yunus, these small and portable solar cell stations have now been placed across rural Bangladesh, a country that suffers from water contaminated by arsenic.

The environmental company Watersprint, has patented the technology that helps purify water by combining UV-LED technology with intelligent software and Wifi that monitors the machine. In case of malfunction, the unit will send out alerts via text message to any mobile phone that is connected to it, as well as through the LED lights on the machine.

Its 12V system is claimed to be so effective that it can be run by a single solar panel. The solar cells also charge its battery, which means that the portable facility can be used around the clock and in rural areas without access to electricity.

NEWS

events

08 - 10 March
JEC World Composites Show & Conferences 2016
Paris Nord Villepinte

31 March
DEVELOP3D LIVE 2016
Warwick Arts Centre

07 April
The Engineering Simulation Show 2016
The Roundhouse, Derby

21 April
FAST Exhibition
Concorde Conference Centre, Manchester

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

28 April
Challenges and Innovations in Automotive Engineering Research
AMRC Knowledge Transfer Centre, Sheffield

14 - 15 June
PDM Plastics Event 2016
Telford

25 June - 01 July
UK Robotics Week
Across the UK

06 - 07 July
Manufacturing & Engineering North East 2016
Metro Radio Arena, Newcastle. Exhibition, conference and workshops

14 - 15 September
Low Carbon Vehicle Event
Millbrook near Bedford

28 - 29 September
TCT Show + Personalize
NEC, Birmingham

04 - 05 October
3D PRINT 2016
Lyon Eurexpo, France

19 - 20 October
Engineering Design Show 2016
Ricoh Arena, Coventry Exhibition, conference and workshops

Increasing PHEV efficiency

Researchers at the University of California, Riverside's Bourns College of Engineering claim to have demonstrated how to improve the efficiency of current plug-in hybrid electric vehicles (PHEVs) by almost 12%.

A key component in a PHEV is the energy management system (EMS) that controls when a vehicle switches from 'all-electric' mode, during which stored energy from the batteries is used, to 'hybrid' mode, which utilises both fuel and electricity.

Xuewei Qi, a graduate student in the Bourns College of Engineering's Centre for Environmental Research and Technology who led the research, said: "Blended discharge strategies have the ability to be extremely energy efficient, but those proposed previously require upfront knowledge about the nature of the trip, road conditions and traffic information, which in reality is almost impossible to provide."

While Qi's EMS does require trip-related information, it also gathers data in real-time using onboard sensors and communications devices. It is said to be one of the first systems based on a machine learning technique called reinforcement learning. In tests on a 20-mile commute, Qi's EMS outperformed currently available binary mode systems, with average fuel savings of 11.9%. Qi also said that the system gets smarter the more it's used and is not model- or driver-specific, meaning it can be applied to any PHEV driven by any individual.

Electric Aston plan

Aston Martin is collaborating with LeEco, the Chinese backer of electric car start up Faraday Future, to develop a production version of the Aston Martin RapidE electric vehicle concept. The companies also said that there was the potential for adding a range of next-generation connected electric vehicles.

In January 2016, LeEco and Aston Martin revealed the first results of their partnership – an Aston Martin RapidE S. The companies have accelerated their plans to develop low emission vehicle technologies as they plan to launch a range of electric vehicles during the second half of the decade.

The RapidE concept was created to explore how the company can take an existing production vehicle and create an all-electric sports sedan. Since the creation of this concept vehicle, Aston Martin has been advancing the work on production feasibility including the identification of technology solutions for battery systems and powertrain. The companies will bring the RapidE to market in 2018.

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.

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115281
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114985
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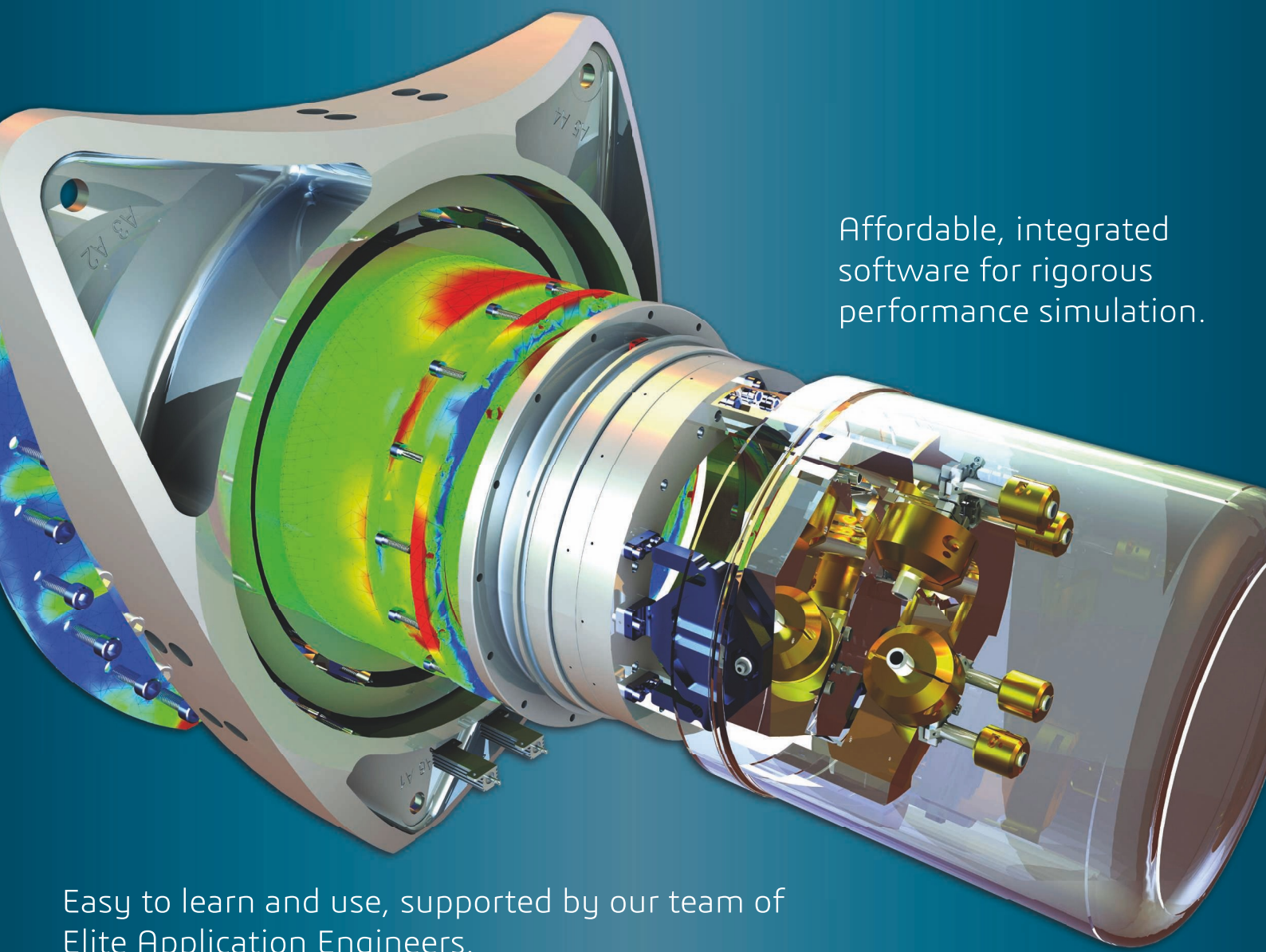

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NEWS

Pipeline drone *does good*

The 'Buildrone' team from Imperial College London has taken first place the United Arab Emirates' National Drones for Good Award, beating over 1000 submissions from around the world. The Imperial Team's drone is able to 'print' material to seal leaking pipelines.

The Buildrone team, part of Imperial's Aerial Robotics Lab, was led by PhD student Talib Alhinai (pictured). The competition was an initiative of the United Arab Emirates, which aimed to bring together the innovative technologies behind civilian drones and show how they can be turned into practical solutions for improving people's daily lives. Alhinai said: "Compared to current methods where humans have to maintain pipelines, our approach offers major time and cost savings while simultaneously reducing risks to engineers when doing inspection and repair tasks."

The drone carries out its repairs by depositing liquid polyurethane foam on a leaking pipeline, which takes less than five minutes to fully expand and seal the area. This technology could be especially useful in the energy and chemical industry where oil spills in vulnerable environments, leaks from explosive methane gas in cracked pipelines and toxic chemicals escaping supply pipes pose a risk.

Design in the EU

The Office for Harmonisation in the Internal Market (OHIM) has announced that applications are now open for the inaugural DesignEuropa Awards.

A report produced by OHIM and the European Patent Office showed that design-intensive industries generate 12% of all jobs in the EU and almost 13% of its GDP, and that companies that own designs have, on average, revenue that is 31% higher per employee than firms that do not.

The DesignEuropa Awards have three categories: Industry (firms with more than 50 employees and/or over €10million turnover); Small and Emerging companies (firms with fewer than 50 employees and/or less than €10m turnover, or companies established after January 1, 2013); and a Lifetime Achievement Award.

Application close July 15 2016.

Simulation Knowledge Bank launched

Eureka Magazine has launched a new website called *'Eureka Knowledge'* that brings together a unique blend of application stories, helpful whitepapers, instructional videos and insightful blogs on a variety of topics tailored for the UK's design engineering community.

The aim is to provide content that informs engineers with the latest technical information to make designs more efficient and projects a commercial success.

In the first of a series of subjects, *Eureka* has teamed up with ANSYS and COMSOL to explore the world of simulation in more detail. Simulation is no longer for specialists and is fast becoming a tool for every engineer, project and industry. Getting it right will see a reduction in design time, identify potential problems earlier and assess real world functionality before physical prototyping even starts.

Each month experts COMSOL and ANSYS will submit the latest information to help you on your way to becoming better and more proficient at simulation, as well as offering tips from industry pros. Find out more by going to the website.

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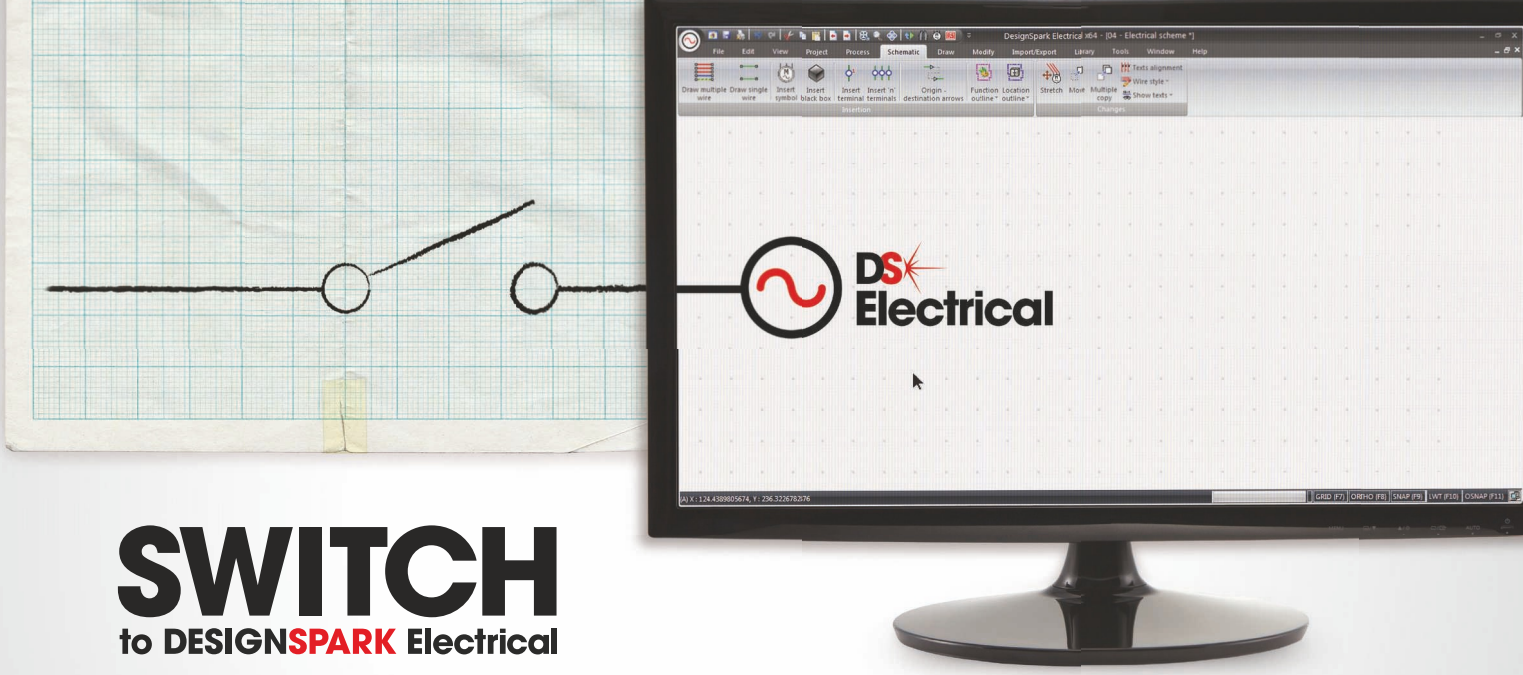

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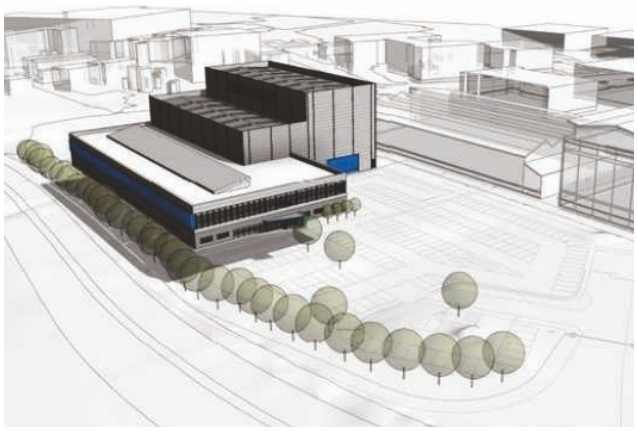
NEWS

Airbus announces UK wing centre



Airbus will open a wing development and test centre at the company's existing Filton site. Due to open in 2017, the facility will develop and test large structural parts, housing around 300 highly-skilled engineers. In addition, it will have an 'open door' policy where external organisations can make use of the equipment and laboratory space.

