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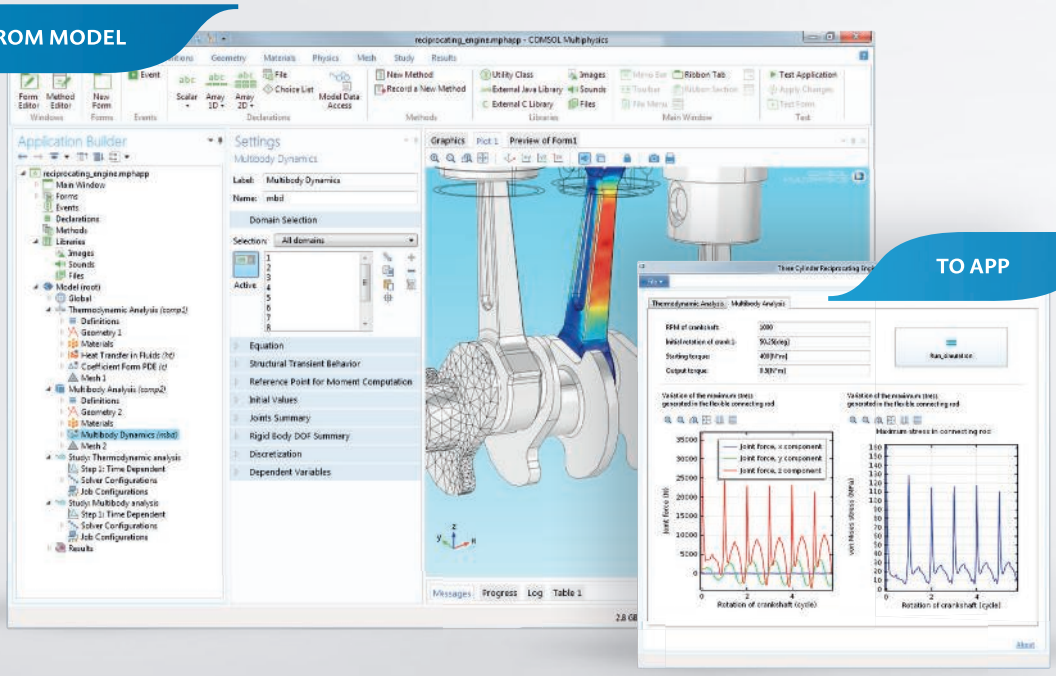

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Solid and unspectacular?

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

What will 2015 bring? Firstly it does appear that the days of boom and bust are over as, try as we might, we cannot create the 'boom' anymore. This is not surprising as all around the world, including for our biggest trading partners on our doorsteps, the recovery continues to be a laboured and nervous process. British forecast annual growth rates for the next few years, of between two and three percent, therefore represent a relatively healthy position.

Growth in the economy is critical at the moment. The deficit appears to be the political battleground in the lengthy run-un to the next election. While both main parties claim to be 'ring-fencing' certain budgets, like the NHS, pensions and foreign aid, and neither willing to admit that budgets will consequently have to be cut, for example, on education or policing, it is not clear where the cuts can come from.

It might therefore be an appropriate time to be worried if you were looking for a government investment in engineering, but contrary to common perceptions it does appear that both main political parties appreciate the benefits of growing the industrial sector as a facet in cutting the deficit. Funding through EPSRC and Innovate UK (the TSB in old money) is genuinely building areas of excellence in the UK in science, technology and engineering. Most importantly in the short term is continuity. And while the Labour government launched the idea of the Catapult centres, for example, it was the Coalition that gave it life and has pledged to grow it. The Labour Party remains committed to growth as the answer to all evils.

Political change probably won't happen in May this year, but even if it does then I doubt, for the reason above, if it will impact greatly on these investments in technology. Which is why, for what it is worth, I predict 2015 will be a solid if unspectacular year for the engineering sector – and I think most of us would settle for that. But, as ever, there will always be room for true innovation to shine through and we look forward to sharing some of that with you through these pages in 2015.

Happy New Year.

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NEWS

Picking up good vibrations

Engineers at Lancaster University are working on a system that allows aircraft wings to generate and store electricity from vibrations.

The work is part of a wider £1 million project led by BAE Systems called En-come, which aims to develop aircraft that can stay in the air for longer periods of time without having to re-fuel.

Principal investigator Professor Jianqiao Ye, of Lancaster University's Engineering Department, said: "Our role is to look at saving the power used to support the monitoring system. There needs to be frequent communication between the aircraft and Earth, and power is needed to send huge quantities of data as well as receiving instructions from a communications centre."

The research will look at how mechanical energy generated by the vibration of the wings can be transferred, stored and used to support the communications system.

Sensors made from special spatial material are adhered to the surface of the wing panels. Vibration from the wings is then transferred to, and collected by the sensor, to generate electricity and maximise the energy generated by the aircraft.

The Lancaster researchers will examine the actual structure of the aircraft and estimate the amount of energy that can be 'harvested' in this manner by looking at the location, geometry of the sensor and the distribution of the energy. The consortium will also look to see how the process could be improved and built on from, for example, a design perspective and by using wireless connections to reduce weight.

Strongest light alloy

Researchers from North Carolina State University and Qatar University have developed an alloy that has a density similar to aluminium and an ultimate tensile strength greater than titanium.

The material is a type of high-entropy alloy, meaning that it's made up of at least five metals in fairly equal amounts. In this case it includes lithium, magnesium, titanium, aluminium and scandium.

"It has a combination of high strength and low density that is, as far as we can tell, unmatched by any other metallic material," said Dr Carl Koch, senior author of a paper on the research. "The strength-to-weight ratio is comparable to some ceramics, but we think it's tougher and less brittle."

The material is expected to find use in vehicles and prosthetic devices. The team is currently working to reduce, or indeed eliminate, the amount of scandium in it (currently 20%), due to its high cost.

More steel to the Scots

Following a successful first 18 months for Barrett's Tube Division in Scotland, the company has announced a major investment north of the border with the launch of Barrett Steel Scotland.

The new business, based in Bathgate, will promote general steels to an expanding Scottish market, serving small and large steel users in a wide range of industries, from blacksmiths to major construction companies and large fabricators.

The company has ambitious growth plans and aims to be the largest independent steel stockholder in Scotland within the next five years.

£10m research into Big Data

Engineering related research and education charity Lloyd's Register Foundation has offered a conditional grant of £10 million over five years to support research by the Alan Turing Institute into the engineering applications of Big Data.

The offer, subject to specific areas of research being finalised, follows the Foundation's Foresight report, examining how Big Data might impact the safety and performance of engineering assets and infrastructure in such areas as energy, transportation and shipping.

Professor Richard Clegg, the Foundation's managing director, said: "Our report concludes that, within the next five to 10 years, we are going to witness step changes in sensor technology, data driven intelligent systems, computer science and algorithms for data analysis, impacting all aspects of the business life cycle – from design to manufacturing, maintenance to decommissioning.

"This report sets the high level strategic direction and funding priorities for the Foundation in the field of 'data centric engineering'. Big data is going to bridge the gap from monitoring 'what is' to predicting 'what if?' The Foundation intends to become a major supporter of international research in the field, partnering with organisations including the Engineering and Physical Sciences Research Council."

For more on the Foundation's report and Big Data see p12.

Materials gains of £20 million

Ten new research projects that will advance the UK's manufacturing capability, develop new and exciting functional materials, and accelerate the translation of the science of functional materials through to application have been announced by the Engineering and Physical Sciences Research Council (EPSRC).

These projects will include:

- developing thin-film materials and novel manufacturing methods for wearable technology;
- improving the mass production of carbon nanotube materials;
- revolutionising the manufacture and use of specialised glass;
- exploiting the potential of flexible perovskite photovoltaics for solar cells;
- developing the materials needed for the new class of photonic integrated circuits for use in communications, sensors, imaging and lighting;
- developing advanced fabrication processes for Gallium Nitride and related materials for the UK's emerging manufacturing industries.

Professor Philip Nelson, EPSRC's chief executive, said: "These grants for Functional Materials research will take advantage of the excellent capability that exists across the UK. The level of partnership between universities and industry means they are well positioned to advance the exploitation of the knowledge and discoveries of our pioneering scientists and engineers."

Less toxic fuel cells

A new fuel cell concept is set to enhance efficiency while simultaneously removing hazardous heavy metal ions.

The direct methanol fuel cell (DFMC) has long been a promising energy conversion system that could be used to power anything from vehicles to providing portable energy. The development has been carried out by South Korean Center for Nanoparticle Research at the Institute for Basic Science (IBS).

Normally, carbon monoxide (CO) poisoning is one of the main factors reducing fuel cell performance along with the presence of hexavalent chromium (Cr (VI)), a toxic carcinogenic heavy metal in the aquatic environment.

The research team applied the Cr (VI) as a type of 'CO scavenger' to the DMFC and the method not only uses the redox process to clean the platinum electrode surface by transforming CO into CO_2, but also the Cr (VI) is converted into Cr (III), which is much less toxic. As a result, the fuel cell is able to maintained a near constant voltage for 10 hours without any presence of Cr (VI).

Solution to last month's Coffee Time Challenge

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Last month we asked you to come up with a device that would allow parents to monitor ear infections in their infants without having to repeatedly go to the doctor.

The solution we had in mind came from Cupris Health, whose product, Cupris, it dubs as the 'the doctor in your pocket'. Cupris is a smartphone based service that makes remote healthcare consultations from home possible. It is essentially a frame that goes round a smartphone, similar to a standard phone protector with a fitting placed over the appropriate phone sensor, typically the camera, to which the instrument can be attached.

There are two instruments currently available – the otoscope to solve the problem we presented with ear infections (pictured above), and an ophthalmoscope for eye examinations. The service is a hardware and software solution, so information about symptoms can be added to the photos and be sent, securely, to a doctor or hospital.

Different phones have different camera and flash positions so a frame is required for each model, but the instruments are standard. Light is provided by the camera's flash. Cupris intends to develop further instruments in due course.

www.cupris.com

Half as exhausting

A project to cut the weight of car exhausts in half is being supported by a grant from the Niche Vehicle Network's Research and Development Programme. Experts from JSE-UK, Unipart Eberspächer and Coventry University - in conjunction with a local high-performance vehicle manufacturer - plan to design and make exhaust systems weighing just 20kg through an intense six-month project.

Manufacturing will take place at the Institute for Advanced Manufacturing and Engineering in Coventry after funding for the R&D project was secured. The new system could be used in cars in 2015.

Marcus Henry, principal engineer at Unipart Eberspächer, said major reductions could be made to the weight of exhausts without adding cost – and predicted the eyes of the automotive world would be on the results.

He said: "We have a vision for the future with lightweight exhausts and that future means they can reduce the overall vehicle mass by over 1%, which is very significant in vehicle terms.

