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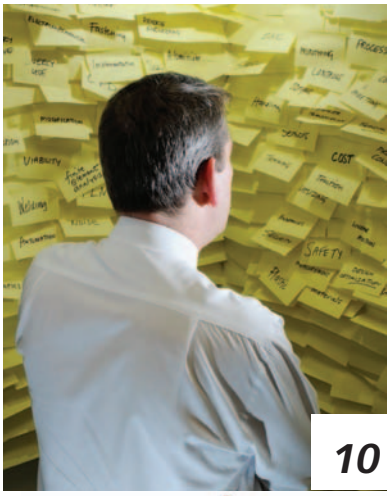
Volume 30 Number 2 February 2010



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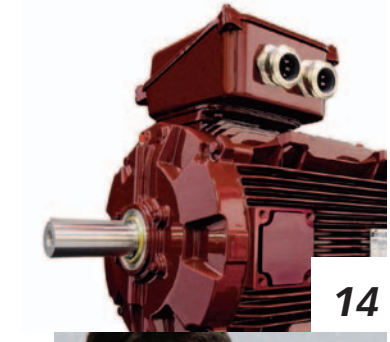

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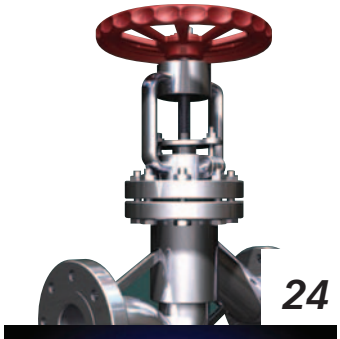

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ISSN-0261-2097

Eureka (incorporating Engineering Materials and Design and Design News) is free to individuals who fulfil the publisher's criteria. Annual subscriptions are £78 UK (£115 overseas or £150 airmail).

If you change jobs or your company moves to a new location, please contact circulation@findlay.co.uk to continue receiving your free copy of Eureka.

Origination
CTT
Printed in England by
Wyndeham Heron Ltd

Published by
Findlay Media,
Hawley Mill, Hawley Road,
Dartford, Kent, DA2 7TJ
Tel: 01322 221144
www.eurekamagazine.co.uk

Getting some answers

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

Becoming editor of Eureka just as the UK emerges officially from 18 months of recession feels like fortuitous timing. Even if the recovery is fragile and the levels of growth less than stellar, I'm sure I can't be alone in feeling cheered by the news.

If the recession has shown us anything, it is that the UK economy must have balance restored to it. Putting all our eggs in the basket of the City has proved well-nigh disastrous and, if anyone is leading this country out of recession, it is our manufacturing sector. With manufacturing output and exports rising, surely the penny will drop and Government will finally recognise the importance of engineering?

But where will the next generation of engineers come from? Innovative engineering is leading the way in reducing carbon emissions and producing alternative energy sources, but dire warnings are emerging that the current skills gap could fatally damage our hopes of meeting these targets. Surely if Government is serious about achieving these goals, it has to match that seriousness with investment in the sector most likely to help it do so?

Organised by Findlay Media, The Future of UK Manufacturing Summit, taking place on 4 March 2010 in London, will hopefully offer some answers. With key speakers from industry, government, politics, economics and industry associations, the Summit will provide UK manufacturers with an opportunity to question those whose decisions will most directly affect their future.

However, while Government has a major role to play, so, too, does industry. After all, unless engineers are positive about what they do, it is asking a lot for others to be.

Got a story? Then drop us a line at eurekanews@findlay.co.uk or call us on 01322 221144

Briefs

VENTURE CAPITAL FUND LAUNCHED

Power generation specialist Alstom and energy management company Schneider Electric, have announced that they are joining forces to launch a new venture capital fund. The fund will finance innovative start ups in the fields of energy and the environment. According to both companies, this is the first time that two major industrial groups have been associated in a joint initiative of this nature.

STUDENTS AVAILABLE FOR SUMMER PLACEMENTS

Businesses in the Advanced Engineering and Materials sector are being invited to offer placements over the summer period for students who are 'work ready' and can make a valuable contribution to the workplace.

The 'Learn Earn and Advance' programme, run by NAMTEC (National Metals Technology Centre) and supported by Yorkshire Forward, provides high calibre engineering and materials science undergraduates for summer placements in 2010 and 2011 for companies in the Yorkshire and Humber region.

For more information, contact NAMTEC on 01709 724990.

BOSCH COMPETITION DEADLINE LOOMS

The deadline for entering the Bosch Technology Horizons Award competition is fast approaching. The award is open to all young people aged 14 to 24 with cash prizes available of up to £1000. Entrants are asked to write an essay of either 500 words for 14 to 18 year olds or 750 words for 19 to 24 year olds, in answer to a question 'Are engineering and technology essential for future development?' The deadline is 22nd March.