Facility general manager and human resources director, Mark Stewart said the wing development and test centre has been, "specifically designed to provide the most advanced working environment and tools for Airbus, our suppliers, our partners and academia, to deliver the next generation of aircraft wing, landing gear system and fuel system designs."

Airbus' Filton site was chosen as the location for this facility because it is already home to approximately 2000 engineers who specialise in wing design, as well as fuel and landing gear systems integration. The site also is home to Airbus Group Innovations' 3D printing plateau and digital manufacturing laboratory and the Airbus low-speed wind tunnel, and is close to other research facilities including the National Composites Centre.

Chancellor of the Exchequer, George Osborne joined Airbus chief operating officer Tom Williams to announce a €44.8million joint investment in the wing integration centre.

The facility will house engineers working in early-stage research right through to in-service aircraft improvements, while a team from Airbus Group Innovations is to focus on emerging technologies. They will have access to a physical test environment that will form a proving ground for future technologies, materials and manufacturing techniques, as well as novel and more efficient testing processes.

Company snippets

Rockwell Automation has purchased MagneMotion, whose systems are used across industrial applications including automotive and general assembly, packaging and material handling.

International TechneGroup has announced a formal alliance with DIGITREAD, a value-added reseller of CAD solutions for PLM migration projects.

French naval defence and energy group, DCNS has selected Dassault Systèmes' 3DEXPERIENCE platform to manage the design, engineering, construction and lifecycle of its naval defence products.

Haydale Composite Solutions has commissioned a composite pipe testing facility to assist in the development and approval of graphene-enhanced polymer materials for use in oil and gas pipelines.

NEWS

GSPK Design to develop health tech

GSPK Design has been awarded a £500,000 phase two funding contract to develop a product to aide those with severe disabilities.

The work was commissioned and funded by the SBRI Healthcare programme, an NHS England initiative, championed by the Academic Health Science Networks. GSPK Design in partnership with The Assistive Technology Team at Barnsley Hospital, The Centre for Assistive Technology & Connected Healthcare at the University of Sheffield and the NIHR Devices for Dignity Healthcare Technology Co-operative, will build on work from phase one and further develop a wireless smart switch to help people who have acute brain injury or severe disabilities using tiny electrical signals produced by muscles to engage with their environment.

Managing director of GSPK Design, Paul Marsh, said: "This funding will not only allow us to develop the product to take it through clinical trials and to market, but it will also allow us to implement medical standards into our processes that will not only benefit us, but also our other customers."

Solution to last month's Coffee Time Challenge

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The solution to last month's challenge to produce a smart shower comes from French based start up Hydrao. Displaying its device at the Consumer Electronics Show in Las Vegas earlier this year, the shower head flashes red as the user goes over a 50 litre threshold. The aim, says the company, is to get people to think seriously about water conservation.

The Hydrao product comes as a standalone showerhead that can be retrofit in less than a minute. Inside is an impeller, which is used to both power the onboard electronics and LEDs, as well as measure the amount of water used, avoiding the need for batteries.

As a visual guide to users, the LED in the showerhead gradually changes colour as more water is used. Once a 50 litre limit has passed, it flashes red to suggest it might be time to get out. And, like all things smart it comes with a corresponding app to allow users to track water use over time, change the upper threshold and see any savings that have been made.

The company reports that Hydrao reduces water consumption on average by 25% and will cost between £60 to £80.

www.hydrao.fr/en/

Laser cutting 3D in multiple materials

A team of researchers from Rice University has created a 3D printer that uses lasers in order to create more complex objects than traditional devices from a range of different materials.

The printer uses a modified, commercial-grade CO_2 laser cutter to create OpenSLS, an open-source, selective laser sintering platform that can print intricate 3D objects from powdered plastics and biomaterials.

Ian Kinstlinger, study co-author, said: "Designing our own laser-sintering machine means there's no company-mandated limit to the types of biomaterials we can experiment with for regenerative medicine research."

The people's car – *not for sale!*

Not only has Riversimple designed a striking new hydrogen-powered car, it is challenging the conventions of car ownership. Tim Fryer investigated the new project and found out that the business model has a profound impact on design.

Striving towards energy efficient transport has been a goal of the automotive industry for decades. Whether driven by high fuel costs or reduced emissions, it is clear that all of us, even those who still prefer larger cars, are concerned about fuel efficiency.

Technologies have improved the efficiency of the petrol engine, while electric engines have also progressed particularly with incremental improvements in battery technology. The hybrid of the two is claimed by some to offer the complementary benefits of both, meeting both environmental regulations and personal practicalities. However, such vehicles are still defined by their initial specifications, typically mpg and range, and this does not necessarily encourage car makers to produce cars that are genuinely environmentally advantageous. Eye-catching mpg figures may encourage sales of a car for environmental reasons, but if that car rapidly degenerates to scrap then it ceases to be a 'green' choice. And this is no longer of any concern to the manufacturer.

'Whole system design' is a philosophy being deployed by Riversimple that ties together car design, business model and environmental performance. The resulting design was unveiled last month and Riversimple's (former) powertrain architect Dr Nicholas Sergent answered the question 'what is whole system design?' "It's optimising a whole system instead of optimising parts in isolation," said Dr Sergent. "If you optimise parts in isolation, you can do a very, very good job, but you might end up with an overall system that's 'pessimised', not optimised. If you look at your whole system and look at the overall impact of each decision you make on every single component design or engineering business model, you end up with a different system that can be more optimised and achieve what you want to achieve better."

In such an interlinked process it is not easy to identify a starting point, but Riversimple took a 'well to wheel emissions' approach [the total emissions from extracting the energy to driving on the roads] for all of the basic technologies - petrol, diesel, hybrid, different types of batteries and hydrogen. Dr Sergent said: "For example, advocates of the battery car say it has got a fantastically efficient powertrain.

"However, you still need a very big battery to get any decent range, so you end up with a very heavy car that needs a lot of energy to move around. You can have a very efficient system that overall uses more energy because it's heavier. So we really looked at everything to try and make a car that would be the most fuel efficient possible with the possibility of zero emissions, if you can have 100% green fuel. Having looked at all powertrain options, we decided that building a hydrogen fuel cell car from scratch would be best."

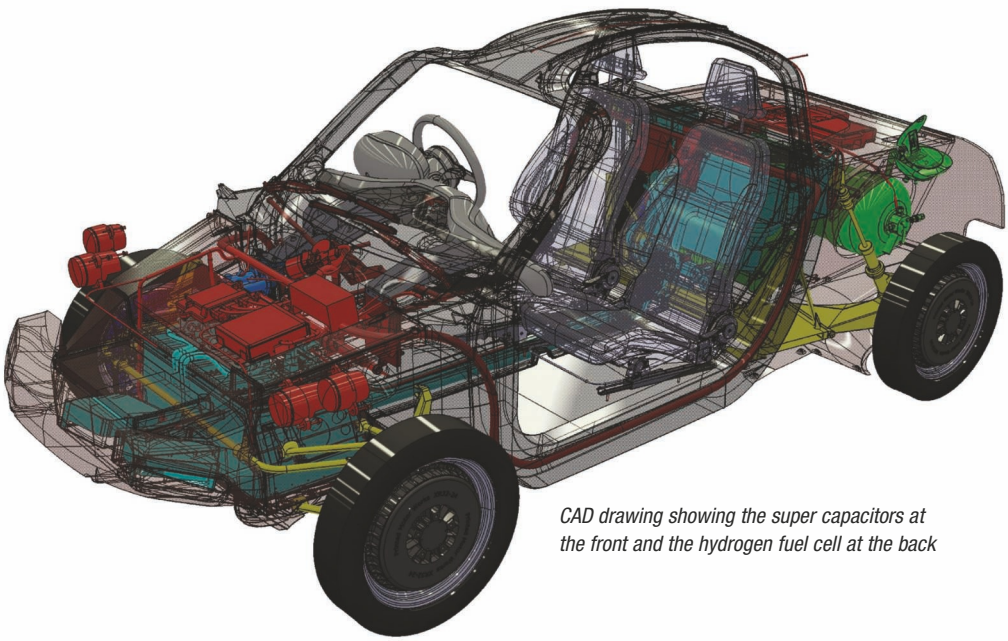
Hydrogen fuel cells

Power demand was also analysed. Cruising on a motorway at regulation speed doesn't take much power, just enough to overcome drag and road resistance. Virtually all cars are now capable of driving at higher speeds, 100mph or more, and that takes considerably more power, although we should assume that no *Eureka* readers ever drive this speed in the UK. Acceleration also requires a lot of power, but most of the time we drive at fairly consistent speed. Dr Sergent summed up: "You end up most of the time cruising at a normal top speed, maybe 60 or 70mph using not much of your engine, and carrying an enormous lump of iron or aluminium that you don't really need."

To remedy this the Riversimple team looked at decoupling the power needs for cruising and those for acceleration. It ended up using a relatively tiny fuel cell for constant power for cruising, and a bank of super capacitors to give enough power to accelerate and for that extra grunt uphill, and also to reclaim energy during braking.

"It means our powertrain is much more tailored to real needs," said Dr Sergent. "It's much smaller, it's also cheaper than having a great big fuel cell or great big batteries to do all this. And what we ended up with is something called the network electric powertrain." [See Fig 1]

There is a fuel cell at the back, a bank of super capacitors at the front and four in-wheel electric motors, one in each wheel. The energy can flow in any direction except back to the fuel cell. During acceleration power can be drawn from the capacitors or from the fuel cell. During braking, energy goes back into the capacitors, which results in a powertrain that is both efficient and lightweight. Comparable vehicles might have a 100kW fuel cell, whereas

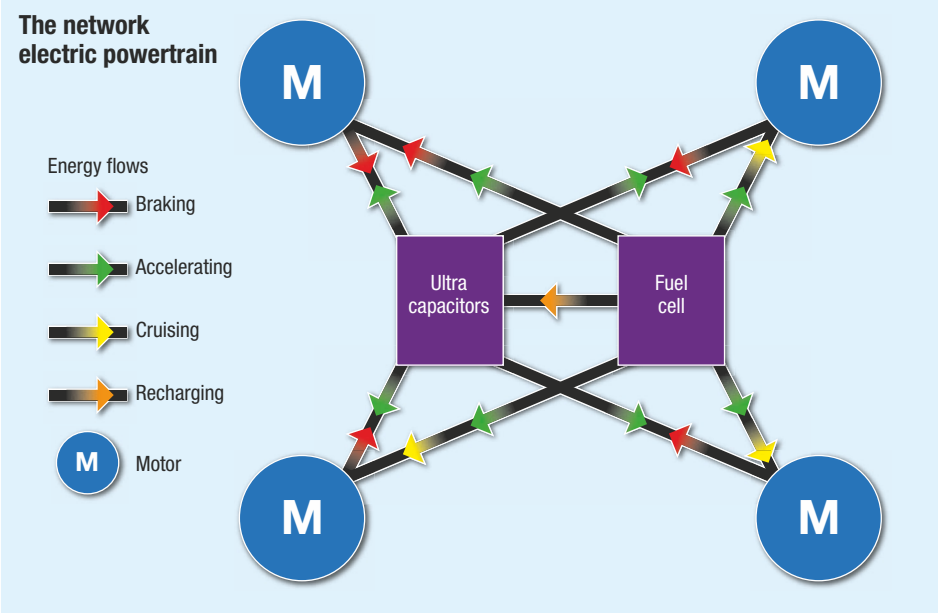


CAD drawing showing the super capacitors at the front and the hydrogen fuel cell at the back

the Riversimple vehicle – called Rasa - uses an 8kW unit – just enough to keep cruising at top speed.