"The new exhaust will be made lighter using advanced stainless steel material to produce parts that are lighter than those made in titanium, the current material of choice for lightweighting."

National college for skills

The Government intends to work with the High Value Manufacturing Catapult and with the EEF, the manufacturers' organisation, to establish a National College for Advanced Manufacturing that will identify the needs of industry and develop training provision to meet those needs. This will be based on autonomous institutions working together under the umbrella of a common National College framework.

The National College for Advanced Manufacturing is part of a new wave of employer-led National Colleges to help the UK develop world-class practical skills with other colleges focusing on digital skills, nuclear, high speed rail, onshore oil and gas, and wind energy. Up to £80 million of capital funding will be matched by employers over 2015-16 and 2016-17 – with a potential total investment of £160 million by 2017.

TECH BRIEF

Racing the thermals

The Infiniti Red Bull Racing team called upon FLIR Systems during the 2014 Formula One season to help them gather critical temperature data for a variety of trackside and factory activities.

As an Innovation Partner with the Infiniti Red Bull Racing team, FLIR has been gathering temperature data from the 2014 challenger, the RB10. FLIR is developing solutions using its miniature thermal cameras, like the Lepton Core, to provide the Infiniti Red Bull Racing team with unique insights into the thermal characteristics of their cars' components and operations.

Commenting on the collaboration, Christian Horner, team principal of Infiniti Red Bull Racing, said: "This year sees the most fundamental changes to Formula One in well over a decade. The team which is most efficient in gathering the relevant data, learning effectively and adapting accordingly will be the one which triumphs.

"The insights which FLIR technology can give us will be critical to our understanding of the new car and could give us a key edge over our rivals."

NEWS

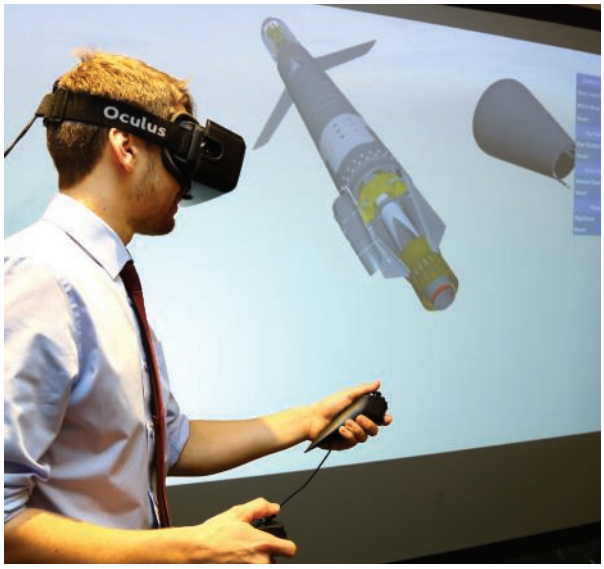
'Industrially relevant' centre

The University of Brighton's Advanced Engineering Centre is being backed with £5m from the Higher Education Funding Council for England (HEFCE). The Centre, which is due for completion in November 2016, will provide cutting-edge facilities for mechanical, automotive and aerospace engineering students.

The Centre will incorporate the University's Centre for Excellence in Internal Combustion Research that has already received £7m Government backing. This Centre of Excellence is being established in partnership with Shoreham-based Ricardo, a technical and environmental consultancy specialising in the development of low carbon vehicle technology. Joint collaborative projects include the development of a near-zero emissions internal combustion engine.

Professor Andrew Lloyd, Dean of the University's College of Life, Health and Physical Sciences, said: "We are delighted with the news that HEFCE will provide £5m towards this new facility to complement the University's ongoing investment to support the expansion of engineering at Brighton. This will allow us to establish world-class specialist teaching facilities alongside the state-of-the-art research base we are establishing with our long term partner Ricardo.

"These facilities will provide a unique opportunity for our undergraduate and postgraduate students to study alongside our researchers and engineers from Ricardo and undertake industry relevant projects at the forefront of engineering.



Lockheed Martin adopts 3D visualisation

Defence giant Lockheed Martin has installed a virtual reality system in its UK facility to help the design and review of a major land vehicle being developed. The ActiveWall by virtual reality (VR) company Virtalis will enable engineers to view 3D CAD models in a more realistic physical environment and improve time to market.

Ryan Neal, a research engineer at Lockheed Martin, explained: "Our customer, the UK's Ministry of Defence, as well as our engineers and business development people, was able to prove-out views of the 3D model through visualisation. This meant that instead of producing detailed performance reports over several months, we were able to view a 3D mock-up of the model using Virtalis' Visionary Render. In effect, words were replaced with interactive 3D pictures."

Lockheed Martin has been an early adopter of Visionary Render software, which allows users to access and experience a real-time, interactive and immersive VR environment created from huge 3D datasets. Users can work alone, in small groups, or collaborate with distant colleagues in a common virtual environment to perform detailed design reviews, rehearse in-depth training tasks, validate maintenance procedures or verify assembly and manufacturing processes.

Lockheed Martin use a transportable version of the ActiveWall that features a 3D digital light projector (DLP) projector, a custom screen and a PC workstation to generate the active stereo images.

www.lockheedmartin.co.uk
www.virtalis.com

Race to Silverstone

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NEWS

3D printing market booms

The 3D printing market surpassed $1bn in revenues during 2012 and growth is expected to continue through all target sectors to reach $20bn by 2025.

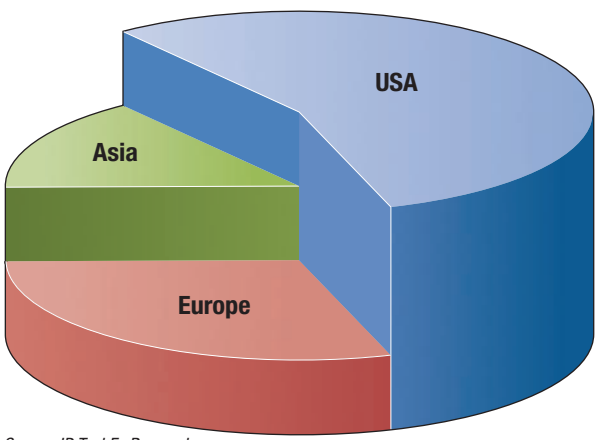
These figures come from an IDTechEx Research report called '3D Printing 2015-2025: Technologies, Markets, Players', which also shows that printer manufacturers are reporting a surge in sales as awareness of the technologies and what they offer grows.

The oil and gas industry is the emerging user of 3D printing with the highest forecast growth followed by the aerospace industry. When significant penetration has occurred into both markets, 3D printing in these industries will lock into the capital expenditure cycles associated with them and, as is the case for CNC machines, periodic fluctuations in sales will occur.

Price remains an issue at the high end of the market with several users reporting that prices of these printers have not moved significantly in contrast to the low to mid-range printers. Printers that used to cost $1m still cost just as much.

Historically most 3D printer manufacturers exclusively sold the materials consumed by their printers, a practice known as vendor lock-in that is commonly seen in 2D inkjet and laser printers. However, an alternative business model where end-users are free to buy consumables from any supplier, known as the free market value chain, has been steadily growing.

Driven primarily by the expiration of key patents, this free market has allowed the prices of both printers and materials to fall. However, innovative technologies that maintain clear key differentiators, particularly while they are still protected by core patents, will continue to permit vendor lock-in.



Source: ID TechEx Research

Safety in space

Magna Parva has been awarded a contract by the European Space Agency to develop novel materials for use in space to help protect spacecraft and its crew. The project will develop laminated materials, which provide more protection per kilogram than current options.

Micrometeoroids and orbiting debris (MMOD) travel at orbital velocities of 8km/s, and a small fraction of this MMOD is large enough to cause potentially catastrophic damage. The second motive behind the development of the 'Low Cost Hybrid Materials' is radiation, which increases beyond the protection of the Earth's magnetosphere.

Magna Parva will be supported by the expertise from a number of high technology companies and universities from across the UK. Director Andy Bowyer said: "This provides an exciting step for the company into a new business area. The materials we develop in this contract will be particularly useful in deep space missions such as those planned for the Orion capsule."

Magna Parva is supported by their subcontractors Fluid Gravity, TISICS, RadMod and Kallisto.

www.magnaparva.com

Sussex engineering lab gets £10m boost

The University of Sussex is investing £10 million in a new engineering and robotics lab on the back of a 60% surge in applications for engineering and computing degrees. Half of the money will come from the Government's £200m fund for STEM teaching. The development includes internal refurbishment of one of the buildings on campus to create a new student-focused hub, as well as a suite of 'top spec' computers and new teaching and project workspaces.

The newly founded Computing, Robotics, Electronics and Mechatronics Centre (CREaM) will allow students to learn about advancements in robotics and autonomous systems by working with the latest technologies behind innovations such as auto pilots, drones, space robotics and driverless cars.

TECH BRIEF

Graze takes its pick

Graze – the suppliers of nutritious snacks personalised to the customer's preferences, has applied cutting-edge technology to meet the challenges of its complex production methods. Due to the millions of combinations of ingredients in each box it requires multiple positions to suit the box configurations, all done at extremely high speed to cope with throughputs, and all in a hygienic environment.

Co-founder of Graze, Neil Thompson, saw a demonstration of the Hygienic XHA motor, part of the ServoTube range, on the Dunkermotoren Linear Motors stand at a trade show. It was running underwater in a fish tank and Thompson saw the possibilities.

During the following months Dunkermotoren's engineers worked closely with Graze's machine designers to produce an XXY gantry formation using three XHA38 series tubular linear motors. By mounting the linear motors as actuators to utilise the integrated field-replaceable polymer lubrication free slide bearings, it was possible to push the dosing head through an infinite series of positions.

www.dunkermotoren.de

Weighed down

With such hype behind the Internet of Things is all this information going to be useful or will it become a hindrance to the engineer and a distraction in finding real innovation? Is Big Data in danger of being too big? Justin Cunningham investigates.

It's the New Year, and although not totally new, there are a couple of phases you are likely to hear a whole lot more of this year; the Internet of Things and Big Data. Both are essentially phrases that have been coined to encompass the concept of embedding sensors into 'things' – like consumer products and industrial devices – and then continually capturing data from them.

This idea of capturing data from 'things' everywhere, offers the tantalising potential to uncover a fair bit of hidden innovation. It's hoped that this mass of data will shed new light on all kinds of societal issues by exposing trends and offering fresh insight into highly complex, and long term, problems from personalised healthcare to city planning and everything in between.

A recent report by the Lloyd's Register Foundation entitled 'The Foresight review of Big Data – towards data-centric engineering' said: "Data will be used to predict and anticipate, plan and decide every aspect of the 21st century.

"The new scale of data availability will change all the strategic sectors... from design to manufacturing, maintenance to decommissioning."