For more information, visit **www.bosch.co.uk/technologyhorizons**

Wave power breakthrough approaches completion

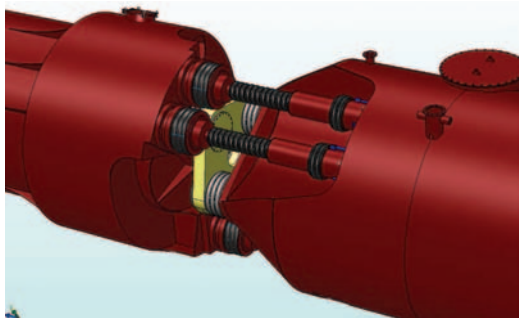
Scottish company Pelamis Wave Power is nearing completion of its new P2 Wave Energy Converter.

The P1 was the world's first machine to generate electricity to the grid from offshore wave energy commercially. The P2 configuration allows more energy storage to be included at a lower cost, as longer individual accumulator vessels can be used. The first P2 unit, ordered by Eon, will be tested soon.

One of the biggest challenges facing the team was how to manage the loads and motion, whilst extracting as much power as possible. The working forces generated across each joint can be several hundred tonnes, presenting problems for the bearings, which have to take up the forces coming back through the joints."

The original P1 had separate hinged joints, which, although they allowed useful working space between the axes, had to carry high transferred loads and were unable to manage the combined motions necessary for the P2 configuration. The bearings themselves were also relatively high-friction, making the system less energy-efficient.

Pelamis' engineering team eventually decided to bring the joints together. This required a completely new bearing solution able to manage combined



angles in a single package. For this, the company turned to Schaeffler for help and support. Key to the success of this new joint concept was a new low-friction material designed and developed by Schaeffler. This modified PTFE fabric liner is a member of the Elgoglide family.

Says Mike Woods, Pelamis' senior engineer: "The new design is a self-contained, modular bearing unit. It's a bit like being able to take an engine out of a car in one go; it allows us to improve our inspection procedures and reduce our exposure to technological risk."

www.pelamiswave.com
www.schaeffler.co.uk

Future of UK Manufacturing Summit launches

Findlay Media and Institute of Mechanical Engineers have announced the launch of The Future of UK Manufacturing Summit.

Findlay Media's executive director, Ed Tranter explains "Just a few years ago, the feeling was that the UK needed to plan for a post industrial economy; one based on finance. But after a period of enormous economic change, within the UK and the wider world, manufacturing has never been more important."

The Summit, which takes place on 4th March 2010 in London, has created the platform to facilitate that discussion. With key speakers from industry, government, politics, economics and industry associations, the Summit will provide UK manufacturers with an opportunity to hear from andquestion the people who will affect the future of your business.

Comprising keynote speakers and a question time panel, the day will cover the full range of issues facing UK manufacturing. In the afternoon, a series of focus group sessions will allow further discussion centred around the crucial areas of Aerospace, Automotive, Defence and Electronics.

If you have an investment in UK manufacturing and want to to be involved in the debate about the sector's future, then this is a must-attend event.

For a full speaker list and more details on the event, go to **www.ukmanufacturingsummit.co.uk**

For sponsor enquiries, contact: Ed Tranter, Executive Director, etranter@findlay.co.uk, 01322 221144

Delegate enquiries: Julie Knox, events manager, jknox@findlay.co.uk, 01322 221144

Ford focuses on sustainability

The Ford Focus is the spearhead of a comprehensive European recycling campaign that has created more than 300 vehicle parts formed with recycled material.

Recycled components in the current Ford Focus include: the heater and air conditioning housing, made from 25% recycled plastics; wheel arch liners, made from 100% recycled polypropylene; and a fabric seat option, made from 100% recycled material.

Sources for this recycled material are everyday items as diverse as plastic bottles, bottle tops, computer and TV housings, compact discs, household carpets and even denim jeans. The noise insulation in all Ford vehicles, for instance, is made from jeans and reclaimed car seat upholstery.

Valentina Cerato, materials engineer at Ford's Dunton Technical Centre, Essex, said: "Ford's approach is guided by its Product Sustainability Index, including sustainable material and substance management. The index covers recycled materials and the use of natural fibres, which continue to replace plastics in Ford components."

Ford is also stepping up research into plastics, rubber, foam, film and fabric, to develop more alternative bio-based materials that are functional, durable and cost-effective in order to decrease dependence on oil-based products.

www.ford.co.uk

TSB FUNDS ELECTRIC VEHICLE BATTERIES

Nearly £1 million of funding has been awarded by the Technology Strategy Board to a consortium developing new battery chemistries for use in plug-in electric vehicles (PHEVs).

The £2 million project, led by battery manufacturer Axeon, aims to accelerate the introduction of next-generation batteries that will offer higher energy density and lower cost. It will take advanced battery chemistry out of the research laboratory and into a real-world PHEV.