The hydrogen fuel cells are nothing remarkable in their own right, they are production units from Canadian company Hydrogenics that are commonly used for forklift trucks. The electric in wheel motors are produced by Printed Motor Works. Dr Sergent said: "We've got all sorts of interesting little creations in this vehicle. For example, the seats are from a British company called the Seat Design Company. It's extremely lightweight, weighs less than 10 kg, and it's made of carbon tubes, aluminium nodes and a lightweight foam. So we've really looked at everything and tried to make it as efficient and as light as possible altogether."

In fact the whole car, in its current pre-production form, is structurally constructed of carbon fibre and therefore extremely lightweight, topping the scales at under 400kg. It is another example of whole system design in action - having a light chassis means that it requires a smaller engine to move it around, which means it can have lighter chassis. The consequence is a two-seater vehicle with an



equivalent fuel consumption of 300mpg.

Rasa, unveiled this year, has been styled by a design studio in Barcelona by head of design Chris Reitz, whose design credits include the new Fiat 500. By the time it becomes a production version its headline specifications will have softened slightly to a weight about 520 kg, offer the equivalent of 250 mpg, and have an adequate 300 mile range. It will also take only three minutes to refuel, because it's hydrogen.

"And it will look cool and be fun to drive," added Dr Sergent, who has taken a step back from the company following Rasa's launch.

Control electronics inside the Riversimple Rasa

Business and design model

This is only half of the story however, because the business model that Riversimple has developed had a profound impact on the design. "We have decided we will not be selling this car," said Dr Sergent, "we will be selling mobility."

This means that customers, instead of buying the car, will pay monthly for a service, and this payment will include all the costs of motoring - the car itself, the insurance, the road tax, MOT, all the repairs, and even the fuel. It is intended to provide peace of mind for the driver who can keep a car for as long as they want before moving on to the next one. However, Riversimple will retain ownership of the car and will still want it to generate revenue for its projected lifespan, which may be 15 years or more.

"When you design a car for this business model, you design it differently," said Dr Sergent. "It means that we've got a direct business incentive to make the car as robust as possible, as cheap as possible to maintain, and as fuel efficient as possible. So we basically have a direct business incentive to make good cars, cars that will last forever, that won't break down, that won't have bits that fall off, because we pay for all of this."

Even at the end of life there is an incentive for the company to have a car that can be recycled or remanufactured – it is the opposite end of the spectrum to car makers who need their customers to buy new cars every few years.

The carbon fibre might be an expensive option for some production cars, but it is inert, won't rust, and the company could get 30 or 40 years use out of it. Also the Rasa doesn't have moving parts in the usual sense – there is no driveshaft, so no lubricants and wear should be far less than in a typical car. Dr Sergent continued: "When you look at the whole system design including the business model, you end up with different engineering decisions, and you can make a system that's more profitable and better for the environment. We're going to make it more and more fuel efficient because it's in our business interest. So you align the interest of the environment, the customer, ourselves, and the whole industry."

It also accelerates technology deployment. Dr Sergent said: "OEMs, need to wait for fuels and technology, battery technology for example, to be as cheap as diesel cars before people will buy them in volume. And we don't need to do that. We can afford slightly more expensive technology, because we make money through the entire life of the car - we can have a commercially viable proposition much earlier in the life of the technology. Today we have a commercially viable fuel cell car with carbon fibre while OEMs can't do that because it would be too expensive for them."

This leasing model for the cars is a philosophy that could be equally beneficially applied to the cars components, although this is not currently the case. Ideally from the perspective of the component supplier, they would like to be selling a new component every five or ten years, but if that component was leased, rather than sold, it would be in the suppliers interests to make components that were both robust and recyclable. "We know we're not going to get there straightaway, and all the business currently works without this," admitted Dr Sergent, "but if we could push our suppliers to consider this whole sale of service model, that would be extremely helpful."

The Rasa has a top speed of around 60mph and is described as a 'local' car – for people going to work or to the shops, maybe needing to fill up once a week. The idea is that a fleet of cars could be introduced to an area serviced by one fuelling station. This is then a commercially viable step forward without having to start out with a fully nationwide network of fuelling stations. The infrastructure can build gradually from all these local schemes without large initial investment from either government or gas companies.

The plan for this year is to build 20 cars for a public trial which will probably be in Plymouth and run for 12 months. At the same time the company will continue to develop the car so that it will be in production and ready for the public in 2018.

riversimple.com

CAD gets emotional

CAD software is evolving to meet the diversifying needs of multi-disciplinary engineers. Certainly this means constant tweaks to functionality, but it also needs to take in the bigger picture. Tim Fryer asked Solidworks' CEO, Gian Paulo Bassi, to bring this picture into focus.

"I think we are at an inflection point," said Bassi. "The meaning of design has changed, but also the meaning of how design happens has changed. Products are not designed any more to provide a specific function. Products are designed to provide an emotional attachment, to provide an experience."

According to Bassi, collecting intelligence about the customer base – the way it is collected and how it translates to providing this emotional response – will provide the fundamental inspiration for the next generation of great designs.

"Design in the future cannot be done in isolation," he said. "Innovation has never been in isolation anyway, but today we have this fantastic technology, the 3D Experience platform, that is designed to connect all the dots that were missing. So it's not only about applications any more. It's about people, it's about infrastructure, it's about data."

Wrapping this together can result in design and manufacturing moving ever closer to the point of sale as the customer can tap into the flexible design environment to customise a product to meet individual tastes and requirements. A nice model for consumer goods perhaps, but is it applicable to more industrial environments?

"Mechanical engineers, especially in small firms, want to create beautiful things"

"This is interesting," observed Bassi. "I visited a crane company who was showing off its beautiful panels for the controls to the crane - really beautiful, fantastic materials, they put a lot of attention on the light, on the reflection. They told me not to question their attention to industrial design for this type of equipment, because that is today's competitive advantage.

"In a chemical plant perhaps aesthetics and emotions are not extremely important. But there is a very large part of the engineering world where consumers are involved. For everybody else what's still important is safety, time to market, precision engineering and so on. We're not forgetting about those things."

However, the launch of such tools as Conceptual Designer and Visualize – the latest addition to the Solidworks suite – help bring the 'designing an experience' philosophy to an individual engineer. It allows companies who might have outsourced industrial design to bring it back inhouse to a more convenient and responsive environment.

Bassi continued: "I think mechanical engineers, especially in small firms, want to create beautiful things. They have these aspirations. They want tools to make beautiful things themselves rather than leaving it to industrial designers. Regardless of the level of beauty that a product has, there are many things that are related to the experience.

"Even for the crane operator, if in some light conditions you don't see what the LED tells you, well, there are safety concerns. So your emotional connection comes from the fact that a very well designed product gives you the peace of mind to know that even if you are in poor lighting conditions you know exactly what's going on in your machine."

The other unmistakable trend that is on everyone's lips is that of the Internet of Things, or Industry 4.0 if that is your preferred terminology.

"We're not chasing the world," claimed Bassi. "The infrastructure for Internet of things is huge. There are big guys like Amazon into it, so I don't think we want to compete with them.

"We focus on design, which is our speciality, our passion, and our competence. But the Internet of Things means a lot of electronics. We are putting a lot of attention on the electronics and we have announced our strategic relationship with Altium."

Altium is working with Solidworks to create Solidworks PCB, an electronics design package that will be released in the middle of this year.

Bassi added: "It makes a lot of sense to say, let's create the best integrated products. So electrical, electronic and mechanical can all happen simultaneously in a very beautiful environment. That is our strategy for Internet of Things."

Other technologies creeping onto the CAD agenda are augmented and virtual reality, a loose distinction between the two being that for a virtual reality experience you need to wear special glasses.

Bassi ventured: "The more you have augmented reality, the more it takes over and does things that all of a sudden become real [i.e. virtual reality]. So I think there is a blurring there. There are benefits in both. Before you do something, you want to see, you want to make, you want to practise something, or if it does not exist in virtual reality, you want to see a model and that's augmented. You put your iPad up and suddenly you can see inside things.

"I like those applications. They are not huge, but there is a lot of interest from big companies, because they see this becoming the future. I don't see those things being massively used but maybe there is a inflection point here, and at some point they will explode."

CV

Gian Paolo Bassi has more than 25 years of experience in 3D, CAD, and PLM industries. He spearheads the development of SOLIDWORKS future product and technology strategies designed for the desktop and the cloud, and collaboration with the user community. He most recently served as the vice president of research and development, where he was responsible for the development of SOLIDWORKS' cloud applications.

Prior to SOLIDWORKS, Bassi was the founder and CTO of RIWEBB where he oversaw the development of new technologies for the Mechanical and Architectural Design Automation industry, collaborating with companies like Dassault Systèmes. Prior to RIWEBB, Bassi served as vice president and CTO of ImpactXoft, where he led a team developing functional modelling and collaboration applications, which are now part of CATIA. In this position, he co-invented three of his five patents in functional modelling. He holds a degree in Mechanical Engineering from the University of Bologna.

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Making the most of **AM**

A new Cambridge University-led project is aiming to shake up the world of additive manufacturing (AM) by developing an innovative set of rules to guide process selection and design optimisation for cost effective industrial part production. So, what exactly will the project entail? What are the key expected outcomes? And what might be the potential applications for broader industry? Andrew Williams finds out.

In the last five years, we have seen AM technologies move from being professional prototyping equipment to becoming almost consumer goods. Despite this remarkable progress, as well as the development of several successful applications in one-off, highly technical or customised products, AM technology has not yet been widely applied in the production of industrial products.

Moreover, according to project leader, Dr James Moultrie, senior lecturer in Design Management at the Institute for Manufacturing (IfM) at the University of Cambridge, the popular claim that 'everything can be made with AM' is misleading. In his view, even if the technology brings several advantages that are not possible with other manufacturing technologies - such as producing 'near-net shape' components at low production volumes, eliminating tooling or design change costs, eliminating stock holding or minimum order sizes, reducing assembly effort by component integration and creating components that use significantly less material - the reality is that these advantages cannot be easily exploited without requiring a set of advanced skills and knowledge in 3D modelling and AM technology.

To address this challenge, Moultrie revealed that the new ESPRC-backed Design for Additive Manufacturing (D4AM) project will aim to develop a set of design rules to guide process selection and design optimisation for cost effective AM. In doing so, the project team aim to work from the perspective of the designer - and hopes to challenge the preconceptions that 'anything can be produced' using AM, whilst at the same time convincing sceptical designers that AM can be an economically viable manufacturing option when properly selected and applied.

AM offers the potential for designing products differently, but success will be helped by following the design guides

"Thus, we hope to add AM into the designer's menu of manufacturing choices and provide sufficient design guidance to enable the appropriate process selection based on functional, technical and economic criteria," said Dr Moultrie.

Two Stage Process

In order to explore the use of additive manufacturing technologies as mainstream production technologies, the project team plans to carry out a series of different research activities centred on two main stages. In the first stage, it will seek to collect and review the current knowledge on design for AM by analysing the relevant academic and non-academic published material and the technical capabilities of current AM machines. It will then investigate design practitioners' experience, knowledge and awareness of AM as a production technology. In the second stage, the team will move on to the development of the design principles themselves.

One of the D4AM projects co-investigators, Dr Richard Bibb, reader in medical applications of design at Loughborough University, said: "This will be achieved by synthesising the results of the previous stage and testing them in a series of experiments to evaluate their applicability to different processes and machines. Finally, we will also explore approaches to effectively communicate those principles to professional designers and industry."

Bibb also pointed out that a number of other research projects and initiatives around the country are currently focusing on the technological development of AM - with examples including the EPSRC Centre for Innovative Manufacturing in Additive Manufacturing, the University of Nottingham-led Centre for Doctoral Training in Additive Manufacturing and 3D Printing and the EPSRC Bit-by-Bit project - and he hopes that the D4AM project will contribute to this ongoing effort and the future developments of AM technology by 'adding the perspective and the needs of the designers.'

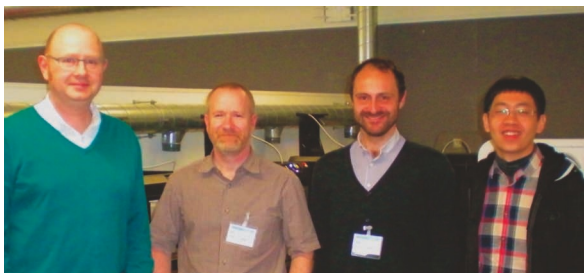
In terms of the anticipated long term impact of the research, D4AM project member Dr Zicheng Zhu, research associate in Design for Additive Manufacturing at the University of Cambridge,

considers the D4AM project as a pilot that 'will lay down the basis for future investigations.' Future studies will extend the outcomes by exploring the latest developments in AM technologies, multiple materials, metals, composites structures and eventually other emerging digital production technologies. The project will also inform the ongoing PhD projects at the Design for Digital Fabrication research group at Loughborough University and the Design Management Group at the University of Cambridge.