The Internet of Things has been described as the overnight success that has been 30 years in the making. Indeed, there is no doubt that it offers huge opportunities, today, for design engineers to add value by embedding all kinds of sensors in products as standard. While this level of monitoring might have once been only carried out at the test and validation stage, now continuous monitoring and connectivity will be demanded in every product from personal health monitoring devices, to cars and combine-harvesters, to factory equipment, all the way up to colossal power plants. And it will happen on a global scale.

ENGINEERS NEED TO FIND VALUE IN BIG DATA BY USING IT TO GAIN INSIGHT AND THEN EXPLOITING IT TO IMPROVE DESIGN AND FIND NEW INNOVATION.

The difference between data and knowledge

However, this all represents one fairly major problem: too much information. Big data, in many cases, becomes too big to handle and getting anything useful from it can be near impossible. This vast sea of raw data will take such a massive amount of processing power to analyse, it begs the question whether Big Data is in danger of weighing down engineers and innovation itself?

Indeed the Lloyd's Register report went on to add: "Big data can be complex to analyse because it comes in many varieties, shapes and sizes and may have been collected over different timescales. It can be uncertain, noisy, and incomplete.

"It imposes demands on infrastructure and on humans. Big data needs analytics; not only the techniques of statistics and machine learning, but also the human skills of insight and pattern recognition to find genuine meaning.

"Collective responsibility and action by citizens, governments and businesses will be needed to realise the potential."

Sensing a problem?

The use of some basic sensors within the average smart phone has led to all kinds of unforeseen apps, and soon almost every product will demand the same element of connectivity and varied embedded sensor suites from a kitchen appliance to CNC machines.

But, the data rates on many sensors vary greatly, with some that can

with data

take readings on a near continuous basis. So how, and where, can all this data be processed?

Andy Chang, senior program manager for academic research at National Instruments, said: "There is no way to process all of this data in a centralised location – it is just not going to work."

Centralised cloud storage has become a big hit for consumers and industry alike in the last few years, with the migration to centralised storage almost reminiscent of the centralised mainframes of old. But this volume of data, from billions of devices, all streaming continuous measurements would fill all the world's data centres before long. It's likely we would simply run out of room to store all the information.

Dr Joe Salvo, a director of global research at General Electric said: "By 2020 there will be 8 billion people in the world, 50 billion connected devices, and each year 50 trillion GB of data will be captured. If we were to store all that on old floppy disks, you'd need a stack of them that would go all the way to the sun and back... 300 times!"

There has always been a give and take between the technologies used to create data and then the technologies used to process them, and there is no doubt we are on the cusp of a significant leap in terms of capturing data, but for many the processes to turn it all in to something useful is an elephant in the room, and something that is grossly underestimated. It is not that solutions are not being developed, it is just that those thinking about embedding sensors – in the hope to gain critical advantage from the information gained – may not be anticipating the potential rod they are making for their own back.

"Data almost becomes a problem as there is so much of it," said Peter Haigh, a power systems engineer at National Grid, which is developing systems to continuously monitor the electricity distribution network throughout the UK. "We produce so much data. We'd actually rather there was less of it, or that it was easier to distil it down to something useful."

Driving value

Enabling value to be driven from Big Data is key to its success. But, how can anyone, or anything, cope with the near infinite information that is likely to be generated?

"We have to learn how to forget things," said Dr Salvo. "That is going to be the differentiator in this new age. How many people save every newspaper they ever got? You process it and throw it away. We need to get comfortable with processing it and then forgetting it. That is going to be differentiator going forward."

Processing near infinite quantities of data on a continuous basis is

The data driven society

It is data on a global scale and will include everything from washing machines to personal health monitoring devices to smart energy meters in the home to the bearings in the gas turbines producing the power... and everything in between. The data is not just big, it is near infinite. And it's quite likely that any future society is not just going to be data reliant, but data driven – using the insight from all this to meet, and predict, the expectations of the population.

It is a daunting, but exciting prospect. It could revolutionise healthcare. Imagine your doctor giving you a call to inform you of a possible medical condition, months or even years ahead of current diagnosis, turning reactive medicine into proactive lifestyle changes.

It is being called many different things from data-centric engineering to Industry 4.0 to cyber physical systems. But they all essentially boil down to the same thing. A data driven world, based on real world measurements, which will shape and steer society in virtually every area imaginable.

essentially what the brain does: using the useful bits while forgetting the rest. And this is what intelligent sensors and analytic software needs to be able to do going forward; filter the data and boil it down to patterns, charts, 'real-statistics', and knowledge that allows people to make confident decisions from company directors assessing macro trends driving a business or design engineers seeing real world performance of products over months, years, and decades. This is where there is true value in Big Data for engineers, the insight in to how to improve design and ultimately where to innovate.

However, getting the relevant information out is not straightforward and is something that varies from industry to industry and person to person, depending on what is relevant and useful to them.

Jim Robinson is general manager of the Internet of Things solutions group, segments and broad market division at Intel. He said: "All the processing that is happening from new and existing devices is useless if you can't do something with the data that you are pulling from them. And this is where Big Data analytics has really come into its own in the last few years.

"I'm talking to companies and industries that are trying to drive value from Big Data and analytics, and they are trying to convert all this data into useful information. But it is very complex, so we believe it's critical that these Internet of Things platforms are built on open and flexible, and scalable, platforms that will ease the deployment."

WE NEED MACHINES INTELLIGENT ENOUGH TO MAKE DECISIONS, SO THEY KNOW WHAT DATA TO KEEP AND WHAT TO THROW AWAY.

Machine intelligence

This is also a key demand for Big Data going forward: machine intelligence. Machine to machine connections need to be able to know what data to keep and what to dump. While Airbus, for example, has eluded to its Factory Of The Future being able to pull up the video accounts of technicians or fitters in order to see exactly what bolts, tools and so on were used years after a build, it raises the question of where will they store all the data? And in a highly regulated industry like aerospace, how will they know what data can be omitted or dumped?

Shelley Gretlein, a senior group manager for the robotics, real-time, and embedded software team at National Instruments, said: "I don't want to throw something away that in 10 years I'm going to regret, especially in heavily regulated sectors. How do I know I won't want to go back and have a look at it to see happened later on?

"So, I think you have to have increased intelligence at the node, so these devices are not one way devices. We need machine intelligence so if it hits a limit, a fault, it will then send the data to a more centralised type location. Intelligence at the node is available now, but it is for users to define exactly how and when – so setting limits on when to take data – and that is the challenge."

There is no doubt that Big Data, and the Internet of Things, offer amazing potential. However, getting there is likely to be less straightforward than many would believe, and it's likely that many engineers will have a problem with too much information or perhaps not be completely sure where to set the limits of when to keep information, and when to throw it away.

But, isn't this what engineering is all about - overcoming the challenge? While it Big Data might well weigh down many, it is certainly only a matter of time before all this information is exploited in ways that will revolution life and industry as we know. It is a question of when, and not if.

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Forward thinker

Speaking at NIWeek in Austin in 2015, Dr Joe Salvo, a director of global research at General Electric, said: "When I was in school in the early 1980's I brought a 10MB hard drive and it cost nearly $1000. Today, in my other pocket I have 2TB of memory encrypted with a little keypad and it costs $79. In 1982 terms it is worth somewhere between $100-$200 million. So project yourself 20 or 30 years in the future. You are going to have $200 million of computing technology and memory and get it for $79 and you'll be able to put it in any kind of device you want.

"We need to build an industrial internet that is going to be able to sustain that kind of computation and that opportunity, linking all the machines in the world together to form networks easily. We are at the beginning of having machines that converse to make decisions, and the intelligence of these machines is getting bigger.

"I believe this is going to lend itself to an information explosion. There is going to be so much data that there is going to be opportunities that we have never dreamed of. This is the end of the information age and beginning of the knowledge age. And it will create a new wave of innovation, the likes of which the world has never seen."

Naomi Climer - CV

Naomi Climer is Deputy President and Fellow of the IET and President of Sony's new global division – Media Cloud Services, based in Los Angeles, USA, with a mission to develop cloud based services for all parts of the media industry worldwide.

Previously, Naomi headed Sony's B2B organisation in Europe (Sony Professional) providing R&D, Sales and Marketing, Systems Integration and Service covering diverse markets including media, broadcast, cinema, sports, security and healthcare.

After studying at Imperial College, London, Naomi trained as an engineer at the BBC and has worked in technical roles in BBC Radio, BBC World Service and BBC News as well as at ITV and in local radio.

Naomi has a strong interest in diversity issues and has been an active campaigner for gender diversity within Sony and within the engineering profession in the UK. As a result of this, Naomi was short-listed for a WISE Women of Outstanding Achievement Award For Leadership and Inspiration in 2012.

Diverse agenda

In the autumn of 2015 Naomi Climer will become the IET's first female president, but her agenda will not just be 'diversity issues', as she explained to Tim Fryer.

Realistically there is not much in terms of radical change that can be achieved in a single year, which is the duration of a term in office for a president of the IET. Therefore, the onus on presidents is to work closely with predecessors and successors to ensure continuity and commitment to the vision to 'Inform, influence and inspire'.

So, despite her distinction of being the first woman in the role in its 143 year history, Climer sees her appointment as the consequence of a long running theme. "It has to be significant," she admitted. "But I wouldn't want to give the impression that it is only now that I am a woman president that the IET is going to pick it up. The IET has been campaigning for diversity in engineering for some time and William [Webb], who is the current president, is very passionate about it. It is an obvious thing for me to do, although I don't want it to be my sole focus, but it is a moment when we can make sure people are thinking about the diversity agenda."

Climer is president of Sony's Media Cloud Division and is based in Los Angeles and it is perhaps more the perspective she has from working there, rather than her gender, that will be her driving influence through her year in office.

"The thing I am particularly passionate about is how to improve the image and status of engineering, especially in the UK," she said. "Living in California, engineers are absolute rock stars. I think it has improved a lot in the UK but it doesn't feel quite the same. It doesn't feel like engineering and technology as a career is as prestigious as it ought to be given the range of job opportunities and the sheer diversity of what you can do. If you want to make a difference in the world then engineering and technology is a very good place to be in order to do that."

The much-discussed dearth of engineers coming through the education system has its roots at the ages of 11 to 14. This is according to Engineering UK, who the IET are joining in a programme to get the word out to children of this age. "People can rule themselves out of engineering and technology careers just by the subject choices they make at 14 and 15," claimed Climer, "so we do need to get to children, but there is a strong feeling that getting to teachers and parents is an incredibly important part of that too."

As part of that, the IET is working with Engineering UK on its ambition to get engineering influencers in every single secondary school in the UK. Climer said: "The idea is that it might be a business or it might be an individual, but every school should have access to someone who understands what an engineering career could mean so they can influence the teachers and hopefully, to some extent, the parents, to catch the children at the right age when they are making choices for life."