Other members of the consortium include the University of St Andrews, a centre of excellence for energy materials, Nexeon Limited, a UK battery materials company developing silicon anodes for the next generation of Li-ion batteries, and Ricardo, a leading provider of technology and engineering solutions to the automotive and transport industries. Successful delivery of this project will thus further consolidate the UK's position and future as a leading innovator and provider of advanced vehicle battery technology.

www.axeon.com

World's smallest 40A, three phase power supply launched

Measuring only 110 x 124 x 127mm and weighing 1.5 kg, PULS UK's QT 40 is claimed to be the smallest 40A three phase power supply on the market. Two versions of the device are available, 24V, 40A and 48V, 20A, both delivering 960W with at 95.3% efficiency.

The QT 40's high performance has been achieved by PULS UK's use of three micro-controllers to maintain optimum efficiency at all levels of load. This efficiency also makes power sharing easier by allowing multiple units to be mounted side-by-side on the DIN Rail without the need for fan cooling.

Other features include near zero inrush at switch-on, shut-down input with high Mean Time Between Failure values and, despite its size, built-in mains fuses. PULS UK's Bonus Power overload design provides 150% current reserves for up to four seconds.

The QT 40 is suited to industrial bulk power applications, such as control systems for large electric motors powering production equipment, conveyors and machine tools. It is also suitable for outdoor applications, where the ability to operate at temperatures as low as –25˚C is important.

Harry Moore, PULS UK's managing director said: "Because the QT 40 is so compact and has such a high specification, it's going to make a big difference to the way engineers design equipment in the future."

www.puls.co.uk

Solution to last month's coffee time challenge

The solution to last month's coffee time challenge – to come up with a mechanism for opening jars – came from MAS Design proprietor Mark Sanders. He used an epicyclic gearbox as a differential. If the gear ratios are chosen such that balancing is equal, you end up with two balancing forces. The product, called Cascade, starts gripping the body, then starts to tighten its grip and twist.

But building a 2500:1 gearbox using the minimum number of components is not easy, which is why the product has massive gears with tiny pinions.

Other solutions were offered by readers, including one from Alan Horsell involving fingers moving radially and along the axis. He said: "Clearly, I stole the idea from the human hand, just added a little more muscle."

Another, rather more low-tech, solution came from Denis Sharp, who suggested the simple teaspoon, "The main problem is that low pressure inside the jar holds the lid on and increases the friction between the lid and the jar. Simply insert the tip of a teaspoon under the edge of the lid, with the bowl resting against the jar, and press the handle towards the jar. The leverage distorts the side of the lid and breaks the seal, letting air into the jar."

Saving the knowledge

The process of capturing, storing and providing access to their resources of human knowledge is a problem that has tested the ingenuity of manufacturing companies for many years.

At one time, it was predicted that all such expertise would be captured by expert systems that relied either on the manual insertion of rules or on a neural net. However, the former approach was time-consuming and problematic if the individuals relied more on experience and intuition than logic, while the logic generated by the latter method can be impenetrable to human programmers.

Nonetheless, the importance of retaining knowledge remains clear. Talking to Eureka recently, Bloodhound SSC driver Andy Green revealed that the turbo pump that will be used to pump the hydrogen peroxide into the car is closely based on that originally developed by Rolls-Royce for the Blue Steel standoff missile that entered service in 1961. The drawings had been lost in a fire, but the designer could still be consulted. It was thus possible to reverse engineer parts that still existed and come up with an improved version of the pump without having to develop it from scratch.

More chillingly, perhaps, Tom Robertson, a retired engineer from AEA, told Eureka a few years ago that computer test data on the stability of nuclear reactors derived from experiments that nobody would nowadays care to repeat, now only exists in the minds of a few old men and data tapes that can only be read by computers than no longer exist.

Clearly, part of the solution lies in meticulous record-keeping processes and effective communication, but only part. There is a considerable gap between retaining knowledge and actually being able to capture it when and where necessary. In a project undertaken between 2000 and 2003 entitled 'Knowledge Capture, Sharing and Re-use in the Design Process', Dr Richard Crowder of Southampton University attempted to address this issue.

Funded by the EPSRC (Engineering and Physical Sciences Research Council) this was a multi-university and industrial contract with Rolls-Royce BAE Systems, the Universities of Sheffield Cambridge and Southampton. Says Dr Crowder: "We started with the statement that 90% of industrial design activity was based on variant design, so there needs to be a clear route for the designer to get back that information on to his desktop as soon as possible. A statement we also pulled out was that in design activity, 70% of it basically comes from previous solutions. So the whole object of the exercise was to give the designer tools and approaches to extract information either from colleagues (ie the expertise across companies) or to provide them with tools to search company archives to access the knowledge of those who are no longer with the company."

The loss through natural wastage of individuals with expertise is obviously a major obstacle to success for any such system, as Dr

you need

Tom Shelley explains how companies can ensure that expertise that is critical to the design process is captured and shared within companies.

Crowder makes clear. "If you go back a number of years, the right people would always be around. But these days, people move so fast that you simply can't rely on that being the case. So you've tended to lose what we always thought of as the wizened old chap at the back of the drawing office who knows everything and who's been there since the year dot. You've lost that kind of resource."