The expectation is that industrial partners, as well as academia, will benefit from the research carried out as part of the project - and that the new design principles will provide a tool for process selection and optimisation, which will in turn 'facilitate the implementation of AM advantages in design and production processes.' Dr Zhu said that presentations at 'prominent companies and events in the UK and internationally' will also be an integral part of the project and will continue 'well beyond the funding period.'

The results of the study will also inform the existing taught courses at Loughborough University's Design School and Wolfson School of Mechanical & Manufacturing Engineering, as well as the Manufacturing Engineering Tripos at the University of Cambridge.

"In addition, appropriate teaching resources will be developed and made available to education and industry partners, including online copyright free resources composed of documents, videos and CAD files," added Dr Zhu.



The D4AM Team (left to right) Dr James Moultrie, Dr Richard Bibb, Dr Patrick Pradel and Dr Zicheng ZHU

Although he is very confident about the long term usefulness of the project outputs, D4AM project member Dr Patrick Pradel, a research associate at the Loughborough University Design School, admitted that developers are still likely to face a range of challenges in using AM methods.

He said: "There is currently a lot of excitement surrounding AM - and there is little doubt that these new manufacturing technologies provide opportunities to make things that would be impossible with conventional production methods. However, even for experienced designers, those opportunities do not always match their experiences."

In his view, there is also still a 'genuine mismatch between what is believed and what is achievable' and, for designers to take full advantage of AM, he believes they need the ability to 'discard some hard-learnt design rules and appropriate a new set of rules targeted explicitly towards AM.'

"There has been some work exploring the design implications of AM when applied to artisan, craft, fashion goods or very low volume production," he added. "The majority of research is from the perspective of manufacturing technologies in the laboratory. In reality, AM remains critically under-used as a mainstream manufacturing process."

Looking ahead, Dr Pradel highlighted the fact that, as an integral part of the research, the D4AM team is also looking at different communication approaches that can be used to effectively convey the design principles developed as part of the project to professional designers and design engineers. For instance, he said that the findings of the research 'could inform the development of new tools and functions in CAD software that can assist with the application of design rules.'

In terms of potential markets and applications, Dr Moultrie also revealed that the project team is targeting the 'wider field of industrial, product and engineering design as applied to complex, multi-component domestic, professional, industrial and scientific products.'

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Andrew Williams is a freelance journalist

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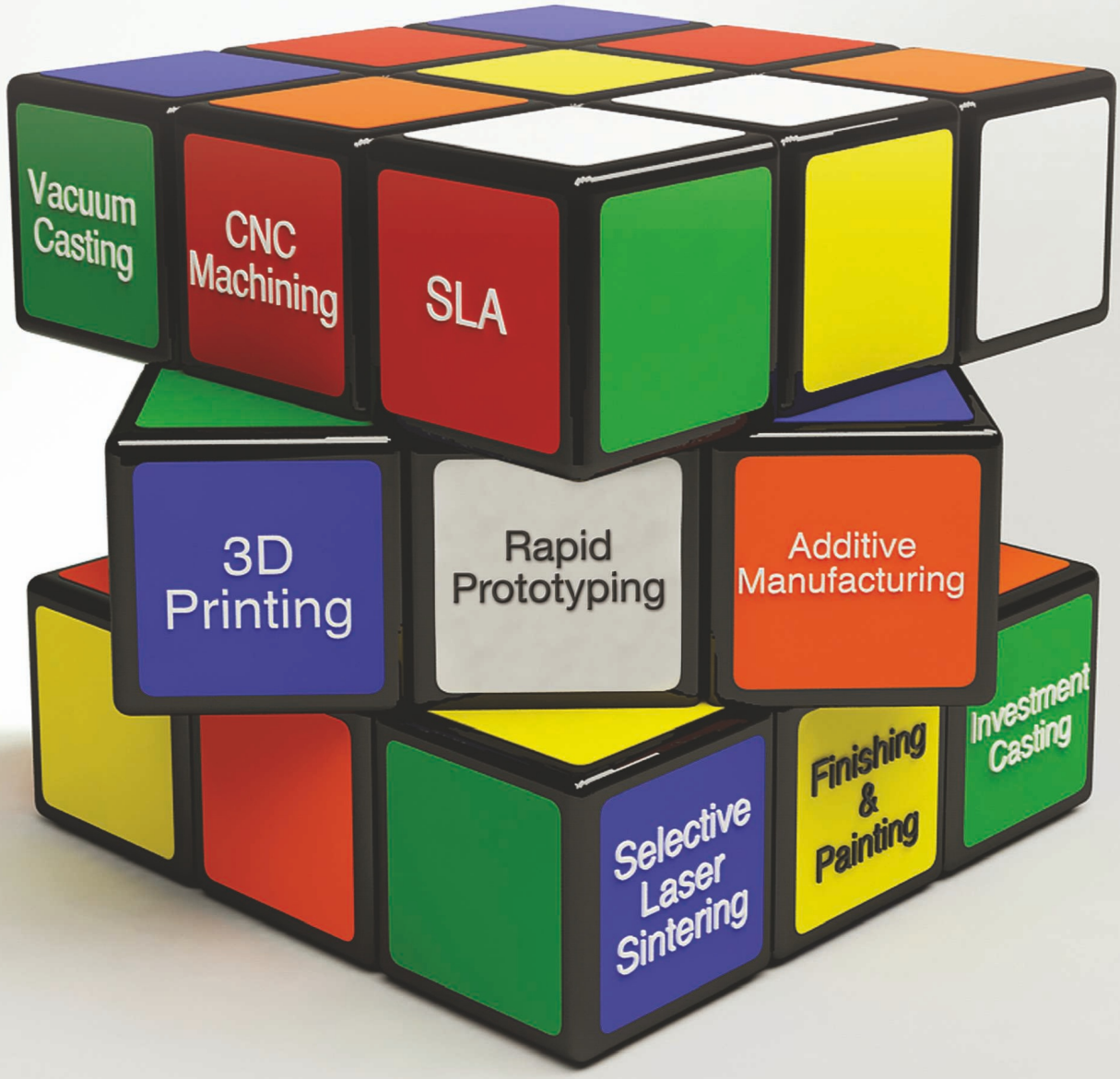

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True colours

Getting colour into a 3D printed part is not easy. Ground has been broken, claim Stratasys and Adobe, who have partnered to find a solution. Tim Fryer reports.

Additive manufacturing is now regarded as a technology that most of us are familiar with. But it is not really a single technology; more of a set of technologies with different levels of relevance for different circumstances. Some of these technologies are more embedded than others, although still mostly in a prototyping environment. But the technology required to produce realistic colour 3D models has been noticeably lagging.

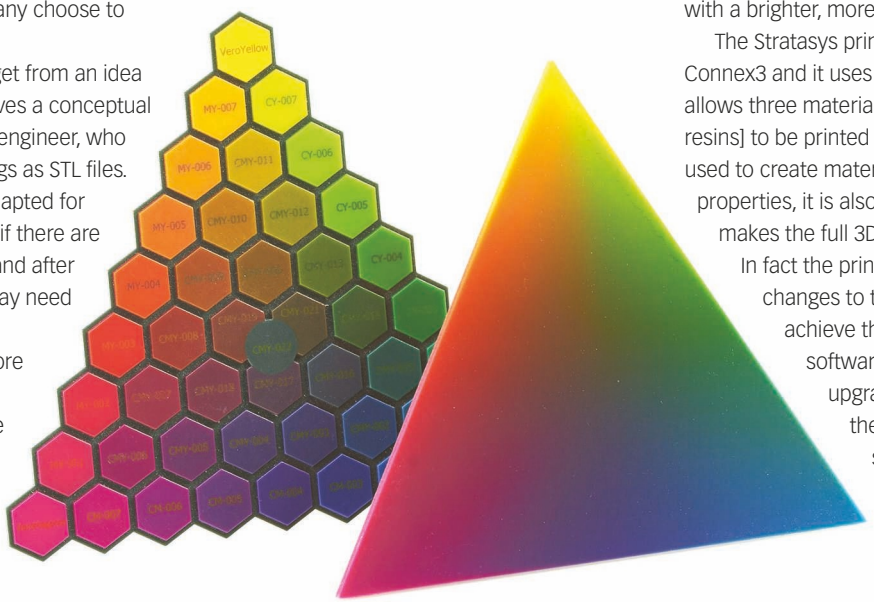
Part of the reason for this is down to the lack of suitable 3D printing equipment and partly, according to John Gould, Stratasys President, North America: "To really mass adopt 3D printing we have to simplify the workflow. Today 3D printing is still too complex. Many times you need to be a CAD engineer to really understand the end to end workflow, and many choose to not adopt."

He described a workflow to get from an idea to 3D printed object which involves a conceptual drawing being passed to a CAD engineer, who then passes engineering drawings as STL files. These in turn may need to be adapted for the particular printer or printers if there are multiple materials and colours, and after printing the parts, those parts may need to be post-processed – cleaned, smoothed and assembled – before going to a paint shop. While this obviously takes in every possible step in a complex process, it makes the point that colour 3D printing is not straightforward.

That is, until now, claims Gould.

Reducing this process to a two stage procedure – design and print – has come about due to a software development forged by Stratasys and Adobe. The resulting solution has been named 'Stratasys Creative Colours powered by Adobe's 3D colour print engine'.

Rather than being limited to 46 colours, there is now a full palate of over 1000 (right)

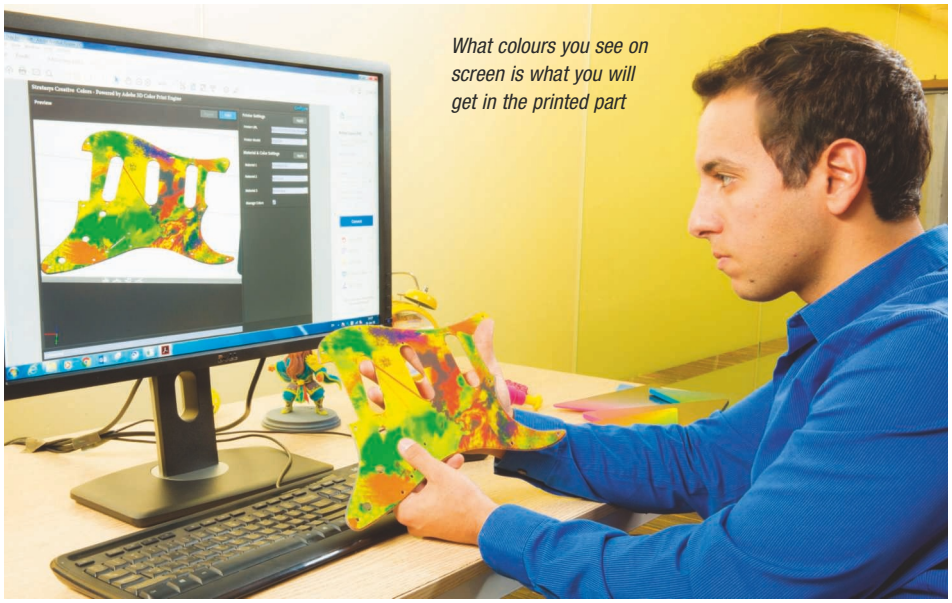


"What we're able to do is to take Adobe's understanding of how three colours can be mixed," explained Mike Scrutton, director of product development for 3D printing at Adobe. "The change effectively with the new software is rather than somebody having to pick one colour effectively from a swatch of 46, you can now 3D paint in an application like Photoshop, in any colour you like."

Bright innovation

What helps is that Stratasys has introduced a couple of new materials - Vero PureWhite is a rigid, opaque white, producing 20% more brightness and UV resistance than the current VeroWhite. And, VeroCyan has been improved with a brighter, more vibrant appearance.

The Stratasys printing platform is called Connex3 and it uses a PolyJet technology that allows three materials [photopolymer based resins] to be printed at once. While this can be used to create materials with specifically tailored properties, it is also the same technology that makes the full 3D printing in colour possible. In fact the printers themselves require no changes to the hardware in order to achieve this colour capability, it is the software that needs to be upgraded. This will be offered in the coming months as standard on new Connex3 printers and available as an upgrade in the interim.



What colours you see on screen is what you will get in the printed part

"It is exactly like any inkjet printer," said Leslie Frost, marketing communications manager of Stratasys. "This machine has eight different heads, and each head has multiple microscopic nozzles that inputs droplets on the platform, just like you would with an inkjet printer."