Finding the right role models to do this is important. While being female, or having an exciting job in engineering might help attract some young people, more will be led by peer-influencing. Climer commented: "We do need young people. Students who are just starting university or engineers who are just starting work also need to be more visible so that the young people who are making choices have access to role models who are more meaningful to them than I could be. For example, quite a few of the recent Young Women Engineer of Year winners, who have a mandate as a role model, are quite active on social media and so are very visible. They are doing quite a range of different exciting things across the engineering spectrum."

> "IF YOU WANT TO MAKE A DIFFERENCE IN THE WORLD THEN ENGINEERING AND TECHNOLOGY IS A VERY GOOD PLACE TO BE IN ORDER TO DO THAT."

Beyond her gender, the other obvious difference between Climer and her predecessors is her location on the West Coast of America. But, she claims, this will not affect her mandatory duties and will in fact bring a different perspective.

"The IET does a really nice job of working with the Government in the UK and making sure it is well informed on technical matters. Those kind of things are quite UK-centric. But because the engineering world is now international, we feel that having a global engineering community is important. So, I do think there is an international agenda that we must keep firmly in mind as we plan for the year. It is one of the things I will naturally bring to the role."

So with only a year in the job, what will count as a success? "It is to do with the image of engineering," responded Climer. "I would like to think that at the end of the year I will feel that the general public as well as policy makers and industry, are seeing engineering in everything, and are more conscious of the role it is playing in everyday life. I would like to think that that level of awareness had gone up as a result of my year."

Device takes a dip

Development of a swimming training aid proved that prototyping products for use in water may be difficult, but certainly not impossible. Tim Fryer reports.

The product in question is Instabeat, a heart rate monitor intended to help swimmers monitor their training schedules. It was the brainchild of Hind Hobeika, a Lebanese mechanical engineer and former competitive swimmer, who worked closely with the Aavid Thermalloy design centre to realise this concept and start prototyping the design for production. Her idea was to provide swimmers with the sort of training information that runners were accustomed to.

"It was based on the idea that it had to be frictionless for the swimmer. There are a lot of watches on the market that can measure heart rate in swimming, but swimmers do not wear them because they do not provide real-time feedback and they create friction," said Hobeika. "We wanted a device that would be integrated into an accessory that swimmers already wear, and swimming goggles were the best option because they are great place to provide feedback for the swimmer too!"

It was decided to design a module that would mount on most goggles, rather than build electronics into the goggles, because goggles are both very personal and disposable items. However, while the technology is in principle the same as for a running or cycling heart monitor, there are a different set of challenges because of the water and the location on the head.

"The artery location can differ between one person and another so we had to add multiple sensors to make sure all cases are covered," observed Hobeika. "The blood flow in this area of the head is really little and the signal needs to be much more amplified than if it were on the wrist or on the finger. The amplification creates a lot of noise and makes it harder to detect a 'clean' signal, thus a good accuracy."

Also, if water goes over the sensor it impacts the heart rate reading, and this had to be accounted for in the mechanical design - to have it in such a way that water cannot interfere with it.

To accommodate the unique design needs of this new device, Aavid Design, a branch of Aavid Thermalloy, was employed to help adapt the product design to accommodate the rigorous and highly specific requirements for the Instabeat. For the Instabeat, the Aavid team worked to refine the design so that it would be more reliable and compact. Product considerations at this stage of the design were that it was to have no connections that would be exposed to water and that information transfer was through USB. Power is supplied by an internal rechargeable Li-ion battery.

Prototype phase

It was the underwater operation of this product that made it particularly difficult to prototype, as Andy Grunes, director at Aavid, described: "The initial challenges were with material selection –

Instabeat is a swimming monitor that can be mounted onto most types of swimming goggles. It allows the user to customise heart rate zones and then will flash signals into the eyepiece to indicate the training 'zone' – blue if fat burning, green if fitness, and red if maximum performance. It measures crucial training parameters like calories, number of lengths, breathing pattern etc and all information can be downloaded, by USB, after the session for further analysis.

selecting the correct materials that would bond well to each other and thus create water tight seals. Effectively the product is electronics moulded into low hardness plastic. In addition to being water tight the product had to be flexible to adjust to any swimming goggles, but rigid enough to hold firm against the swimmers head for good heart rate measurement. So the hardness range of the plastic further limited the material options."

Other factors to consider when choosing the materials were compatibility with the long term use in environments such as sea water, chlorine, and direct sunlight. Aavid worked with a number of plastic manufacturers and moulding specialists before determining the best combination of plastics to use. Grunes added: "It was determined that to get good seals between the plastic and the 'guts' in our initial prototypes we had to employ a production-type process, injection moulding."

Design process

The mechanical design team took a 3D surface file from the industrial design team and laid the surfaces into an assembly with the electronics. There was some back and forth to adjust surfaces slightly to allow space for the internal components. Once the outside surfaces were set the mechanical team repaired any surface irregularities and ultimately created a virtual solid around the electronics in 3D CAD.

Since the silicon casting is low temperature and pressure, all the electronics could be moulded over without risk of damage. Grunes said: "Before moving to injection moulding the prototype design was fairly simple – design the electronics and cast silicon around them. A soft tool was built to hold the electronics while silicon was hand poured and cast in place to complete the first product prototypes. The handmade prototypes were an important step in the development and gave a platform for refining some algorithms and heart rate measurement. Unfortunately the handmade prototypes did not stay completely water tight and could not be used easily in the swimming pool, which is where they needed to be for further refinement. The decision was made to injection mould the next set of prototypes."

Injection moulding introduced a series of new challenges that ultimately had to be faced anyway, but the design team had to be wary that facing these production challenges in the prototype stages was not disrupting to the core technology development such as heart rate accuracy, usability, and comfort. Because injection moulding is a high temperature and high pressure process the design team simulated the process to be certain that components were properly protected.

Through thermal modelling of the moulding process it was determined that the battery would exceed its recommended temperature during the injection moulding without adding significant insulation, which there was not space for. The team decided to design the product such that the battery would be installed after moulding.

In addition, to protect the PCB components from the pressures of injection moulding, a composite shell was designed. "The material compatibility between the outside rubber skin and the internal PCB shell was critical to the cosmetic and functional results," said Grunes. "If the rubber skin did not adhere to the internal 'guts' there would be separation, air pockets would form, and water could ingress."

Aavid Design brought the project from concept to a working manufacturable product, with the primary concern being protection of the electronics through the high temperature and pressure experienced during injection moulding.

Unsurprisingly, Instabeat's designs did have to evolve. Grunes explained: "To position the electronics accurately within the injection moulding tool required support pins. This was especially challenging because the heads-up display portion of the electronics is on a flexible PCB. The support pins create physical holes through the outside skin of the device. To minimise the impact the pins have on the industrial design, we kept them all on one side and arranged them in an aesthetically pleasing as possible way, and designed custom plugs to fill the support pin holes afterwards."

The product was launched in August 2014, but development has not stopped there. Could the product be used to supply more 'in-swim' information or even music and headphones? "Absolutely," said Hobeika. "Lots of exciting features coming in the next versions, so stay tuned!"

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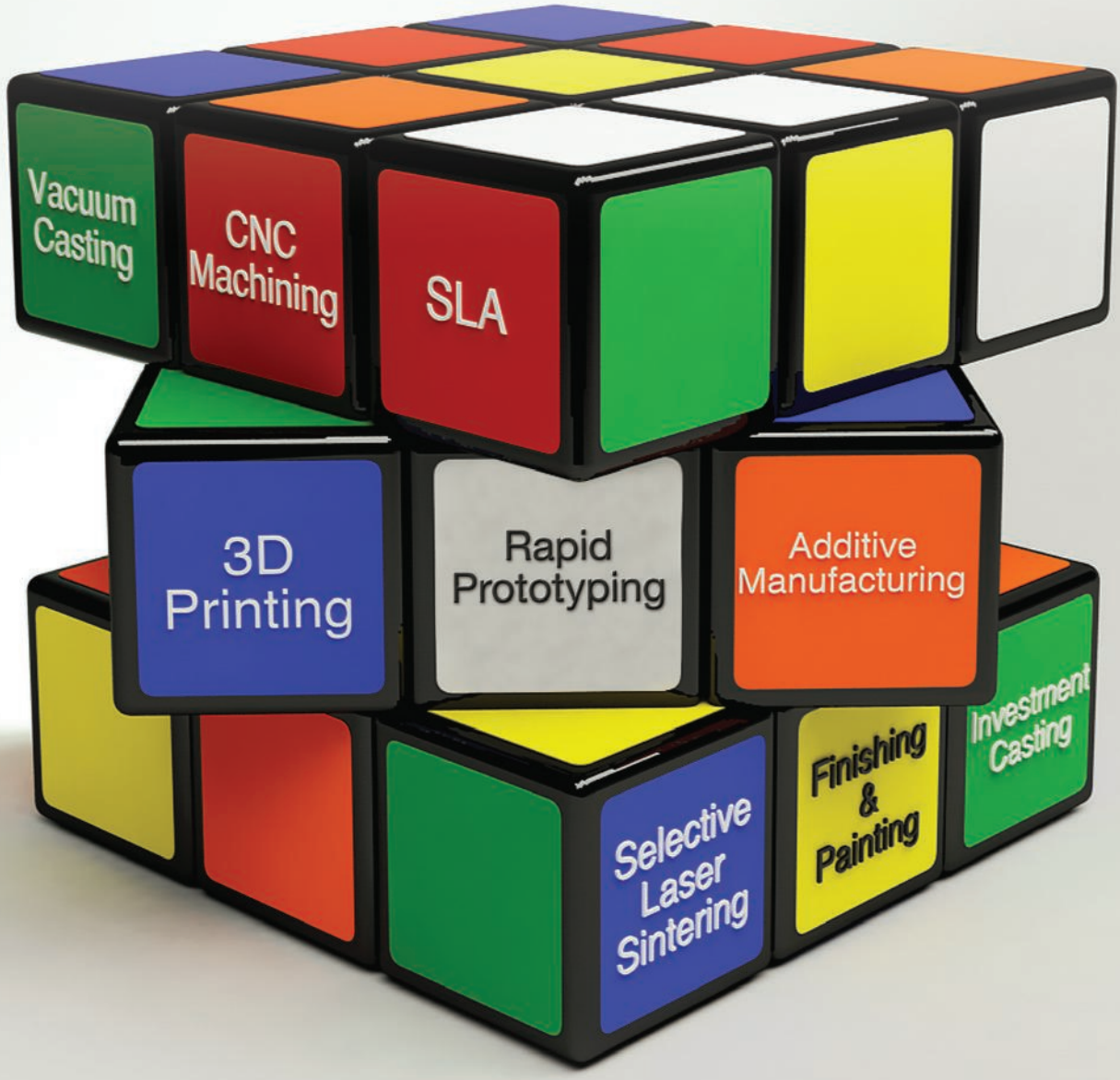

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Moving to the fast lane

As the market for electric vehicles gathers speed, so too does the expectation of performance. But making an electric sports car is a notoriously difficult challenge. Justin Cunningham finds out why.