The solution was for Southampton University to develop what was called 'Expertise Finder', a system to enable designers to access the wisdom of the entire company past and present to find solutions. However, this approach faced a number of problems, most of which lay in the human aspect of any such system.

Says Dr Crowder: "If your approach relies on people to say they have expertise in a particular area, the chances are it will fail. Those who do have the expertise may say 'I don't want to be pestered by 250 other people asking for advice' and so not volunteer. Meanwhile, others will say 'Of course I'm an expert' because they want to get on in the company and they aren't quite as expert as they suggest."

Instead, the project chose instead to use existing data to identify expertise. This ranged from examining company reports to noting the positions of individuals within the company and building an information resource from there." We mapped together a number of databases, put in subject areas and it came back with a list of likely people who would be able to help with that particular issue."

Of course, this study was undertaken with a view to it being effected by large companies and Dr Crowder does feel there are different requirements, depending on the size of the organisation. "The smaller the organisation, the less of a problem there will be because everyone knows everyone else," he says. "The problem with large companies is that they're often multi-sited and you tend just to work within your group. So you have 'the watercooler effect'. People will ask: 'Do you know anything about x, y or z?' and the answer will either be 'Yes, try Fred in another division' or 'no' and they've got to do all the work all over again."

However, certain rules apply regardless of the size of the company. Says Dr Crowder: "The biggest problem is the accuracy of the initial data. Everybody said their initial data was correct, but when you got down to it, there were lots and lots of errors – even down to mistakes in the company telephone directory, which caused a lot of grief at first. However, we proved the concept itself works and therefore I see no problem in rolling it out across any size of company."

An example of methodology in approaching this problem can be seen in Procter and Gamble, which employs Siemens' Teamcenter Product Lifecycle Management system for this purpose. Here the problem was particularly acute, as the company's R&D division consists of many separate laboratories. Data was previously fed into vertical applications developed by each laboratory, where it remained accessible only to those that had developed it. No method for either sharing such information across the company or even indexing it it could be located. And, because the company has 130,000 employees in 80 countries, personal networking was impractical to say the least.

This problem has been addressed by the introduction of 'electronic notebooks', on which users enter their discoveries and ideas into the software in the same way they did in their laptops or paper notebooks. This information is then available to authorised users in the rest of the company.

Again, storage of all data is a critical part of the discipline. For the system to work perfectly, the research and development should begin

Design Pointers

- It is essential to store data about design requirements and decisions in such a way that it can be subsequently accessed by others who may need to make use of it.
- This requires use of a suitable associative database and a process that ensures that the right data goes into it
- An alternative solution is not to expect people to load information into a database but to form networks among people who have knowledge and then capture it

with capturing the requirements for the project, such as purpose, weight, quietness and cost, leading to a product definition to which all other information can then be linked. It should then be possible for somebody to go back months later and access both the initial requirements and all the design decisions.

Legacy data, on the other hand, remains an issue. According to Siemens, materials on laptops could be cut and pasted into the new software module, but material that exists only on paper is still a problem.

The emphasis on processes and meticulous recording is reiterated by Dassault Simulia's Tom Bianchi when he says that companies need to have 'a process that requires the recording of design decisions and the reasons for them'. For this reason, Dassault's main PLM offering Enovia enables the linking of engineering models and parts of models to other items held in the database.

Says Bianchi: "Because of the data being associated with the model, it is much simpler to access items in the database than it used to be." Examples willing to be cited include Ascari cars, which makes small numbers of supercars at Banbury. Bianchi said that Ascari recently discontinued one of its lines, but recorded everything that had gone into the car in a database so that it could all be retrieved if the company started to sell the car again in the future.

Again, though, Bianchi concedes there is a problem with expertise that only exists in the minds of humans, citing the example of steel mills in Yorkshire that have had to bring back 70 year old former employees when they need to make adjustments to their rolling mills. However, in cases where the human expertise no longer exists or is not accessible, Simulia offers a facility to undertake non-linear simulation to rediscover the optimum set-up parameters and this information is then retained electronically in the system so that it cannot be lost a second time.

Both Teamcenter and Enovia scale down for use by smaller companies, while for Pro/Engineer users, PTC offers PDMLink and Windchill. Firms accustomed to basing their design on AutoCAD, Inventor or SolidWorks can use the data management packages produced by these companies – Vault in the case of Autodesk and various PDM packages in the case of SolidWorks. In every case, however, it is probably the process of storing all documents, associating them with designs and making them findable and accessible that is more important than which software package is used.

For all the advances in knowledge capture techniques, it seems the gap left by Dr Crowder's 'wizened old chap at the back of the drawing office' has still not been filled entirely. However, by use of the available technology and, perhaps more importantly, scrupulous application of the associated disciplines, it should be possible to ensure that, in the future, he doesn't cast quite so long a shadow.