Each colour has two heads and two further heads print support material. A full range of colours will only be available if a five-colour (red, yellow, blue, black and white) machine is developed. Is this on the horizon? "I'm sure that is something that is being looked at and worked on," said Frost. "Limiting yourself to three materials and three colours is somewhat limiting your palette. So I'm sure that something is going to come out in the future. I just don't know anything as of right now."

For the time being, the Creative Colours software is going to change colour management for the CAD user. "What we're able to do within Adobe Photoshop is take our knowledge of how these materials combine inside the Connex3 and effectively give that information to the Photoshop user," said Scrutton. "We can help guide and in some ways constrain their use of colour in the application so that you know that the colours you're picking are achievable on the printer with these materials."

The new software now allows over 1000 colours to be used. Just as importantly, claimed Scrutton, there will be no surprises when the colours are printed: "We've actually taken Adobe code, Adobe technology, and put it inside [the Stratasys] printer. And the good thing about that is that it means it's exactly the same code inside Adobe Photoshop that our designers have. It's exactly the same code inside of Adobe Acrobat and Adobe Reader, which is what your clients used to preview that PDF." In other words – what is printed out is the same as what was seen on screen.

"Everything that you normally do in Adobe Photoshop, now you can apply to 3D printed parts," continued Scrutton. "You can pull in an image, you can do textures and different gradients and everything. So it adds a whole different layer to what the designers are going to be capable of using to design."

www.stratasys.com
www.adobe.com

Paper progress

There are not many full colour solutions currently open to the 3D printing market, but one of them has been Mcor's novel paper-based technology (see Eureka, Dec 2015 'Multi-coloured paper maker'). That technology has now been improved with its new printer ARKe, which is a desktop unit. It will replace the company's existing IRIS range, offering a substantial saving in outlay (from approximately £10k down to £6200), a fourfold speed improvement and 1.5 better colour resolution.

The principal difference is that in the old machine the sheets of paper were prepared separately and drawn into the machine. ARKe features a continuous roll of paper and all the preparation steps – cutting the paper and applying the adhesive, which also contains the pigment – are done in the single unit. "The idea is that the ARKe will operate just like an ordinary 2D desktop printer that can be accessed by WiFi by everyone," said Dr Conor MacCormack, co-founder and CEO of Mcor Technologies. "We have a bold goal – to put a 3D printer in every office, classroom, and eventually every home, and Mcor ARKe will help achieve this aspiration. A defining launch for our company, the Mcor ARKe will help designers and engineers alike bring their creative visions to life."

Acceptable file formats are STL, OBJ, VRML, DAE, 3MF. Resolution is 0.1mm on all three axis, and colour resolution is 'photorealistic HD Colour'4800 x 2400 DPI in X, Y and 254 in Z (up to 508 in Z with 50GSM paper). Moreover, the main consumable is paper, so it is a very cheap system to run.

mcortechnologies.com

Automation in **silicon photonics**

Creating a silicon photonics assembly system requires sub-um accuracy – not an easy task but it can be done with clever use of automation

Silicon photonics is the study and application of photonic systems using silicon as an optical medium. Silicon photonic devices can be made using existing semiconductor fabrication techniques and because silicon is already used as the substrate for most integrated circuits, it is possible to create hybrid devices where the optical and electronic components are integrated onto a single microchip.

With the demand for faster telecommunications, the need for optical solutions in these environments is on the increase. As such, silicon photonics that can enable data to be transmitted at terabit-per-second rates is increasingly used to act as the connection, not only for long-haul data transmission, but also for on-chip communication, chip-to-chip and chip-to-board. However it is very 'challenging' to position these optical components in any volume on a silicon substrate, and 'challenging' typically means expensive.

Reducing the challenge

To pave the way for cost-optimised mass production it is necessary to automate complex positioning tasks and the associated active measurements. The various components for manufacturing semiconductor chips can be produced with common commercial equipment. However while production at wafer level has cost effectively become highly automated, as soon as you break away from the wafer level to full packaging technology, the costs soar.

The integration of light sources at the wafer level and the connection of the optical inputs and outputs prove to be challenging due to the optical mono-mode glass fibres typically being less than 10µm in diameter and the optical waveguides on silicon wafers ranging from 200 to 400 nm in width. Connecting optical mono-mode glass fibres, requires maximum precision in handling, positioning and adjustment as well as the highest possible production speed to serve the mass markets. PI took on this challenge and developed an automated photonic assembly and alignment system. The specialists for micro- and nanopositioning are able to leverage a number of in-house technologies for this task. This resulted in an automated turnkey solution which can be adapted to numerous applications.

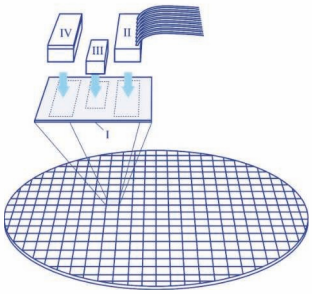


Fig. 1 Chip packaging: silicon substrate (I), fibre connection (II), external laser source (III) and flip-chip bonds (IV)

In Fig 1, a silicon chip already diced from a complete wafer is assembled in a ceramic package and optical elements are then bonded to it, for example, a fibre array, positioned with sub-µm accuracy.

The micro/nano positioning vision-guided robot picks up the components and places them on intermediate holders. Then the photonic components are positioned with high accuracy on the substrate, employing a high resolution image processing system based on cameras in the visible and shortwave infrared range (SWIR).

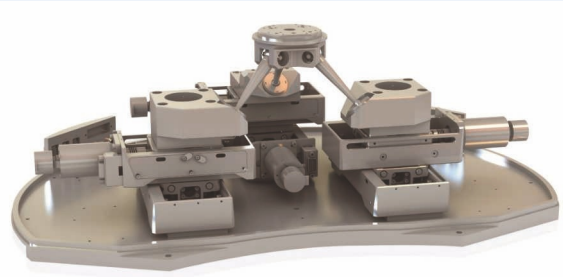


Fig. 2 In contrast to serial kinematics, in parallel kinematic systems all the actuators act directly on the same platform

The task is managed by a combination of linear positioners and micro-fabrication robots operating in six degrees of freedom, the so-called SpaceFAB's from PI.

The Parallel-Kinematic Principle

The parallel-kinematic SpaceFab principle is based on three XY stages that jointly position a platform using three struts with a constant length and a suitable joint configuration (Fig. 2). This enables the realisation of fast and high-precision travel. In contrast to serial kinematics, parallel kinematic systems have all actuators acting directly on the same platform, in other words there is no accumulation of guiding errors as in 'stacked' systems, thus increasing accuracy greatly. But there are also other advantages: for example, low moved mass and consequently better dynamic performance equal for all motion axes, no moving cables to cause friction, and a considerably more compact design.

The XY stages, which were developed especially for applications in optical waveguide alignment, can be equipped with rotary encoders or high-precision glass measuring scales in a closed servo loop.

Controlling the Hexapod is extremely intuitive and enables the user to set an arbitrary point in space as centre of rotation. This freely definable pivot point is maintained independently of the motion, a feature which has proven especially invaluable for optical adjustment.

This method allows extremely precise positioning of the photonic components based on the initial position feedback of the photonics components supplied by the imaging system. This phase is called 'first light' which states that optical signal continuity can be measured and monitored. This is a prerequisite for searching and detecting peaks in the sub-micron range with a high level of accuracy. Successful fine alignment is followed by an automated bonding cycle with epoxy resin. This customised pre-production automated solution for silicon photonics reduces the entire manufacturing process to only a few minutes, which compares very favourably with the usual 40 minutes or more required today for manual production.

With their turnkey assembly and adjustment system, the specialists for micro- and nanopositioning have contributed to a major advance in silicon photonics mass production. It will be interesting to see how the future develops.

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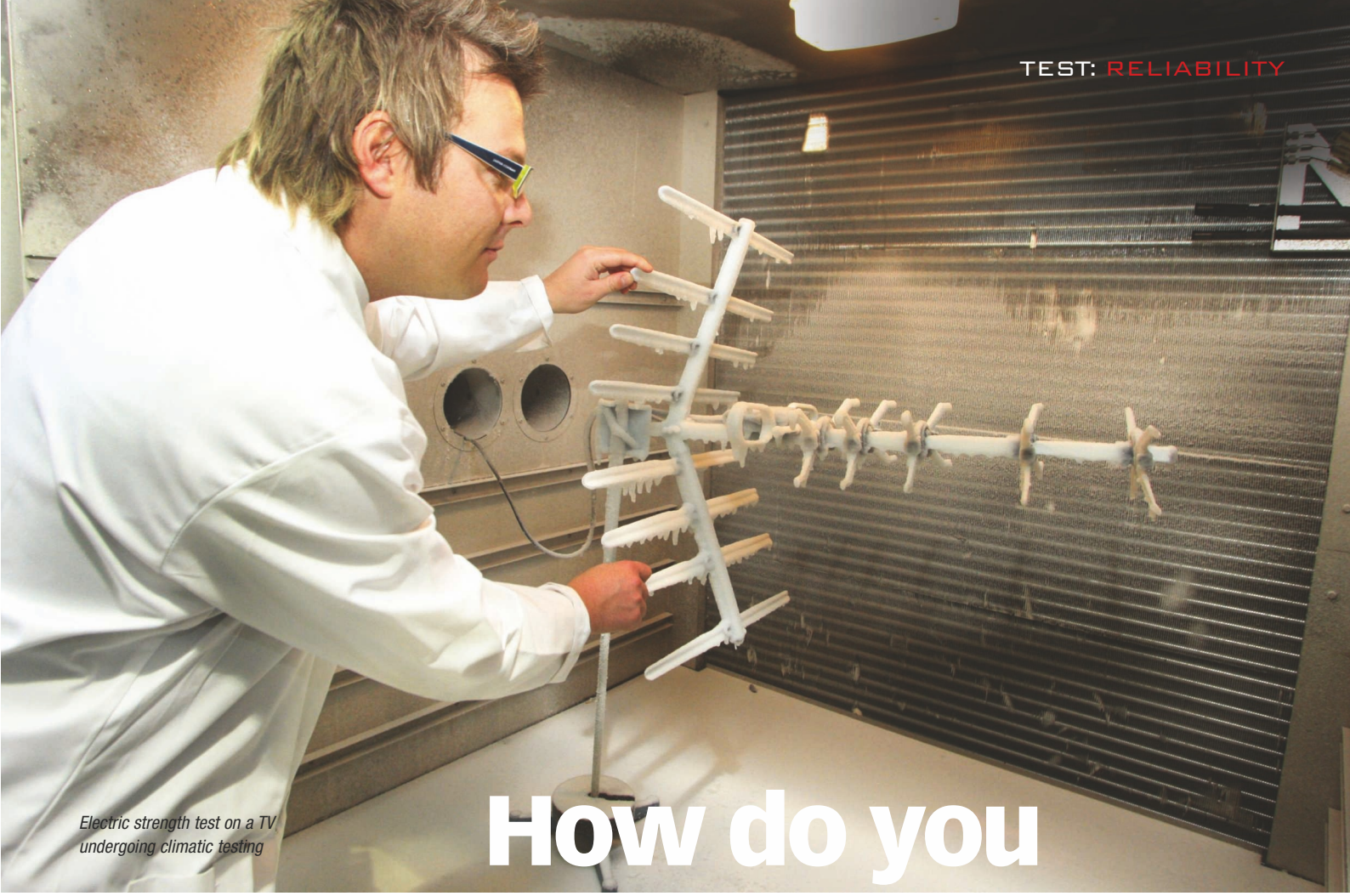


Electric strength test on a TV undergoing climatic testing

How do you design-in reliability?

While there is an expectation that a product will be reliable over its (long) life, the market still demands value for money. Design engineers, claims Jean-Louis Evans, must therefore use test techniques that are fast and cost-effective while also producing worthwhile results that assure product reliability.

The term 'reliability' is internationally defined as the ability of an item to perform a required function under stated conditions for a stated period of time. However, this definition requires some further explanation in order to be a useful guide to the meaning of reliability.

The 'required function' includes the specification of satisfactory operation as well as unsatisfactory operation. For a complex system, unsatisfactory operation may not be the same as failure. The 'stated conditions' are the total physical environment including mechanical, thermal and electrical conditions. The 'stated period' of time is the time during which satisfactory operation is desired and is often called the service life of a product.

There are also different measures of reliability, depending on the application of the end product.

'Survivability' is the probability that an item will perform a required function under stated conditions for a specified period of time, but without failure. Survivability applies only to applications in which failures will not be routinely repaired, whereas the generic definition of reliability does include the possibility of repair.

'Availability' applies where there is the possibility of both repair and failure, and it is a measure of the degree to which an item is in an operable state when called upon to perform.

And 'Maintainability' refers to the maintenance process associated with system reliability and is the degree to which an item can be retained in, or restored to, a specified operating condition.