Hybrid and electric vehicles have been on the market for some time now. Indeed, it was Toyota to claim the first serious volume production with the Prius. But nearly 15 years on, and 5 million cars later, the roll out of next generation clean vehicles seems to have been as slow and subdued as the vehicles themselves.

Electric and hybrid vehicles have a bit of an image problem. They are perceived as sluggish and many are concerned about practicality. Range anxiety is now a phase commonly used to describe this feeling of apprehension. Overall all, electric vehicles – and hybrids by association – have been labelled as somewhat dull.

And there are good engineering reasons why. The power density from batteries, extra weight from motors, two powertrains (if it's a hybrid), slow charging, and transmission trade offs... there have been a host of technical hurdles that are still some way off being completely understood and overcome.

However, 2014 was a redefining year for electric and hybrid cars, and any thought that driving one is strictly for the dullard has been overtaken with a new generation of sports cars. This year has seen a shift from it all being about saving the planet to aiding performance. Formula E began in earnest: the first high profile fully electric racing series to put a bit of glamour and excitement, along with speed, into the market. In addition, Formula One cars, the McLaren P1 supercar, and BMW's i8 are all hybrids released this year that put electric power in the fast lane.

"People want more excitement from electric cars," said GKN Driveline's vice president of product technology eDrive systems, Theo Gassmann. "And this is especially going to be the case going forward. At the moment they tend to be smaller city cars but we will see more high performance electric cars coming to the market as many people do not want to compromise that driving experience."

GKN has recently completed a project for BMW, specifically to enable its i8 to have the kind of performance associated with higher performance BMWs. It has developed a transmission for the electric powertrain of the vehicle that was essential in providing the necessary speed and acceleration.

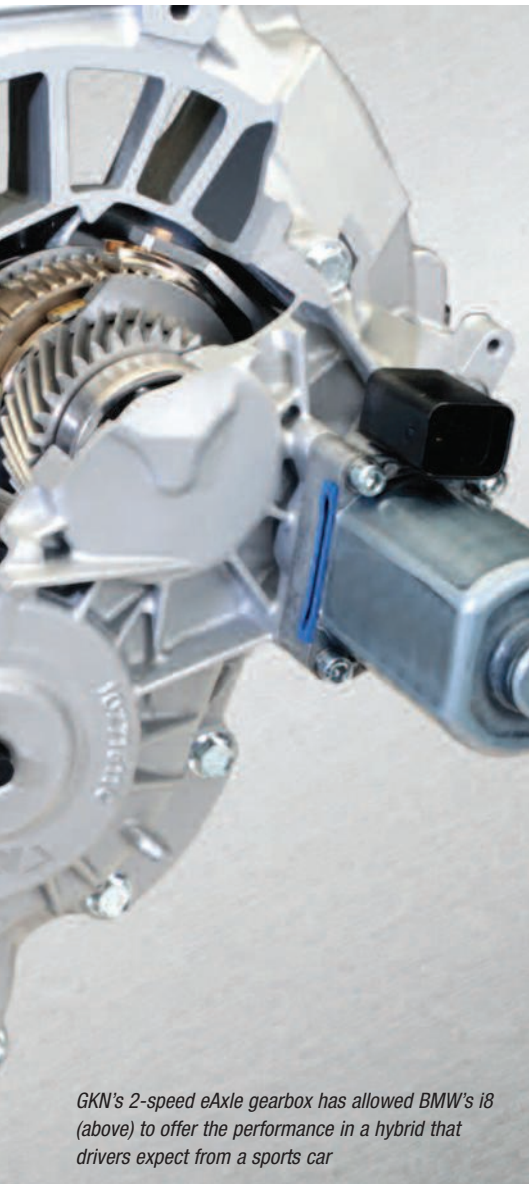
The BMW i8 uses a downsized combustion engine, a 1.5-litre 3-cylinder turbocharged unit, which puts out 220bhp and 300Nm of torque. While impressive, with a curb weight close to 1500kg, it will not deliver the performance expected of a BMW sports car. Making up for this is an electric powertrain, rated at around 125kW (170bhp).

"A significant part of the power and performance is in the i8's electric system," said Gassmann. "Some 'axle-split' hybrid cars use a disconnect, so at higher speeds the electric motor is disconnected from the wheels. It means the gear ratio is set to offer acceleration at low speed. But it also means you have to disconnect the

electric motor or you compromise your top speed."

For BMW and GKN a single fixed gear ratio would mean a significant part of the acceleration or top speed was compromised. With the aim to get the car from 0-100kph in less than 4.5seconds and enable a top speed of 250kph, both the initial launch capability and top speed were essential in offering the impressive hybrid performance that would change the perception of what a hybrid car can be going forward.

The resulting innovation was the development of a 2-speed eAxle gearbox. GKN claim this is a world-first as the gearbox is able to operate over the entire speed range of the car and provide



GKN's 2-speed eAxle gearbox has allowed BMW's i8 (above) to offer the performance in a hybrid that drivers expect from a sports car

continuous electric power to the wheels in two different ratios to meet the performance targets.

"The combustion engine has a 6-speed automatic transmission in the rear and in the front is an electric system driving the front wheels," explained Gassmann. "The eAxle gearbox in the front acts as a gear reduction system as the electric motor runs up to 12,000rpm, so you need to bring it down to the necessary wheel speed, and then the differential splits the power to the wheels."

Transmission innovation

GKN Driveline does not have much experience in conventional 2WD transmission technologies for the automotive industry and did not have a part in the 6-speed automatic transmission development for the combustion engine of the car. It also had little to go on, as electric powertrain transmissions are predominantly in the prototype, motorsport and concept stages. GKN is producing eAxle gearboxes for electric AWD and axle – split hybrid vehicles for quite a while, but they are all with disconnect system. So it knew a fresh approach was needed.

Weight targets and packaging requirements were also pretty tight, as was the development time of just two years from concept to production. The team opted to keep components commercially available where possible and used conventional materials. For example, the synchroniser system for shifting gears is a commercially off the shelf component, which also helped to keep the cost of development and subsequent unit costs to the level required.

"Essentially, we had to start from a blank sheet of paper," said Gassmann. "The first generation of electric transmission has been single speed to minimise risk and complexity, but this next generation of hybrids and electric vehicles is likely to start using more 2-speed transmissions."

Diminishing returns

Gearboxes for combustion engines have steadily seen an increase in the number of gears available over the years from four to six in manual cars, and up to nine for some automatic cars. So while the development of the 2-speed gearbox is an achievement, is it likely that we could soon see a move to 3- or 4-speed?

"A 2-speed doesn't sound that exciting, when we have 9-speed automatic gearboxes, " Gassmann admitted. "But the challenge and the exciting part is to do it with an electric system. It is a totally different compared to a combustion motor. For a start you have no clutch so the motor inertia is directly linked to the gearbox and it is a very stiff arrangement with no elasticity. Shifting such a high inertia is a big challenge."

And more is not necessarily better, as extra gears introduce losses. For electric motors that have very smooth and gradual power curves, rather than the power bands of combustion engines, it means that actually the 2-speed transmission is a good solution to the problem.

"There are discussions around 3- or 4-speed transmissions and how many speeds we actually need if you have a proper electric motor in the driveline," said Gassmann. "It is a trade off between complexity costs and what you would gain in terms of performance. Simulation has shown that going from a single speed to a 2-speed will give you up a 10% gain in system efficiency. But, going more than 3-speed doesn't give you as much. The 2-speed is a very good compromise in terms of overall complexity, cost, packaging, and efficiency."

The eAxle is set to bring together driving dynamics and as well as improved CO_2 emissions as it enables combustion engines to be downsized. The technology responds intelligently to driver inputs and delivers the high-torque all-wheel driving experience as well as the useful pure electric mode or day to day efficient parallel hybrid mode, to offer something for every driving need. All in all, it hopes that it will help the BMW i8 win hearts and minds and set the road map to a cleaner future without compromising the fun.

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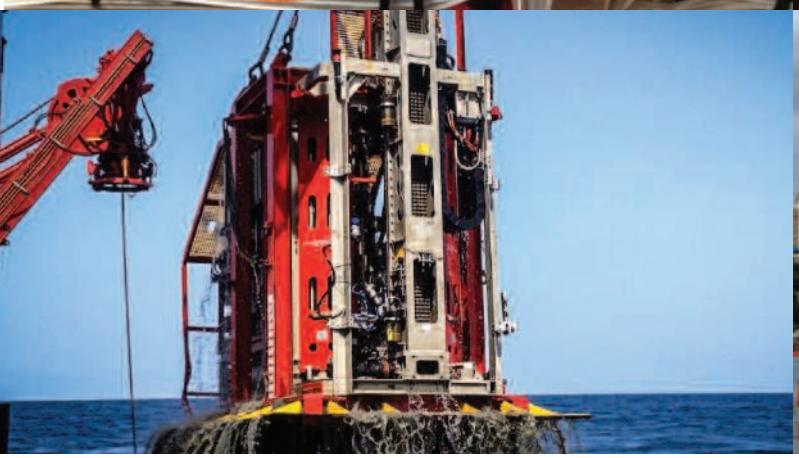


Drilling in the deep

Oil exploration is an expensive business, but new technologies – in particular a new type of subsea drilling rig - is helping to bring down these costs, as Tim Fryer reports.

Current fluctuations in oil prices have highlighted the key characteristic of the oil industry – it is expensive business. While we, as consumers, are benefitting from an easing in prices at the pump, and the knock-on effect of cheaper groceries in the shops, it is not too difficult to see the pendulum swing the other way - American's responding to their glut of shale oil by consuming more, and Middle Eastern producers protecting prices by cutting back on output.

Along with the wider economic mayhem this all creates, it also does not make it easy for the oil and gas industry to maintain consistent development plans. That oil price pendulum swings a lot faster than the development cycle of new reserves and when prices are low it makes investment in exploration a delicate calculation. And without the exploration now, it could be that resources are thin on the ground in the future.

What helps is the introduction of new techniques and technologies that can bring down the cost of this exploration. The main reason that this cost is currently so high, when we are talking about offshore resources, is that the traditional core item of equipment is a drill ship. The distance between the surface and the seabed, which can be several kilometres, needs to be added to the length of the actual drill hole when accommodating the necessary drilling rods. They are also required to be reasonably stable if drilling is to be both accurate and controlled. As a consequence drill ships tend to be very large and very expensive.