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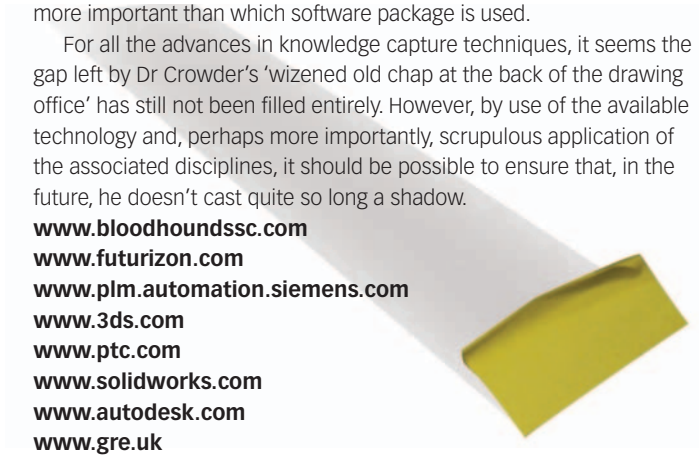

FUTURE SOLUTIONS

Because it supports aerospace products that are in some cases decades old, retaining knowledge is critical for BAE Systems. However, while it has an existing process for recording data, it, too, struggles with knowledge lost in the minds of older engineers working on legacy equipment.

To deal with the problem, the team at Rochester has been working with the Chatham Campus of Greenwich University and has come up with the idea of creating networks and holding meetings to generate knowledge, and then adapting a proprietary audio-video streaming technology, developed for another purpose, to record, tag and index it.

The idea was revealed in a discussion around a paper presented by Barry Piorkowski, a PhD research student at a research meeting on the Chatham site.

Key to this is a piece of proprietary technology that BAE Systems has that can look through an audio-video stream of data for particular types of sound pattern or event, and then trigger something to happen. In the defence and security arena, this is normally some kind of action, but it could also be to tag to where this happened, with the tag data stored in a meta database. Applied to the knowledge management situation, this would mean looking for key spoken words, and then tagging where they are spoken, allowing appropriate sections of recording to be retrieved and studied subsequently.

The project is in its early days – 18 months into a 36 month cycle. The current aim of the project is to produce an inclusive but secure proof of concept pilot at The Base, which is otherwise known as the Medway Innovation Centre in Rochester.

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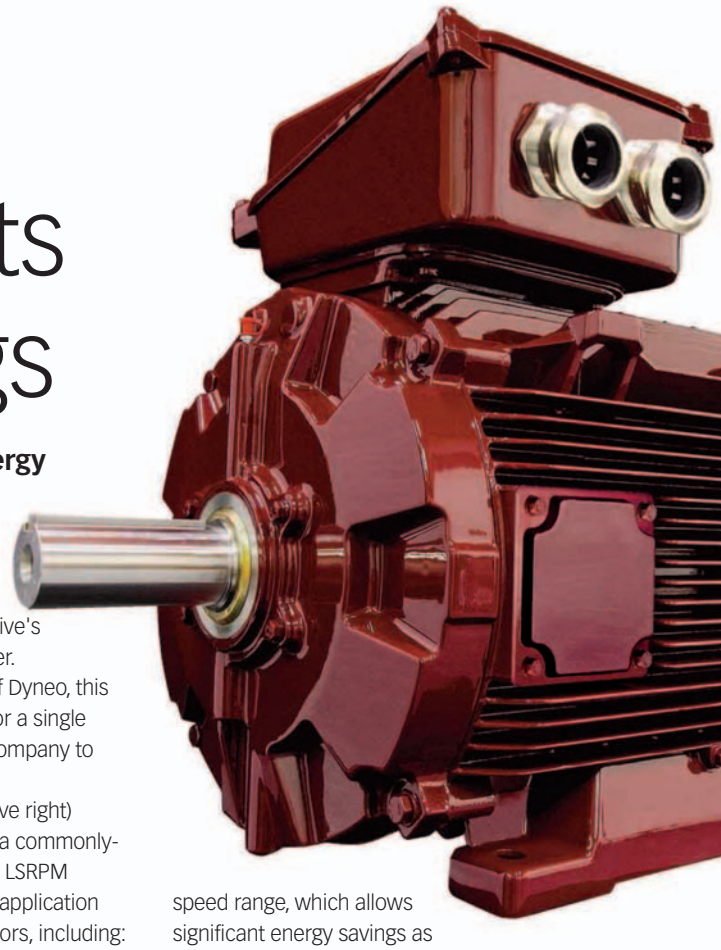
Permanent magnets offer energy savings

Permanent magnet motors could make a big difference to energy consumption and the bottom line. Paul Fanning reports.



Although permanent magnet motors are by no means new, recent improvements in their quality and magnetic strength means they now offer a viable alternative in a number of applications.

Clearly, their key advantage is that the magnetic flux is produced by the magnets themselves without generating any losses. Consequently, at the same torque, the current drawn by magnet motors is significantly lower than for asynchronous motors. This means that the principal source of power loss is eliminated, making for a considerable difference in efficiency.

In addition, magnet motors do not suffer from the slip required for operation in asynchronous motors, meaning even less power loss. The ability to replace, or even retrofit, existing systems with these motors is therefore proving increasingly attractive for a range of applications.