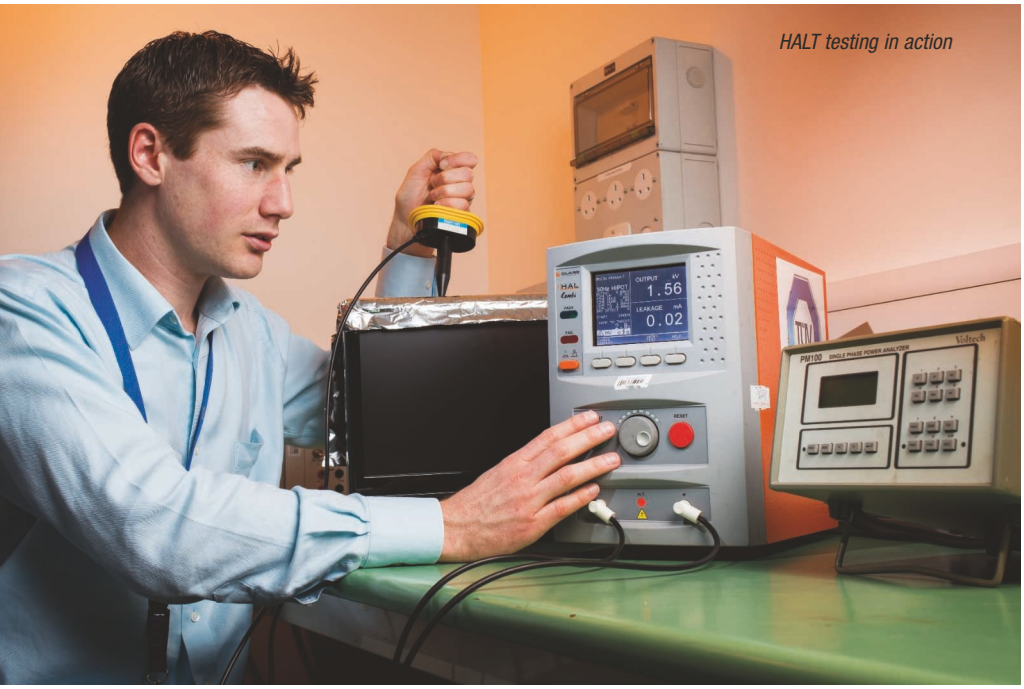
Time to market speed

In a fast moving marketplace, competition for new products means that time to market is a vital factor of success. However, the traditional approach to reliability evaluation has been life cycle testing, which involves tests carried out within the product's 'expected environment' or using actual operational conditions.

However, this is an unrealistic approach for design engineers that need to quickly assess across the product development lifecycle if both prototypes and the final product are going to deliver on reliability.

Accelerated life testing and environmental stress screening have become increasingly accepted as methods of assessing product reliability. Not only do they give a level of confidence that a product will not develop faults after delivery, they also provide a process for the design engineer to identify any design defects or component problems.

Accelerated life testing is based on using real-life operational data, trying to accelerate fault conditions by applying key operational failure-causing stresses at levels above those that the product would experience in its application environment. This accelerated approach allows a



HALT testing in action

distribution of failure times to be obtained, albeit at more stressful conditions than ordinary operating conditions. It also requires the distribution of failure times to be related to the distribution of failure times that would be anticipated under normal operational conditions. This would call for an accelerated life model to be created which is typically characterised by a linear relationship between failure times at different sets of conditions.

The key operational failure-causing stresses that contribute most commonly to the impairment of a product's reliability are:

- Temperature cycling – extending the temperature, (both high and low), to which a product is exposed accelerates stresses due to differential expansion of components and materials. The more extreme the temperature cycle, the higher the acceleration factor.
- Vibration – this promotes mechanical failures and the deterioration of material strength, due to such cyclic stressing, is known as fatigue. If a product's normal operational vibration environment is known, then it can be accelerated too.
- Power cycling – this is the act of repeatedly turning a piece of equipment off and then on again to check that an electronic device reinitialises its configuration and continues operating normally.

The benefit of accelerated life testing is principally that it helps detect the design flaws which are most likely to give rise to a product's 'infant mortalities'. The disadvantage is that this method may precipitate some unrepresentative failures and Highly Accelerated Life Testing may therefore provide the answer here.

Highly Accelerated Life Testing

A key difference between highly accelerated life testing (HALT) and traditional accelerated life testing is that stress factors, such as high temperatures, are applied directly to the component or sub-assembly under test and not to the system as a whole. This can make a great difference in accelerating failure rates. Thermal and mechanical stimuli are also applied separately, and then together, in order to determine the operating and destruct limits of the item under test.

Defect analysis is a key stage in the HALT process and is conducted once the operation and destruct limits have been identified. The operating limit is defined as the point at which the unit remains operational but any further increase in stress causes a recoverable failure. The destruct limit is the level at which the product stops functioning and remains inoperable. This test method has been proved to expose design flaws within hours when traditionally this might have taken many days or weeks using conventional test methods.

History lesson

When designing new versions of an existing product, data from previous reliability tests, as well as in-service failure information from warranty returns, will be available. However, product reliability history can be relied on too much when assessing the next generation. This is because what can be perceived as the slightest alteration, such as the use of different plastics, more up to date electronic components, or a change in the manufacturing process can have a significant impact on the product's reliability.

It is therefore imperative that some form of gap analysis is performed between the known product currently available on the market and the new version under development. The gap analysis data should be mapped onto previous reliability information to gain a clearer understanding of the upgraded product's reliability.

Human error

As all design engineers know, there is no accounting for end-user behaviour. This is where reliability testing can unravel as it focuses purely on product performance and not what people might do to it, as products are often used in ways that the designers never envisaged.

In an ideal world reliability tests should therefore be taken a step further to include user tests in the field. Observations can then be made of how the product might be used and how maintenance will be managed. In the rush to release a product onto the market, this is a key part of reliability testing that is often overlooked, but we are increasingly seeing standards that try to compensate for this element of non-intentional use by the end-user.

As time to market constraints require accelerated testing that cannot guarantee 100% reliability and end-user behaviour cannot be predicted, reliability is difficult to guarantee. However, it is often brand reputation that sets one product apart from another, of which product reliability is a key element. To remain competitive, companies must select the appropriate techniques to develop a product's reliability that are fast, cost-effective, and produce worthwhile results. Without the ability to gauge reliability throughout the design cycle there is no assurance that the final product will meet expectations.

Jean-Louis Evans is managing director at TÜV SÜD Product Service

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DESIGN • DEVELOPMENT • PROTOTYPING • MANUFACTURE

Bringing drive into the design

With energy efficiency a legislative demand these days, engineers using motors are increasingly deploying drives to meet requirements. But is it always the right choice? Tom Austin-Morgan investigates.

With the rise in the efficiency of motors in recent years driven by legislation, is there a time when the drive could be made redundant due to more complex programmable logic controllers (PLCs)? Or, is there a perfect combination - the Holy Grail - for combining motors, drives and PLCs?

Andrew Stephenson, managing director at NORD Drivesystems UK, said: "When designing or operating machines it makes sense to use a drive system that gives the machine the required performance at the lowest operating cost. However, does using the highest efficiency motor with a converter (drive) really give you the lowest running costs? Are there any other elements in the drive system that should be considered? Of course the answer is that it depends on the performance requirements of the machine that is to be driven."

Continued role for drives

Drives allow real-time management of a system but are not particularly flexible. On the other hand PLCs enable multi-domain functionality — including logic, motion, HMI and process control — giving a greater range of control.

Jonathan Smith, field business leader for drives at Rockwell Automation, said: "Will drives be removed from the equation? Not in my

Large-scale case study: ABB to power the world's most energy-efficient pulp mill

ABB has signed a contract to supply the complete power and process electrical systems for Metsä Group's bioproduct mill in Äänekoski, Finland, opening in 2017. The mill will produce 1.3million tonnes of pulp per year and bioproducts such as tall oil, turpentine, lignin products, bioelectricity and bark-based solid fuel.

Using over 1000 of the most advanced energy efficient motors, both direct on line connected motors and frequency converter controlled motors, and state-of-the-art power systems, the site is claimed to run the first ever industrial electrical network operating at 33kV. The mill will produce 2.4 times more electricity than it consumes and is designed to produce 1.8TWh of power, representing 2.5% of the electricity produced in Finland.

"We are extremely happy that we can participate in the largest investment in history of the Finnish forest sector," said Tauno Heinola, managing director of ABB in Finland. "Our products will be part of ensuring the mills' high availability, reliability and efficient production, as well as their energy efficiency, fully in line with our company's Next Level strategy."

Small-scale case study: Spray deposition positioning system

The University of Oxford's Department of Materials – Oxford Materials – approached LG Motion to design and manufacture an XYZ gantry positioning and motion control system for a research project using spray deposition to manufacture film energy storage electrodes and devices.

The objective was to provide a cost-competitive mechanical positioning and motion control system that would cover a scanned area of 300 x 300 x 200mm. The integrated modular system's specification called for relatively low speeds, low duty cycle and medium precision to perform the required scanning with a load of up to 3kg.

An open loop stepper motor based positioning system was used based on LG Motion's linear dovetail slides, the XSlide range.

LG Motion also provided a simple GUI front-end program that is said to allow simple entry of scan patterns and spray timings without the need to program which gives easier and more consistent testing.

The Arcus Technology PMX-4ET-SA was selected as an advanced 4-axis motion controller and stepper drive providing linear and circular axis interpolation, a 6MHz step and direction pulse rate for smooth and fine resolution microstepping combined with fast synchronising inputs and outputs for the coordination of motion and external events required for the application.

Flexibility in system design was a crucial deciding factor for the choice of the LG Motion system. The mechanical assembly is modular and the Arcus controller provides quick and simple programming. This flexibility in turn allows Oxford Materials to adapt the system as the research project develops, including the ability to add encoder feedback for position verification should there be a requirement to increase the system repeatability in the future.

opinion. In fact, I think they will get more imperative as time goes on."

Smith said that adding a drive to a motor or PLC may reduce the motor's efficiency by 2 or 3%, but allows more control, increasing the overall efficiency of the drive system. He also explained all three can be interlinked to complement each other.

Stephenson warned that the use of a PLC depends on the application it is being used for. "If the application doesn't require variable speed and the load is constant then in reality you have worse efficiency by adding a converter or PLC."

This is a view echoed by Vasi Karhinen, managing director of ABB Technology: "Simple, low power applications generally only need a motor to control them, because it is just a case of switching the process on or off.

"You would use a frequency converter where you need to optimise the acceleration and deceleration of the motor. This saves a lot of energy each time the motor starts and stops, typically around 40 to 50%."

For applications where the load varies or where external mechanical baffles or valves and chokes are used to maintain pressure or flow then it is ideal for a PLC to be incorporated. They can reduce the energy used by automatically reducing the torque or speed to suit the application requirements derived from the inverters own current monitoring and/or functions such as internal PI control. The PLC can also provide basic functions such as soft start which again aids energy efficiency.

Stephenson said: "The use of inverter drives to achieve energy efficiency savings has been prolific. In a huge amount of cases, especially fan and pump applications, energy savings as high as 50% can be achieved."

The focus of development in drive systems turns out to be the motor.

Karhinen said: "At ABB we are looking to increase the overall efficiency of our motors, especially in Europe due to the International Efficiency (IE) ratings. From IE3 to IE4 there has been a big leap in motor efficiency, and IE5 is coming out shortly. If you have the most efficient motor it doesn't really matter how efficient the controller is as it doesn't affect the overall efficiency that much."

NORD offers a different perspective: "At NORD we are looking at 'what does a field device look like going forward?'" Stephenson explained. "With both technologies interlinked you not only control the motor through a command-based approach, you can control it through an instruction-based approach. You can also control position. So the lines are being blurred more between a drive and a motion controller."

With an integrated drive and controller system capable of programmable commands, a load can be moved without the need for multiple sensors. This could potentially lower the cost of the system, while increasing its flexibility.

"Going forward we see that, rather than being omitted from designs altogether, drives will only be able to operate with a PLC in complex systems that require the movement of a load, for example," Stephenson concluded.

When designing or incorporating drive systems many aspects need to be considered depending on the type of function the system will carry out, from fans and pumps to HVAC or production lines. The advice from Stephenson is that providing a machine's performance requirements to a drive supplier will achieve the best solution. He said: "Request a breakdown and documented analysis for the selection - and if you're not convinced then get a second opinion."