[Clockwise from top left] The CompactRIO unit providing control for the ROV Drill.
The ROV pilots control all operations from cabins on the the surface vessel

The dynamic positioning ship is far smaller and cheaper than traditional drill ships

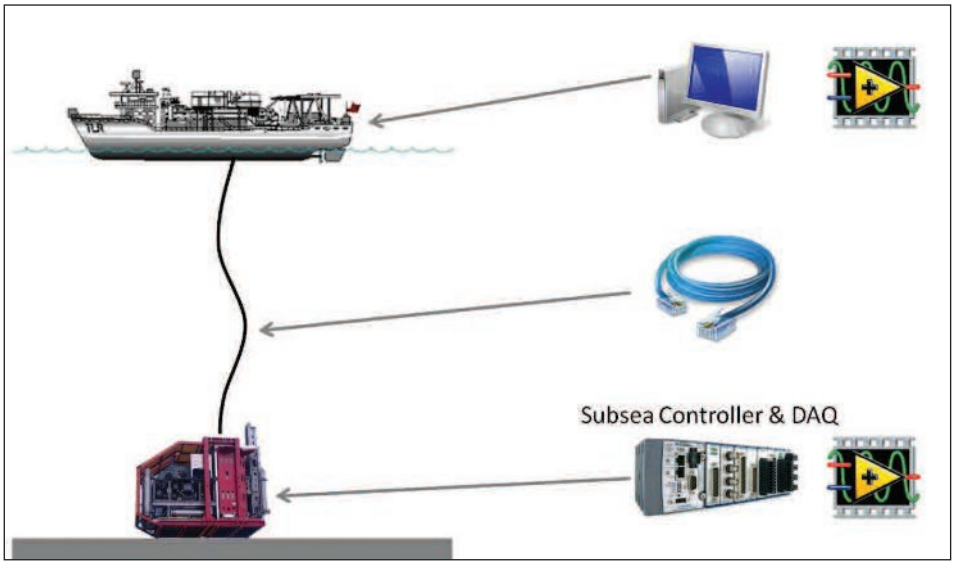
The ROV Drill being lowered for assignment off the coast of Japan, before relocation off West Africa

Canyon Offshore has been taking its operations to the seabed for nearly two decades, principally for trenching operations and some other engineering services based around underwater remotely operated vehicles (ROVs). About five years ago it started looking at a project that became known as ROV Drill.

The logic behind this is to take the portability and flexibility of an ROV into the subsea drilling environment. This fits the model for modern oil exploration according to Martin Griffiths, the senior software engineer for Metis Automation, who was involved in the ROV Drill project.

"I suppose they are taking more speculative chances," said Griffiths. "Where in the past there might have been a dead certainty that there was oil somewhere, nowadays it is small, isolated drill sites all over the place and you need to able to move around quickly and easily between them."

ROV Drill is actually moved around on a small DP vessel with an 'A' frame at the back. DP, dynamic positioning, is frequently used in exploration and research activities as it is equipped with the technology (e.g. sonar and



radar) to ensure it can maintain position in heavy seas without the use of an anchor.

Canyon developed the drill hardware with Cellula Robotics. There are two key parts to ROV drill – the drill and the robotic arm. This arm can select any one of up to 60 tools from a rack that is arranged in a semicircle around it. The arm takes a tool, positions it at the drill head and screws it on. There can be a variety of tools from drill bits, drill rods and casings for taking core samples.

If the objective is to drill one long hole it could be that the tool racks are filled with 3m long drilling rods that will be used to build up the drill tool piece by piece. However, ROV Drill can be used for a number of separate drilling activities and can remain underwater for several shifts, or even a week or two. In this case, samples can be returned to the tool rack for storage until ROV Drill resurfaces.

Alternatives to PLCs

Without the need to retract the total drill for each bore, as is the case with a drill ship, the ROV Drill is far more nimble and time efficient. But such functionality requires a considerable degree of control and that caused Canyon to reappraise existing control methodology. The rest of the company's ROVs used PLCs, but with a view to changing the approach Canyon looked to Metis Automation, an NI Alliance member.

Griffiths commented: "There are some quite complex control challenges on here. Subsea PLCs are proven and have quite a track record, but there are challenges on this that PLCs couldn't meet. You need to do a few things subsea. You need to do some really fast and accurate logging rates, so if you are taking load tests to prove to your customer that this is the place to construct [a production platform] you need to have really good evidence of that. The CompactRIO will let you have those flexible, sometimes fast sometimes slow, logging rates.

Emergency code

"We have completely redeployed our code to it a couple of times when it has been subsea. Once there was water grass on some of the proximity switches so the drill completely locked up. They sent a text to say that they were going to retrieve the drill that would mean taking eight hours to retrieve, and then troubleshoot so it would not be working for at least 24 hours. And they only get paid when it is operable in water. They were off the coast of West Africa. I connected remotely from my laptop, deployed some new CompactRIO code that over-rode the proximity switches and put in some alarms based on analogue measurements so that they could finish of their dive, finish off the job, brought it back and did all the maintenance only then."

Martin Griffiths, Metis Automation

You may be down there for weeks at a time when the logging rates might be slower, but sometimes you might want to speed that up."

CompactRIO is a software configurable controller from National Instruments and it lies at the heart of the ROV Drill. "We have got some really critical control conditions going on down there," continued Griffiths, "so dive site to dive site we have got no idea what kind of conditions we are going to meet. Some places have extremely strong side currents, so we have to put a lot of effort into just controlling the stability of the drill. We have got several control loops running in parallel, some trying to keep it stable, some trying to move the arms, sometimes against really strong currents to move the drill bit back and forth."

Accurate drill control

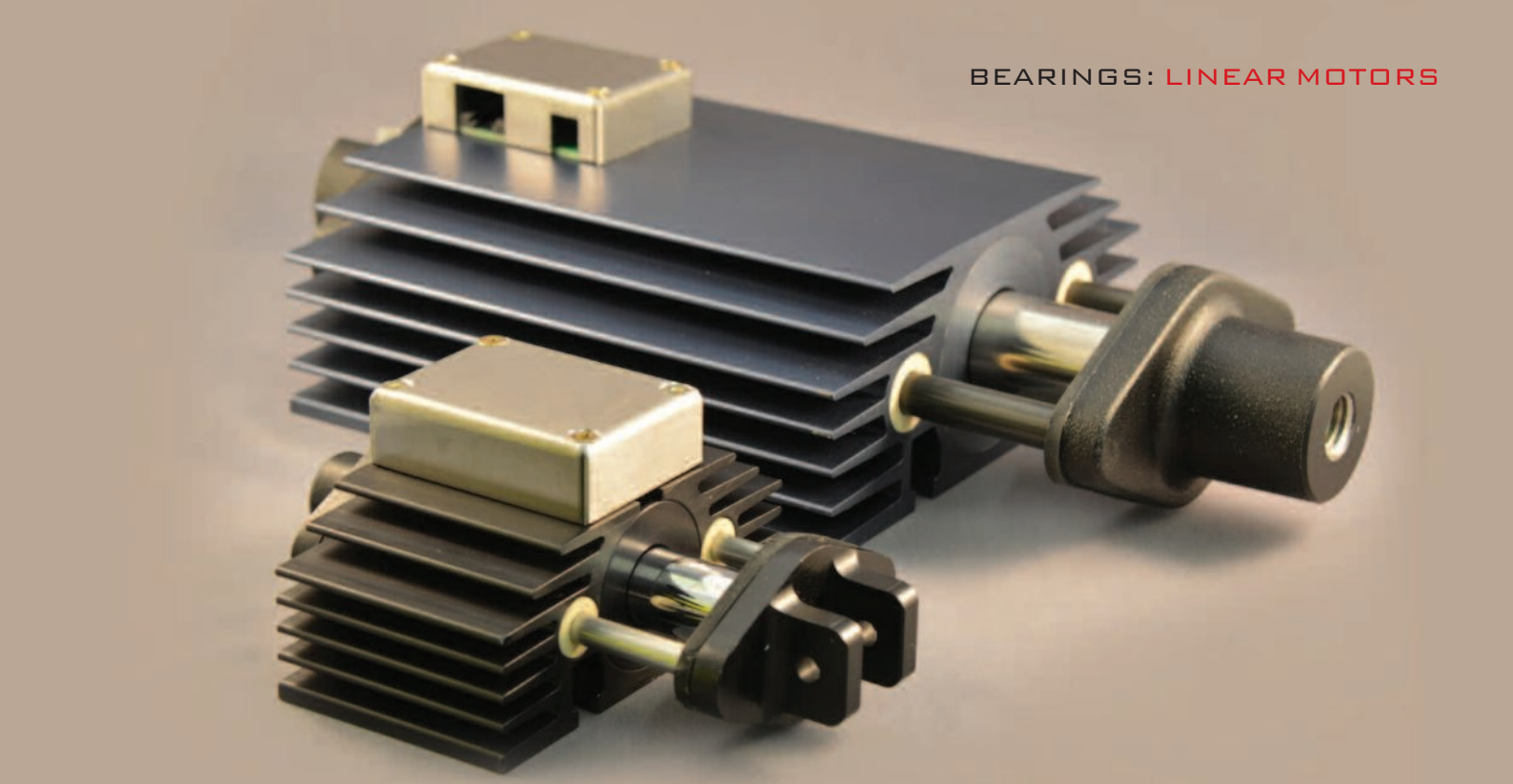
However, the most critical function involves controlling the speed and force on the drill bit during a test – in some tests this force is the important parameter rather than taking samples. Griffiths continued: "CompactRIO allows you to assign higher priorities – so when we are drilling we might want to put all of our speed and all of our effort into controlling that drill, but when we are moving the arms we might want to slow down the drill control because it is at idle and move onto something else. That is something that the PLCs were not able to let us do, but the CompactRIO allows us to move around and completely change the configuration."

An Ethernet expansion chassis is used to increase the number of inputs as there are over a hundred proximity switches, sensors, control valves and the like, but the single processor of the CompactRIO handles all the tasks.

ROV Drill is connected to the surface by an umbilical – Ethernet over fibre optic – that carries all communications and power. On the support vessel is a control cabin from which the ROV pilots have access to video feeds and all information from the ROV Drill.

"We have got some neat LabView interfaces here that show the position of the arms and the drill bit, and a huge amount of feedback. They just control everything from this control chair," concluded Griffiths.

Two systems are currently in operation; one in the North Sea and the other currently deployed off West Africa.



Constant thrust for static designers

What makes a brand new product resonate with its target audience? *Direct Thrust Designs* has found out that even 'game-changing' technology takes time to be accepted. Tim Fryer reports.

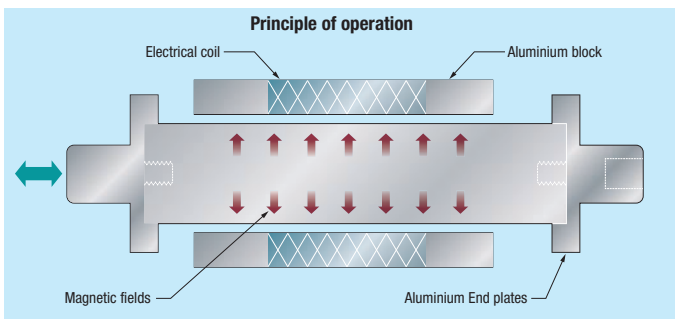
Compressed air is relatively noisy, expensive and inefficient according to Hugh-Peter Kelly, managing director of Direct Thrust Designs. According to most other people, it is a necessary evil.