Dyneo's LSRPM range of synchronous permanent magnet motors is designed for direct replacement with standard induction motors. By reducing rotor losses, the Dyneo system's patented radial magnet rotor technology greatly improves the drive's efficiency and specific output power.

According to Philippe Petiolat of Dyneo, this system was previously produced for a single customer, but its success led the company to develop it for general distribution.

The LSRPM series (pictured above right) makes this technology available in a commonly-used IP 55 IEC mechanism. Equally, LSRPM motors have just as many fields of application and use as those for induction motors, including: pumping, ventilation, compression, conveying, extrusion, process control and generators.

The innovative design of the magnet rotor increases efficiency by almost 10% to levels approaching 98%, while the size reduction is around 50%. This type of motor is intended for applications for which electricity consumption is high and continuous. This means that, in a large number of cases, the time to return on investment for replacement of an asynchronous motor by LSRPM will be less than one year, according to the company.

Of course, the savings available may well be dependent on the application. Although, says Petiolat: "We offer a tool that allows customers to select the application they want, put in the relevant details and compare the standard AC and PM solutions. The system then calculates the energy consumption, calculates the cost and deducts the savings.

With an available power range up to 400 kW in an aluminium frame, the LSRPM is significantly smaller and lighter when compared with a conventional induction motor of the same power rating. Equally, the modularity of the series, with its foot mounted, flange-mounted or face-mounted configuration, plus the numerous associated options, makes it easy to replace any conventional drives already installed.

The key advantage of this motor is that the efficiency remains almost constant over the speed range, which allows significant energy savings as soon as the motor is running under rated speed. "It is here you really start to see the difference," says Piotelat.

Quite how much difference can be seen in a comparison between the efficiency level of PM, EFF2 and EFF1 (roughly equivalent to IE1 and IE2) motors at full speed (3000rpm) and half speed (1500rpm). At full speed, the PM motor is peaks at just under 98% efficiency, while the EFF1 and EFF2 motors peak at 94%. However, at half speed, the difference is startling, with the EFF1 and EFF2 motors not getting above 86%.

"At one company," says Piotelat, "we have undertaken a study that shows that using PM motors in their refrigeration devices 24 hours a day will save them £9400 per year."

Another company to have shown the energy-saving benefits of this technology over traditional motors is Baldor, which recently developed a novel permanent magnet-based solution for controlling commercial building cooling tower fans.

Although Baldor's Robin Cowley prefaces his comments by pointing out the irony of talking about what is in effect an IE4 technology when in Europe there will not even be a requirement to implement IE2 technology until 2011 ("The EU is way behind the rest of the world – it's criminal," he says), he is nonetheless enthusiastic about the benefits of permanent magnet technology.

"The thing about PM motors," he says, "is that

Design Pointers

- Published in September 2008, the IEC 60034-30 standard defined new efficiency classes (IE1 to IE4) for motors and harmonised the different requirements for induction motor efficiency levels around the world.
- By 2011, all new motors will have to meet the IE2, high-efficiency rating. By 2015, all industrial motors between 7.5kW to 375kW must either meet the higher IE3 premium-efficiency rating or meet IE2 rating and use an electronic drive.
- Permanent magnet motors have the potential to deliver IE4 levels of efficiency.

they've been around for a long time, but they've been fairly small and expensive because of the rare earth magnets used in them. Now, though, we're going beyond 200MW with them."

Traditionally, the heating, ventilating and air conditioning systems of medium to large-scale office and industrial buildings have been driven by standard AC induction motors connected to the fan via a drive shaft and disc coupling arrangement into a right angle gearbox. This approach does offer a number of disadvantages, however. The gearbox runs at high speed and requires regular inspection and maintenance of the lubrication and seals, while misalignments in the power transmission system can cause vibration, wear and noise. Most importantly,, the complex power transmission system introduces significant energy losses.

The new technology is based on a permanent magnet motor that packs the high torque required into such a compact space that it can easily be retrofitted into cooling towers – sitting underneath the fan in the space currently required for the gearbox element of conventional power transmission systems.

Controlled by a Baldor VS1 drive with a specially-developed speed control algorithm combined with variable speed control that is optimised for the building cooling application, the motor used is a synchronous type from Baldor's RPM family (pictured below). Thanks to dramatic improvements in the magnetic and thermal properties of permanent magnet materials in recent years, this technology now represents a viable alternative to conventional AC induction motors and delivers a significant energy efficiency advantages – even compared with the latest premium-efficiency types of motor. Baldor's motors employ a permanent magnet internal to the rotor, offering a higher power density than motors with external magnets.

Laminated frame technology is used in the design, eliminating the conventional cast iron outer frame of large AC motors and allowing more room for active (ie torque-producing) magnetic material. This produces a highly torque-dense motor, allowing installation in the same space that is currently used for the gearbox. The motor will provide continuous constant torque over its entire range from zero up to base speed, and employs optimum pole construction to maximise both efficiency and power.