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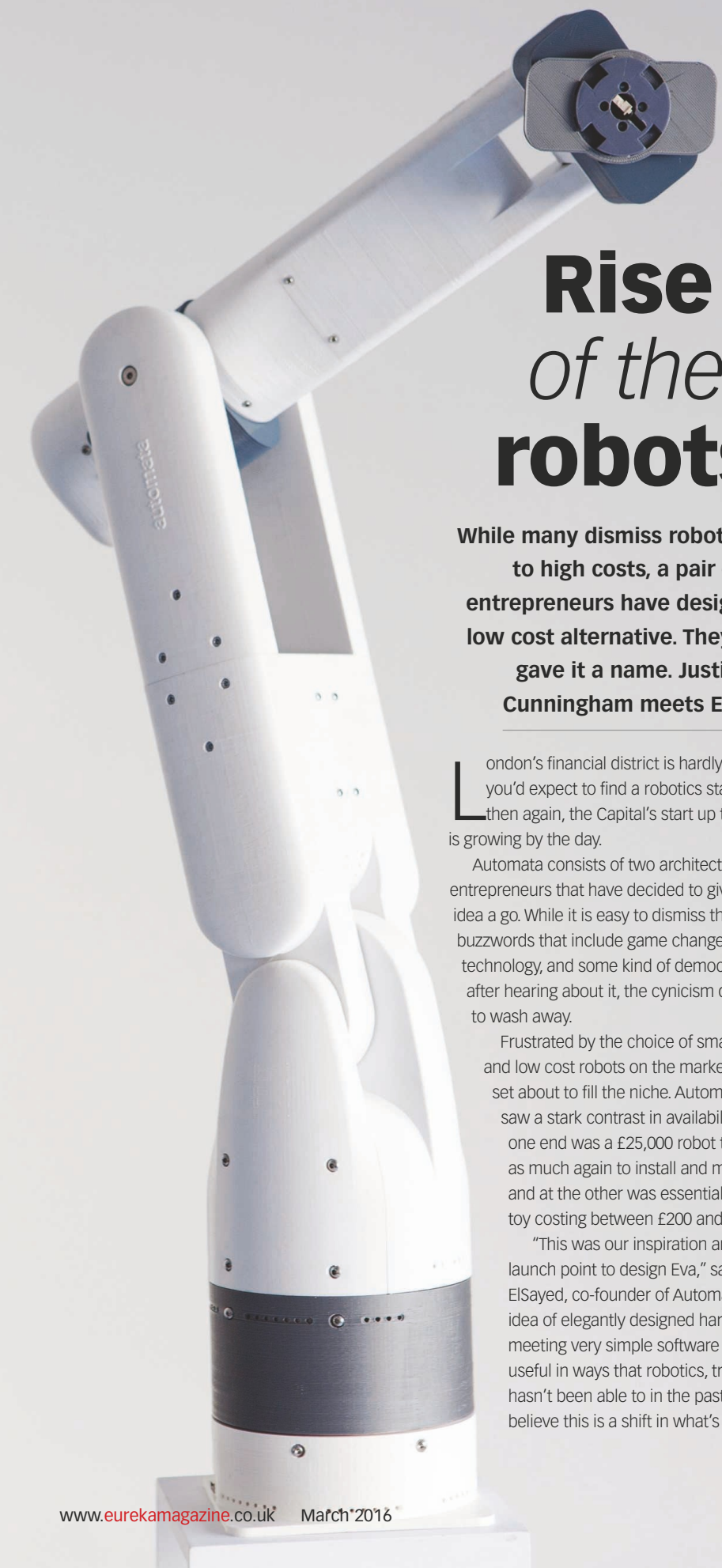

Rise *of the* robots

While many dismiss robotics due to high costs, a pair of entrepreneurs have designed a low cost alternative. They even gave it a name. Justin Cunningham meets Eva.

London's financial district is hardly the place you'd expect to find a robotics start up. But, then again, the Capital's start up tech scene is growing by the day.

Automata consists of two architects turned entrepreneurs that have decided to give their big idea a go. While it is easy to dismiss the buzzwords that include game changer, disruptive technology, and some kind of democratisation, after hearing about it, the cynicism does begin to wash away.

Frustrated by the choice of smaller scale and low cost robots on the market, the pair set about to fill the niche. Automata said it saw a stark contrast in availability; at the one end was a £25,000 robot that costs as much again to install and maintain, and at the other was essentially a useless toy costing between £200 and £500.

"This was our inspiration and the launch point to design Eva," said Mostafa ElSayed, co-founder of Automata. "It's this idea of elegantly designed hardware meeting very simple software to become useful in ways that robotics, traditionally, hasn't been able to in the past. We really believe this is a shift in what's available.

"She's a lightweight, easy-to-use, very low cost robotic arm. She is 2.2 kg, runs off USB or wireless protocols, and you can buy the hardware for just under £3000."

Though the personal nature and personality they've given to Eva is slightly disconcerting, the pair are living and breathing this development. They claim to have made 13 hardware iterations in the last 16 weeks, with everything designed and made in its London offices.

What's more incredible is that neither founder is a traditional roboticist... or even engineer. They have worked in the computational design research group at London architectural firm Zaha Hadid, and they are clearly more than proficient at coding.

Undeterred by lack of experience, the pair began by designing and then 3D printing the outer casing of the robot, sourcing and assembling all the electronics, and also writing from scratch the software to deliver what they say is a unique offering in the market.

"This is hardware development at the speed you'd expect from software development," said Suryansh Chandra, the other co-founder of the company. "Most of our mechanisms are also 3D printed. If we design a part today, we can assemble it tomorrow."

At full stretch Eva can pick up 750g. If the payload is closer, it can pick up 1kg. Though making the mechanisms from 3D printed plastic means they are perhaps on the weaker side, for many of the repetitive applications the robot is aimed at, the payload is around this mark. And a big benefit is that it does not need lubrication. Though, again, this limits usage in one sense, in the other it opens up many more applications – including work in the food sector, an area still carried out largely by hand in the UK.

One problem that was encountered on early iterations was the motor overheating. However, the inclusion of fans means the problem was quickly solved. It was a simple case of ordering the fan components online, modelling the parts and connections in CAD, and then printing them out. The iteration was completed in days.

"We are aiming for around 3000 rotational hours in the life span of one robot," said ElSayed. "For traditional users that is around 16 to 20 months of usage. By that point, there will be a new version of the robot with further improvements.

"At this price point, we don't believe it makes

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sense to sell the robot as a piece of hardware and say, 'here, take it for £3000'. We want to sell a service and use a subscription model. You pay us £250 a month to cover your hardware, software, insurance, and if something breaks."

At the heart of this product is software, which is key to delivering the intuitive experience non-robotic users will expect to easily get Eva up and running. To make it as simple as using a smartphone for the first time, the pair have put together software that makes the robot 'learn'.

Though that might sound rather spooky, in practical terms, it's a revelation. Users will teach the robot by example, literally by manhandling it through the motions and to the positions it needs to repeat.

"It's called Teach by Example," said Chandra. "But this kind of software is normally at a price point above £30,000."

The pair basically wrote their own version of the software from scratch, enabling them now to sell it with the robotic hardware.

"The idea is that by combining very low cost hardware with incredibly easy to use software, you open up a whole new set of markets to robotics," continued ElSayed. "Suddenly, for businesses where robotics just wasn't on the agenda, Eva is the obvious answer."

The applications are vast with a host of jobs that are repetitive and manual from fast food restaurants or coffee houses, to picking and placing factories, to start ups that want to upscale production and begin to industrialise a manual, repetitive process. Many that might benefit from the use of robotics, don't because of the initial investment.

"A traditional robotics company want a couple of months and tens of thousands of pounds to design a traditional robotic solution for you," said Chandra.

Automata is currently working with a company making chipsets for Boeing, where the process

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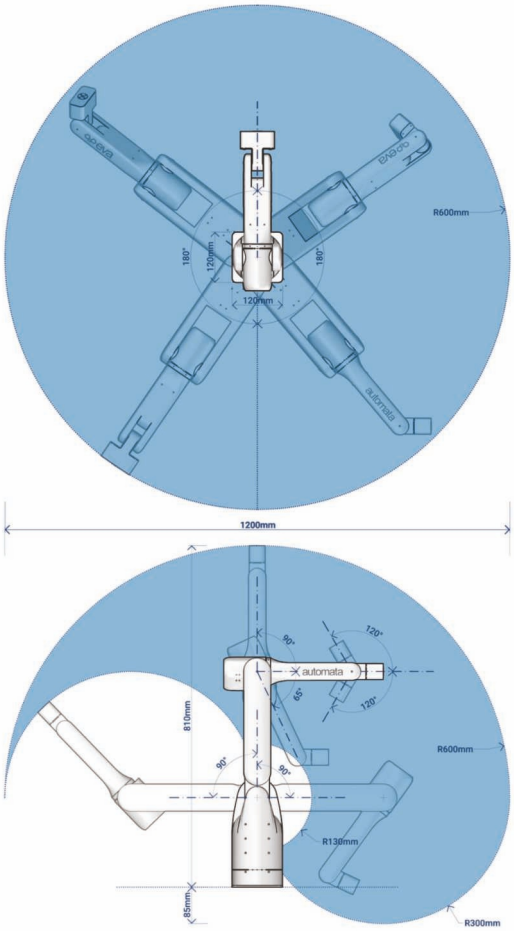

Eva's operational reach envelope

basically involves dispersing epoxy. The company own a $30,000 deposition epoxy machine, but need a person to manually use a couple of syringes at one end. The big problem is the 20% error rate they are getting.

"He said to me, 'I really don't mind if your robot reduces my throughput, but just improve my error rate,'" said ElSayed.

Automata is currently looking for UK businesses willing to pay a subscription for Eva, and currently has more than 35 signed up. It is keen to begin running pilot projects to develop its roll out and begin finding new robotic applications.

"We thought manufacture had moved East, but in talking to a few companies, they are saying, 'we're moving back to the UK'," said ElSayed. "These companies want to be running more efficiently, need to compete, and robotics is a big part of that. We've spoken to a variety of companies, but they all say the same thing: they're small, can't afford a big robot, but need to stay competitive."

You might think that traditional robotics companies wince at the thought of having a new player on the block with a low cost alternative. However, ABB Robotics runs an Idea Hub Innovation Challenge in London, which is a competition with 1400 companies entering internationally, of which three are eventually offered funding. Automata has been selected to be one of those three.

"We're not aiming to compete with high-end robots such as Universal Robots or these kinds of companies," said Chandra. "They prioritise precision. What we are arguing is there is a market for lower precision, lower payload use cases. And they are potentially greater than the traditional robotics market.

"What we prioritise is it's easy to use and retask. I shouldn't have to change the insurance, install secure fencing, or talk to a third party where they have to fly in someone from Germany to fix it."

Automata is currently taking the robots to factories and piloting its roll out before it hopes to open it up to a larger audience later in the year.

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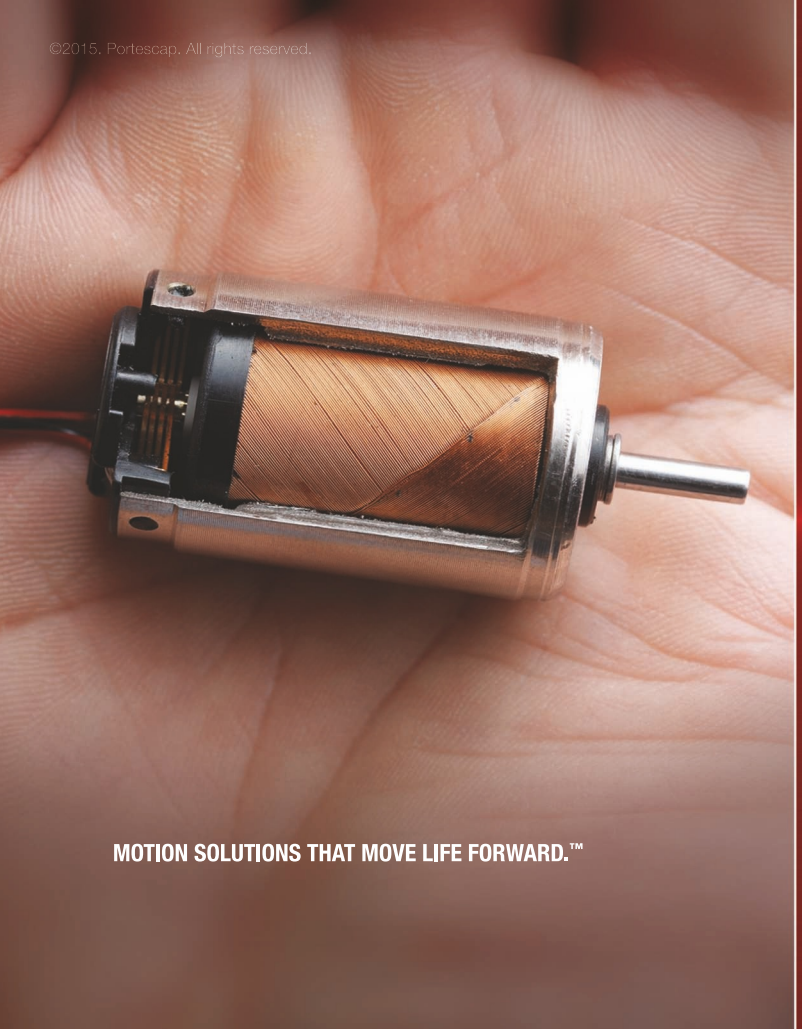

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Drive over to *take control*

A handful of co-located exhibitions will take place at Birmingham's NEC from 12 – 14 April 2016. Tim Fryer casts an eye over what is going on.