What Kelly was comparing compressed air with is its use in driving air pistons as against his company's alternative of the ElectroPiston, an electrically driven linear motor. However, uptake for the ElectroPiston has been frustratingly slow for Kelly since its introduction of the latest model last year with much of the frustration coming from the advantages he perceives his invention has over the traditional alternatives.

Kelly does appreciate where some of this reticence comes from. "If people have an automation machine for churning out 10,000 biscuits an hour it has got to work. There was that case at Gatwick in the spring when the electric motor failed on the luggage line and it caused chaos for days – flights cancelled and holidays ruined. That is why engineers are so conservative, they need to be sure before they change. As an engineer I am sympathetic to that. But when I can go in and demonstrate that something looks, sounds and feels better, and they can't invest £120 on a sample piston, that is frustrating."

The product itself was outlined in *Eureka* a year ago, at a time when the new iteration of the product was completing its development phase. Although the principle had been deployed in the previous generation that had principally been used by a single client in mainland Europe, the new version was aimed at a broader market.

Linear motors are typically used in high precision applications on account of their higher capital cost. Kelly invented the tubular linear motor in the 1980s and was initially disappointed that they didn't conquer the world. In retrospect the price issue prevented this from happening – these motors required a positional feedback signal, linear encoders and control electronics and the software to control it. "What I did was take the tubular linear motor and reshape it so that it can be used to go backwards and forwards, but with no software, no electronics and no encoder," said Kelly. "I wanted to come out with a product that could rival pneumatic pistons. And that is what we have done."



The result is the ElectroPiston and a key aspect is its simplicity. You put electricity in and it goes. The motor housing comes in three cross-sectional sizes and can be cut to any length. The housing contains a single electric coil or two coils for more powerful motors. The piston rod has permanent magnets inside it and the magnetic field works against the electrical coil to create thrust – and that thrust is constant over the length of the stroke. Kelly said: "The tube with its special sequence of permanent magnets, and the design of that in conjunction with the coils in the housing ensure this perfectly even thrust."

This thrust is completely proportional to the current. Also, there are two sensors at each end that give out an analogue signal to show the position the piston is in, which allows determination of what action comes next – changing direction for example. Timing can also be adjusted. So without having any control

electronics built into the unit, the ElectroPistons can be set for any form of repetitive motion. "It is incredibly sensitive," added Kelly.

Trusted bearings

"The choice of bearings, the rods, the bearing material is just as important as the motor. If you get that wrong then it won't work," said Kelly. "Importantly for us we decided to run with igus bearings right from the start. They have been fantastically supportive to us and we have had endless meetings, for example, to make sure we have the right grade of 'DryLin' bearings."

Having selected the bearing Direct Thrust life tested a piston to 100million cycles, which took nearly three months even with the accelerated mode of operating. This accelerated wear check, which the bearing passed unscathed, equated to one cycle per second for 16 hours a day, five days a week for seven years. "People need something that will go backwards and forwards all day every day and be sure that it is going to last," added Kelly. "We probably would have got away with using lower spec bearing technology but not with the same degree of confidence. When you go and see potential customers you can say it has got igus bearings inside it and that seems to put people's minds at rest. To some extent, you want to be able to delegate some of the responsibility to others. So if you have got a reputable, well-trusted industrial partner, then you can relax and know that the bearings will do its job."

For similar reasons the guide rods have also been bought from igus and are made of a specially hardened aluminium. Being aluminium they are light, so that reduces the 'to and fro inertia', which does matter in very fast moving systems.

The consequence is a system that requires no maintenance, unlike its pneumatic counterparts. But still the assurance of these maintenance-free igus components does not appear to be enough to cause engineers to cast aside the compressed air that they are so familiar with.

"People just don't know about it because it is new," claimed Kelly. "I think that is part of the problem - getting people to realise that there is an electric piston that can replace air pistons."

The ElectroPistons have gained recognition as finalists in both the British Engineering Excellence Awards and the IET Awards, but designers remain interested rather than committed.

To address this issue Direct Thrust approached a supplier of compressed air systems to put conservative figures on the installation of a new system, and these are outlined in Fig 2 (below), along with the equivalent costs of an ElectroPiston system, demonstrating that the overall cost for the latter system is approximately a fifth of that for a traditional one over a five year period. It accounts for investment in the compressed air infrastructure – the compressor, valves, control and distribution lines etc – and this may already be in place in many industrial environments, but even then Kelly argues that the cost of running and maintaining pneumatic systems is not often taken into account.

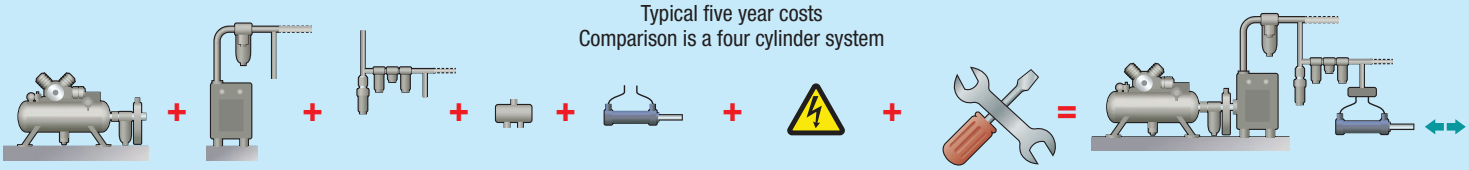
Indeed, said Kelly, some design engineers only look to the capital cost as that is what their customers are most interested in.

"It is purely about what goes out the door and what profit they can make from it, regardless of what that means for the person who has bought it," he said. "And that is counting against us. The cost of the compressed air and possibly maintaining it is not their problem. Compressed air does cost money and there are safety implications as there is a heavy onus on manufacturers. So people need to take account of the whole equation. Over time this system saves money, both for the installer and the user. But feet are stuck in concrete – it is unbelievably hard to get people to change."

directthrust.co.uk
www.igus.co.uk

ElectroPiston cost comparison

Typical five year costs
Comparison is a four cylinder system



Compressor	Air preparation drying/distribution	Filtration/ oil	Control valve 4 x £130	Cylinder 4 x £140	Electricity 2.2kWh x 8 hours x 50 weeks (October 2013)	Maintenance 2/year *	
£350.00	£810.00	£245.00	£520.00	£560.00	£587.50	£400.00	Capital cost £2485.00 Annual running cost £987.50

Excludes typical installation costs of £1920.00

Five year total £7422.50

600W power supply and relays	4 x ElectroPiston EP-GP-D-01/130 4 x £173.10	Electricity 600W	Maintenance	
£215.00	£692.40	£146.87	£12.80	Capital cost £907.40 Annual running cost £159.67

Excludes typical installation costs of £380.00

Five year total £1705.75

**Statutory maintenance requirement*
Comparison calculations are based on continuous operation of 4 air pistons/4 ElectroPistons for 8 hour shift

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Top test for Airbus

Aerospace is one area where data abounds – but obtaining the right data, by deploying the right tests, and then using it usefully is what counts. *Eureka* asked Matt Farrelly to explain.

In the digital age, ensuring the success of a product is difficult; vast data is needed to even begin to understand what market forces might pose a threat at a given stage of the product's lifecycle. Added to the economic environment of global recession, anxious investors and globalisation, the current world is not an easy place for product design engineers or project managers. Risk is potent, increasingly unpredictable and, arguably, higher than ever.

This rings more true for some sectors than for others, particularly those requiring the most investment in terms of time, money and resources. A key example, of course, is aerospace in which the development stage often runs into several decades. Globalisation, in particular, creates new pressures on the current industry giants. According to Boeing, by 2033 China is set to dwarf the United States, with the market over the next two decades valued at $870bn. Expansion into these markets may be lucrative but will also serve to increase costs for the Western OEMs, particularly in the context of fierce competition from home grown low cost manufacturers such as the Chinese state-owned Comac.

A method to mitigate against such circumstances is to maximise efficiency in all stages of a product's development thereby competing in terms of cost and time-to-market.

The Airbus A350 undercarriage being lowered into the test rig {inset}

System level integration testing is often the critical point in the development of any large and complex product. Incompatibilities, bugs, safety issues and validation problems can hinder time-to-market objectives and have serious implications in terms of cost. It is therefore an area where making improvements that help achieve high level system maturity as early as possible in the product lifecycle will bring considerable benefits.

The use of Hardware-in-the-Loop (HIL) is becoming increasingly prevalent in many technology-based sectors. In simple terms, HIL simulation allows for physical components or systems to be tested within a simulated parent system environment. This technique permits the integration of a system in effect to be tested prior to actual, physical integration. The advantages of this span cost, time-to-market and safety.

Having been conceptualised 15 years ago, HIL is not a new technology but it is being applied with a level of innovation not seen before. One example is Spherea Test & Services' U-TEST solution. The company has put U-TEST to the test on the largest of stages with the Airbus A350 programme. In this case, U-TEST was used as a HIL solution for actuators within the landing gear system.

An aircraft's landing gear is a complex and highly integrated, mission-critical sub-system. Integral to the design process is predicting and validating the failure rate within the environment in which it will be operational. For Airbus A350, testing of the actuators began at simulation stage, with the actuator as a synthetic component within a synthetic aircraft. The bench then evolved to include physical instrumentation and measurement equipment 'into the loop'. This progression continued in tandem with the development of the Unit-Under-Test (UUT) until eventually a physical test rig was built. The rig, controlled by U-TEST, inflicted external parameters onto the actual product which were generated by the simulation of the rest of this aircraft. In effect, the subsystem's integration into the parent system was tested prior to actual integration.

This ability to evolve an integration test bench in parallel with the development of a product offers additional benefits. Primarily it makes the bench more cost effective because it creates an opportunity for expanded use and limits the need to heavily modify. Secondly, it creates continuity within an organisation's test activities - feasible due to the open (e.g. Linux and Eclipse) and modular features of the solution.

Matt Farrelly works for Spherea Test & Services.
www.spherea.com

Scintillating **sintering**

Laser melting metals has the potential to revolutionise aircraft part design and manufacture. *Eureka* talks to three industry experts to find out how.

The last 10 years has seen marked change to the way aircraft are designed and made. While they still largely take on the general shape of a cigar tube with wings, the structure is highly optimised. One of the major changes in recent times has been the introduction of composite materials, which have helped bring about step change improvements in fuel efficiency by significantly reducing the weight of the overall structure.