In this type of application, the interior permanent magnet synchronous motor design uses energy efficient technology that, in combination with the elimination of the gearbox and drive train transmission losses, results in a more efficient system compared to conventional fixed speed designs. Additional significant energy savings can be gained by being able to operate the fan at reduced speeds during non-peak load conditions. The direct drive also reduces noise and eliminates the issue of cooling tower water becoming contaminated from leaky gearboxes.

Says Cowley: "By removing the gearbox, we've eliminated a complete component. And, of course, a gearbox only consumes power."

To give some idea of what this system can deliver in terms of efficiency, it was trialled prior to its launch and compared with a conventional cooling tower fan drive system at a university building with identical twin cooling towers housing 5.5m fans. One tower was left as originally constructed, while the other was retrofitted with the new Baldor permanent magnet motor and variable speed drive. Independently verified power measurements showed a decrease in input power of approximately 13% for the direct drive arrangement when running at full load – amounting to significant savings over time.

According to Cowley, interest in this technology is increasing, with Baldor close to having some of these systems installed in the UK. He says: "Obviously, this is an emerging technology, but in applications where you're looking at a motor with a drive, then permanent magnets make a lot of sense."

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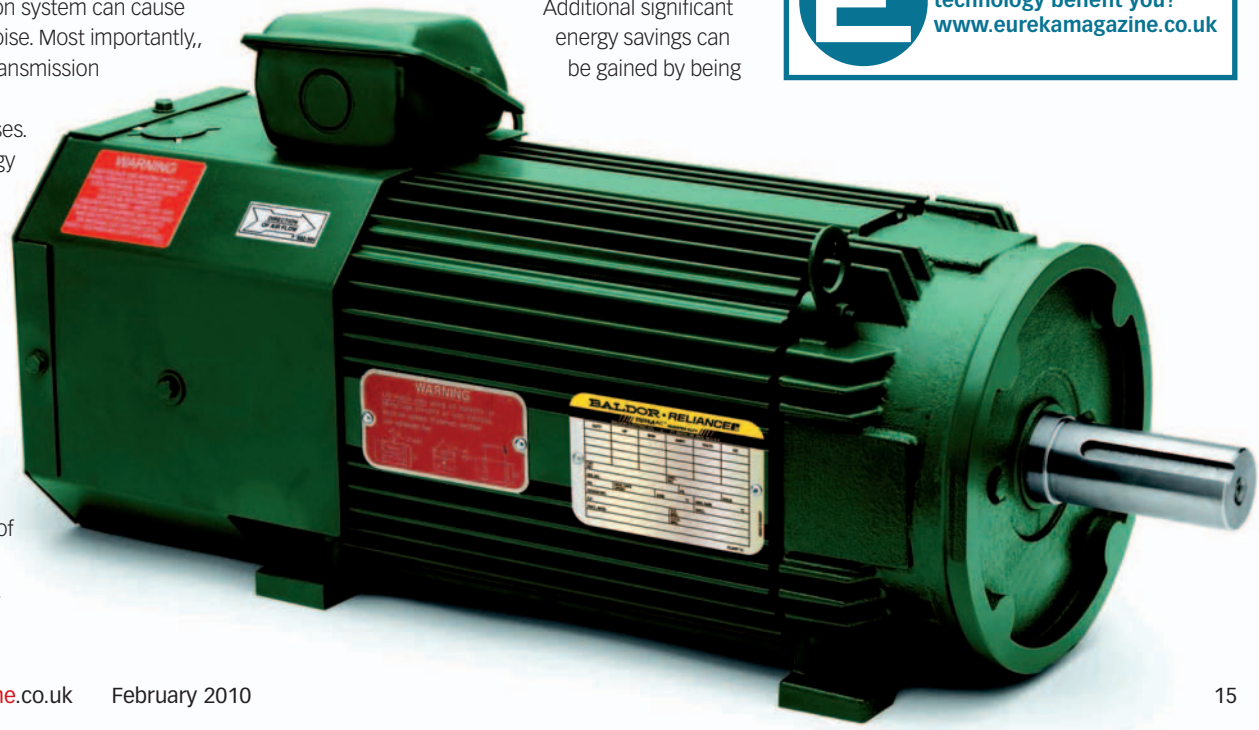
Would permanent magnet technology benefit you? www.eurekamagazine.co.uk



Staying positive

UK managing director of Bosch Rexroth Paul Cooke believes that the economic downturn has created opportunities as well as obstacles. Paul Fanning finds out more.

There is no shortage of people at the moment eager to tell you that the economic downturn that has afflicted the economy over the last 18 months was inevitable and that they saw it coming. However, not many can claim to have been planning for it a year before it happened.

One company that can is drive and control specialist Bosch Rexroth. Says Paul Cooke, UK managing director: "We launched our downturn strategy in late 2007. We deal very actively with the mobile construction sector, which was hit very early. So we saw a decline early on and were able to react accordingly."