Of most interest to *Eureka*'s readers will be the Drives & Controls exhibition, which covers automation, power transmission and motion engineering. This biennial event will include a Robotics Demonstration Area for the first time, and this will add to such technologies as variable speed drives, motors, sensors, programmable controllers, pneumatics, mechanical power transmission equipment and test & measurement products that will be shown by over 350 exhibitors.

The robotics demo has attracted many big names including: ABB Robotics, Applied Engineering, B&R, Harmonic Drive AG, Mitsubishi, Staubli, and Active8 Robots. There will be several examples of the new generation of 'collaborative' robots – or 'cobots' – designed to operate safely alongside human workers, without needing a protective cage. For example, robots from the Danish cobot pioneer, Universal Robots, will be demonstrated by the company's UK distributor, RA Rodriguez.

The collection of exhibitors features many of the leading names in the automation sector, and includes Eaton, Siemens, Danfoss, Weidmuller, Dunkermotoren, Rittal, Parker, Brook Compton, IFM Electronic, Schneider Electric, Nord, Wago, Semikron, Transdev, Pepperl + Fuchs and Harting.

There will also be a series of half hour seminars spread across four theatres, each with its own theme. Across the three days there will be 15 – 20 presentations on these broader themes of Drives, Maintenance, Energy Dialogue and Fluid Power & Air.

Drives & Controls has teamed up with the Industry Entrepreneurship Network (IEN) to put on a series of three panel discussions. The three sessions will cover the topics of 'Blended Education', 'Entrepreneurship in Industry' and 'The Economics of Manufacturing' with panels formed from the network's membership of established entrepreneurs, industrial companies and leading UK trade, science, education and engineering organisations.

New products that engineers can prod and explore at the show will include: a new inverter and geared motor from Lenze; Carpanelli's stainless steel motors; the Cone Drive range of slew drives on the R. A. Rodriguez stand; and Harmonic Drive will be showcasing its new CanisDrive range of compact hollow shaft servo actuators.

Drives and Controls is the largest of a five show suite that comprises Fluid Power Systems, European Offshore & Energy, Air-Tech (Compressed Air and Generators), and Plant & Asset Management Exhibition.

Fluid Power & Systems occupies around 10% of the total event and focused on hydraulic and pneumatic equipment, together with products that facilitate better electro-mechanic system design and application for improved process automation, control and monitoring. Covering hydraulics, pneumatics and instrumentation, this section of the event is supported by the British Fluid Power Association.

Possibly only of peripheral relevance for Eureka's readers will be Air-Tec – all things compressed air and generation, Plant & Asset Management aimed at maintenance and operations/production engineers, and the European Offshore Energy Exhibition.

Entry is free of charge to seminars and exhibition. Also on at the same time at the NEC, but not organised by the same exhibition company, is Mach – the manufacturing show - and National Electronics Week, for those interested in the latest in electronics design and manufacture. MACH takes place biennially and is an interesting event with around 600 exhibitors it attracted just over 23,000 visitors in 2014 and featured 6500 tonnes of live working machinery. Reportedly, £177m of business was attributed to the last show.

Graphic choice

The equipment you work on can have a significant impact on the designs you are able to produce. In a future Design Plus we will look at the workstations themselves, but in this first outing, Tim Fryer looks at the capabilities of graphics cards.

New technology and its applications are the bread and butter of *Eureka*, but design engineers are often called on to fulfil many other roles in their company. Invariably you will be managers, whether that is managing your own projects, design teams or even entire companies. You may also be called on to have input in numerous other functions; marketing, supply chain management, recruitment, business development, health and safety, environmental policy...the list is endless. DESIGN PLUS is a new regular section to address such issues.

Does your graphics card improve or diminish your design ability and productivity? Have you ever stopped to think about it as individual component rather than just a specification of your workstation? Have you told your IT manager what you want?

What complicates the picture is that the traditional tower workstation is not always the computer solution of choice, with more mobile workstations sharing central resources. On top of this the actual demands are obviously increasing all the time – high quality rendering, visualisation, virtual reality and so on, all place demands on the graphics processing unit.

There are two main factors that will affect performance, and one of these is simply the computing power. I spoke to Brent Oster, solutions architect at NVIDIA, at the recent Solidworks World conference. At this event one of the hot topics was the introduction of Solidworks Visualize, the latest tool to combine high level rendering into a design package. It looks good, but does this require an expensive graphics card to run?

"Not at all," claimed Oster. "It will run on the workstations CPU only. However, it is eight times slower than if you put in on multiple GPU drives with NVIDIA."

In terms of computing power, its topline product is the Quadro M6000 card which features a 12GB memory and 3072 cores, but at $5000 is not cheap. Further down the range are less expensive versions with less cores.

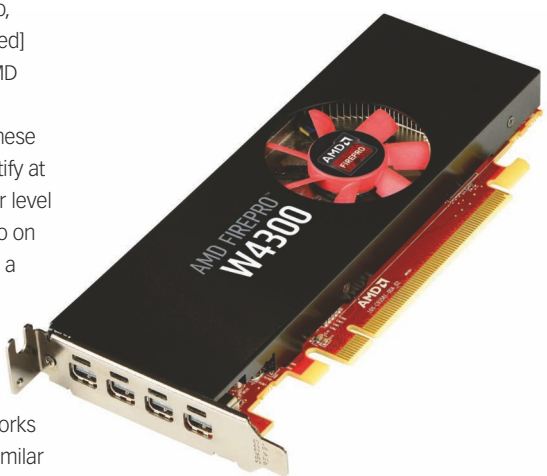
NVIDIA is one of two companies that dominate the professional graphics card market, the other being AMD. Like NVIDIA, it has a range to suit requirements. Complex and large models, requiring visualisation and possibly simulation as well, might want to plump for the top of the range FirePro W9100 at a similar price to its competitor, but again, more affordable versions are available, including its just announced FirePro W4300 at about a tenth of the price.

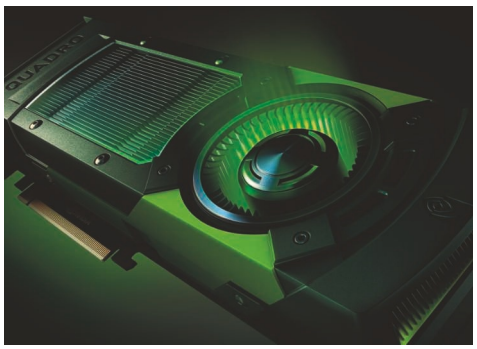
Antoine Reymond, industry executive design and manufacturing, AMD, highlighted the other feature that engineers should be aware of if specifying a graphics card. Speaking at the same event, Reymond commented: "There's a recommended list of workstations. We work with SolidWorks to make sure our products are certified by them and are showing on their website, so those companies like Dell, HP, Fujitsu and Lenovo, provide a complete [certified] configuration using the AMD FirePro.

"Solidworks is one of these companies that would certify at CAD level, at the processor level and at the system level. So on the graphics side, we have a very rigorous process of certifying our graphics with them."

The environment dictated that it was Solidworks used as an example, but similar processes are in place with the other leading CAD companies.

The bottom line is that there are numerous consumer graphics cards out there, but it will take a professional card to get the best performance for an engineer with complex designs. The suppliers of these cards, principally NVIDIA and AMD, work with both workstation and software companies in developing optimised solutions designed for the professional design environment, rather than the less dedicated performance you are likely to get from an equivalent consumer GPU. Moreover, the choice is open, particularly in towers or servers - you can have the graphics card of your choice, you are not tied to the card that comes with the box.





(Top) AMDs latest W4300 FirePro
(Below) NVIDIA's Quadro M6000

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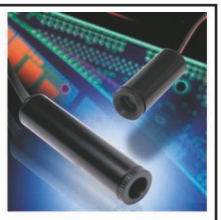

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More practical buoyancy

Life jackets are large and cumbersome. Putting one on is like strapping on a beer belly. You lose manoeuvrability and they have a tendency to make even the most coordinated of people, clumsy. It is comparable to giving someone a blindfold to protect their eyes while shooting. Effective, yes. Practical, no.

The life jacket is used for a number of activities where full dexterity would be useful including windsurfing, white water rafting, holding on for dear life on a rickety boat, or indeed swimming backwards.

Of course, despite the incumbent difficulties, most people still wear one. They're not called a 'life' jacket for nothing. Every year they save 1000s of lives and enable people to enjoy the water in relative safety. But, of course, there are those that opt not to; they think they are strong swimmers, find them restrictive and say they can do without.

The challenge

The challenge this month is therefore to come up with a better life jacket for leisure activities. Any device should not compromise on safety, but it should provide the user more mobility while wearing it.

Inflatable armbands or rubber rings might be a suitable option, but they are not entirely comfortable, and require the user to blow them up when they are needed, which may be at a moment's notice. The inflatable jackets found on aeroplanes are perhaps a step in the right direction, though they are still not exactly practical.

Any life jacket should fall in to the category of 'casual wear' and be able to be worn by those at the beach or taking part in water activities, all day. They should be comfortable and enable users a full range of body movement. In particular children should be able to wear them, but if, for example, they are swept out to sea by a strong current, they will be safe in the knowledge that the life jacket will provide adequate buoyancy.

Like always, we have got an idea in mind of how this is best achieved and we will be publishing it in the April issue of *Eureka*. In the meantime, let us know how you'd tackle the problem by emailing the Editor at ***tfryer@findlay.co.uk*** or leave a comment on the *Eureka* website: **www.eurekamagazine.co.uk**

Our solution to last month's Challenge, how to reduce water consumption when showering, can be found on page 12 of this issue.

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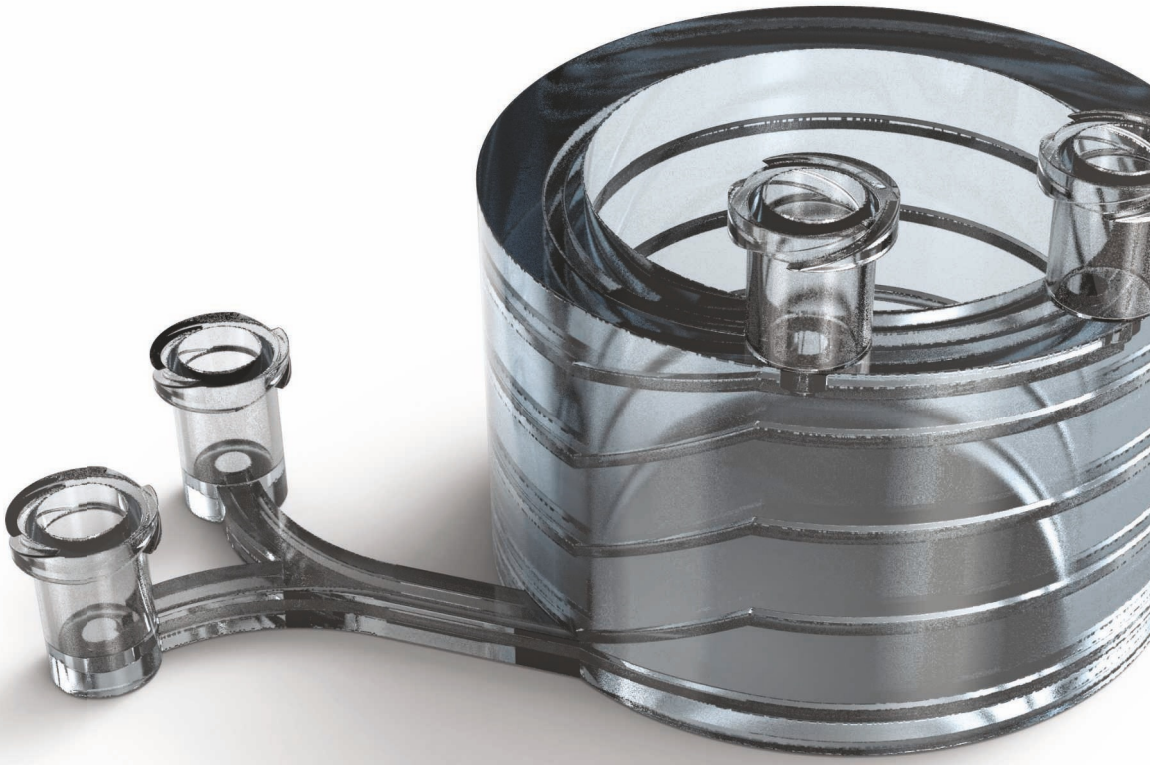

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