All of this has happened relatively quickly. So, it begs the question: are we at the leading edge of the next big technology? Additive manufacturing technologies are beginning to be used for serious aircraft production. And, it is not just development work, with a bracket connector on the Airbus A350 XWB highlighted as a forerunner application. So could additive manufacturing have a similar impact on the aviation industry over the next 10 years?

"Our primary objective is to reduce weight," said Peter Sander, head of emerging technologies and concepts at Airbus. "Additive manufacturing and laser melting metals allows us to design completely new structures that can be more than 30% lighter than conventional designs using a casting or milling process."

While it's unlikely to lead the industry back, on mass, to metals, what is likely is that the metal materials used in aircraft, still around 50% of the structure, can be reduced in weight by a significant amount. And this is all possible because of the high degree of geometrical freedom additive manufacturing processes allow.

"Additive manufacturing and laser melting metals allows us to design completely new structures that can be more than 30% lighter than conventional designs using a casting or milling process." Peter Sander, Airbus

Frank Herzog, chief executive of Concept Laser – an additive manufacturing specialist, said: "It gives the ability to economically keep component density under control and determine the microstructure quality. Another fundamental feature is the ability to define the force distribution within the component, which is often impossible with conventional parts, or is considerably more difficult to achieve."

And this design freedom offers near infinite geometric possibilities that enable outside surfaces and also internal structures to be designed, specified and optimised. And this means that parts can be made to be functional.

Professor Claus Emmelmann, chief executive of Laser Zentrum Nord, said: "Additive manufacturing offers greater freedom of design since undercuts and interior channels can be used to provide cooling, for example, on a [bigger overall] design."

Indeed, additive manufacturing could well bring around a paradigm shift in the way engineers can, in the not too distant future, think about the design and development of aircraft components.

Professor Emmelmann added: "The advantage for structural elements used in aircraft are obvious. For the brackets we're currently focussing on, this means a

"Engineers are discovering that 3D printing offers many answers to problems posed by force absorption, required durability, high quality standards and also bionic design."
Frank Herzog, Concept Laser

considerable weight reduction, which in turn translates into lower fuel consumption or the potential to increase the load capacity of an aircraft.

"In the past, compromise with lightweight construction has been necessary due to the restrictions of conventional manufacturing – restrictions we are now able to elegantly avoid."

One such drawback that can be avoided is the ability to control the internal geometry of a part to remove as much weight as possible while keeping the necessary strength. The use of topography optimisation is helping engineers carry out this kind of analysis virtually, but additive manufacturing allows these complex, and often seemingly random, structures to become physical flight-ready parts.

Sander said: "With laser melting we can manufacture very fine – even bone-like – porous structures. The aircraft parts of the future will look 'bionic'. Nature has optimised functional and lightweight construction principles over millions of years. We are currently investigating and analysing these solutions found in nature with regard to their applicability. Initial prototypes indicate great potential, and the process could launch a sort of paradigm shift in design and production."

How big will this be?

Though there are still many technical restrictions to be overcome, such as the cost-effectiveness of particular parts and the industrial availability of metal powders, it is unlikely that complete aircraft will ever be printed, even in 10 years.

However, Professor Emmelmann thinks it will be used more ubiquitously in the future. He said: "I'm confident that future laser additive manufacturing will be capable of producing increasingly larger and more complex components in a cost-effective manner. This will be possible thanks to the rapid pace at which the system technology is being developed, and the increased productivity associated with such advances. I see great potential, in particular, for structural components with dimensions of up to 1m, as well as for engine components."

As well as the many potential advantages in the design of components, there are also a number of potential areas during production processes that could benefit. The ability to print straight from a 3D CAD file gives a great deal of flexibility of what you make and when. And this could help slash development and procurement cycle times.

Herzog said: "Additive manufacturing is generally characterised by various aspects: decentralised, rapid turnaround, quick time from implementation to the finished component. It also allows for lower logistics and warehousing costs. It uses fewer resources than conventional manufacturing methods, which makes it a green technology.

"With regard to the safety aspects of components, engineers are discovering that 3D printing offers many answers to problems posed by force absorption, required durability, high quality standards and also bionic design."

Additive processes are set to shorten development time by as much as 75%. Airbus, for example, currently budgets around six months to develop a component – but with additive manufacturing it claims the same parts could be developed in just one month.

Professor Emmelmann said: "It's now possible to produce functional samples of components that are very close to being ready for series production without incurring the high cost of tools or other pre-production expenses. It means sources of error can be identified in the early stages of the design process, which allows for optimisation much earlier."

Production benefits

While milling an aircraft part has been a standard process since the early days of flight, it does result in as much as 95% of a solid billet being machined away. So the process has the potential to cut waste and offer economic advantages. Laser melting offers the potential to produce components with near-final contours, and by contrast needs just 5% of its surface to be machined away to form the finished part. This makes the process especially attractive when using expensive materials, such as titanium.

A bracket for the Airbus A350 XWB is an early example of how additive manufacturing could be used in the future

Although the resulting swarf is recyclable, it is a process that incurs cost and resource.

Professor Emmelmann said: "In aircraft manufacturing, we work with the 'buy-to-fly' ratio, and 90-95% is a fantastic figure. The process generally results in positive effects for manufacturing costs for small to medium-sized unit quantities as the higher investment costs for casting moulds are eliminated, as is the cost of tooling."

Initial studies by Airbus show that the number of manufacturing steps necessary could be cut in half, since the process yields near-net-shape parts. The resulting components can also be welded, meaning the constriction of smaller print tray sizes can be overcome.

Professor Emmelmann said: "Since we do not require any special tools or clamps for the additive manufacturing process, we can produce the component directly from the 3D CAD data. This time factor ensures that in many cases we can work considerably faster than we can with conventional manufacturing processes.

"I see great potential in particular for structural components with dimensions of up to one metre, as well as for engine components."

Prof Claus Emmelmann

"If the direct cost of manufacturing a milled component is compared with the cost of manufacturing the same component using laser additive manufacturing, the additive process is usually found to be less cost-effective. However, when the components are redesigned, so they are lighter or have a higher functional performance characteristic, there are already many examples of circumstances in which the use of additive manufacturing processes offer cost advantages."

Time for a rethink

Similar to aircraft structures, Airbus is currently rethinking the entirety of aircraft systems with laser additive manufacturing processes in mind.

The term LaserCUSING describes the technology of using a laser fusing process to form components layer by layer

"We are facing a continent of opportunities and options," said Sander. "We are entering a new territory, one with fascinating opportunities on the horizon. Initial prototypes produced in our development work show significant potential in terms of reducing costs and weight. Functional integration is one of the possible new options."

The comparatively small unit quantities involved in aircraft manufacturing could actually favour laser additive manufacturing techniques. The additive manufacturing process does not allow for the advantage of any economies of scale, as is the case for other production methods.

It means that unit costs change only very slightly as production volumes increase. Conversely, conventional production methods, such as pressure casting, are more cost-efficient for producing large unit quantities. But additive manufacturing is still a technique in its infancy, with much development still to come.

Herzog said: "Laser output has been increased to 1000W while the assembly speed for aluminium parts has been accelerated by a factor of 10 to 15. In my view, this represents fantastic progress. With very large components, the internal stresses in the part increase due to the nature of the process.

"The limits can be expanded further with an intelligent joining technique in the sense that assembly could play an important role for large components that are to be manufactured cost-effectively. This makes it possible to develop components with large volumes and extremely long components that extend beyond the assembly space sizes offered by current or future laser melting systems."

Though larger parts may well be possible in the future, from a cost-effectiveness standpoint, smaller components that can be manufactured with the systems already available seem to offer the most immediate advantage.

Potential for existing aircraft

Spare parts for aircraft are considered a necessary cost-intensive and logistical challenge due to the long lifecycles of many components. The problem, to meet the challenges of global availability, warehouse stock, lifecycle and time pressure is one exciting area where additive technologies could make an impact on existing aircraft, not just offer potential to those in the future. Spare parts can be manufactured where they're needed, without tooling, and on demand, instead of having to fill large warehouses to store rarely needed items around the world.

Sander said: "Since February of this year, Air Transat in Montreal has been flying with the first spare part printed and delivered by Airbus.

"The former manufacturer of the injection-moulded part for a Cabin Attendant Seat in an A300/310 was no longer available and the tools had been scrapped. The question we faced was whether to invest in new tools, at a cost of $36,000 or take advantage of 3D printing? By using the laser melting process, we were able to offer the part at a cheaper price from the outset, without tool costs. As a result, we no longer store hundreds of parts in warehouses, but instead, we will operate decentralised spare parts printing centres and only manufacture plastic spare parts when they are requested. A similar strategy is being pursued for metal components."

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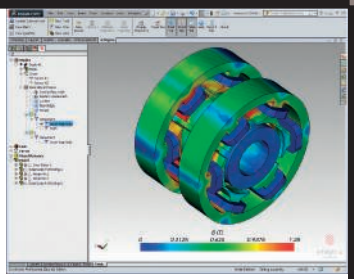

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Portable power

Mobile phones have allowed many parts of the world to bypass hardwired landlines, enabling millions to tap in to the power of telecommunications without the intensive infrastructure and cabling that much of the developed world has implemented.

Communication by mobile phone has brought about numerous social, economical, health and security benefits for many rural communities living in the third world. However, the uptake poses the major problem of charging them.

While mobile phones are readily available in developing countries, rather paradoxically, access to electricity can be inconsistent and users don't always have the power they need to charge their phones.

In many rural areas and third world communities electricity can be sparse and not readily available. And, when it is available, communities often vie for it against other, arguably more important, uses.

In some cases, where temporary vaccine clinics have been set up with solar powered roofs to keep the vaccines cold, electricity generated for freezers has instead been used by locals to charge mobile phones, such is the demand.

The challenge

The challenge this month is to therefore come up with a cheap and accessible source of electricity. Now, while many of you might initially think of a diesel generator, the ideal solution to the problem should be clean and non-polluting. We are looking for personal power generation that is affordable, so any large scale developments should also not be considered.

The idea is to have a generator that is able to harness all the various types of natural energy surrounding whatever community it is. If it is close to a river or stream, then it should be able to use that flow of water to generate electricity. Alternatively, it should just as easily be able to harness the wind or sun as well as mechanical power such as bicycles, or even straight forward muscle power. Whatever is available should be able to be turned in to useful electricity that can charge a normal mobile phone.

The solution we have in mind is a small device that is able to take advantage and create energy from numerous natural and clean sources, is low cost and relies on well known technologies. The generator itself is no bigger than a bottle of water, but it also relies on numerous attachments to capture the individual sources of power. Our solution will be in the February issue of *Eureka*. In the meantime, see if you can create something better.

Any ideas that you would like to share with us? Feel free to send an email to the editor at **tfryer@findlay.co.uk**

The answer to last month's Coffee Time Challenge - how to provide accurate medical information from home - can be found on page 8.

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