The form this strategy has taken has been simple, but effective. Says Cooke: "We're no different to our customers, so we look to provide the same things we need. We need reliable suppliers. We have to make sure that we improve our efficiencies and we have to make sure we reduce our costs because we've got less volume coming through.

"And we have to focus on innovation because, if we really want to come out stronger, we have to have better products and to get ahead."

Innovation has certainly been a key plank of the company's strategy. "The best companies are keeping their foot on the pedal," says Cooke. "For instance, globally, we've spent as much on R&D in 2009 as we did in 2008 and 2007, which is 4.5% of our turnover. It's essential to do that if you're a technology-led organisation."

Bosch Rexroth has not emerged unscathed, of course. "Like many companies, the growth track we were on has been interrupted. However, I would say that the downturn has thrown up opportunities," says Cooke. This is borne out by the fact that the company has grown its market share over the last 18 months, attracting more than 300 new customers in 2009.

Key to this success has been Cooke's desire to change the company's approach to its customers. Since becoming managing director following Rexroth's acquisition by Bosch in 2001, he has implemented a number of strategic changes, the most important of which has been a greater emphasis on working more closely with its customers.

He says of this approach: "I think the UK manufacturing market has been a challenge over the last few years – even before the recession – and I'm very proud of our record in that period as we've managed to grow our business significantly in a difficult environment.

"We've done that by adapting our business to offer the value-added services and the ability to offer complete solutions in a variety of projects. So we've really biased our business towards engineering and very importantly towards the after-sales service."

This change has taken a number of forms. For example, in 2006, the company set up service centres in South Wales, the Republic of Ireland and Bradford, complementing existing partner companies. Says Cooke: "We've had to get closer to customers. Most customers don't just want to talk about products, they want to look at the benefits of what we can do for them. I always say it's not just about great products, it's about great people. We've got to have both to be successful."

The availability of such people, however, is something that worries Cooke. "There is a skills gap," he says. However, he is clear about the role industry has to play in overcoming this shortfall, saying: "Business leaders spend a lot of time talking about the role of the government, but industry itself has an equally, if not more important, role in attracting these people into our industry.

"We have to be really positive about the role we have to play. We have got challenges, but let's be really positive about engineering."

Cooke and his company practise what they preach in this respect. The company operates graduate schemes, supports a variety of awards for young engineers and invites young people to its headquarters to get a feel for engineering. "I am passionate about it," says Cooke. "Too often, young people see engineering as being all about grease and spanners, but in reality it's about engineering our future.

"You've got to make simple points. For instance, we say to them that, here at Bosch Rexroth, we make the London Eye go round, we make Tower Bridge go up and down, and we're involved in ocean energy projects for the future of efficient energy. That's our technology, that's what we do."

Looking ahead, Cooke is generally positive, saying: "The downturn has maybe acted as a catalyst to make people realise that we do need manufacturing. I'm optimistic about the future."

www.boschrexroth.co.uk

Early days

Paul Cooke, UK managing director of Bosch Rexroth, was first motivated to become an engineer by his father, who was chief engineer in a company that made mining machinery.

"My dad got me into engineering," he says. "But I was always quite excited about it and the potential it had. I always saw it in a very positive way. After all, engineering is all around us."

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New carbon-carbon composite breaks through the cost barrier

Tom Shelley reports on the development of technology that revolutionises the manufacture of high-performance friction materials

Although widely used for aircraft and F1 brakes because of their lightness and energy absorption, carbon-carbon composites are currently extremely expensive due to the time spent making them. However, a new wet processing method developed by Freno Huntercombe allows them to be produced in a fraction of the time.

The current method of making carbon-carbon composites is to react a carbon fibre pre-form with a mixture of gases in a furnace, thus depositing carbon in the interstices. Since this normally takes between 500 and 800 hours, the resulting material is very expensive.

While F1 cars usually use a new set of brake linings for each race, aircraft brakes have to endure 2000 to 4000 landings. An Airbus A380 has 16 sets of brakes at a cost of approximately £20,000 to £30,000 per brake, making them a major cost item. According to Boeing, use of carbon-carbon composite brakes enables weight savings relative to steel brakes that range from 250kg on a Boeing 737-600 or 700 to 443 kg on a MD-10 freighter. Naturally, this allows more passengers and/or freight to be carried or fuel consumption to be reduced.

The cost of nanocarbon discs could be greatly reduced by Huntercombe's new process

The breakthrough achieved by Freno Huntercombe is the development of a process in which the carbon fibre pre-form is infiltrated by carbon nanoparticles in a water-based suspension. These are followed by ceramic particles that are then reacted to produce a phosphate ceramic. This takes 20 to 30 minutes, meaning composite brakes can be produced at a similar cost to cast iron and steel equivalents.

"Unlike F1 brakes, because ours is a ceramic, wear is low and cold and wet performance is excellent."

The compressive strength of the material, according to research director Dr John White, is 100 to 120MPa, which is about the same as that of carbon-carbon fibre composite brakes made by the chemical vapour deposition route. However, as managing director Martin Murphy points out: "Unlike F1 brakes, because ours is a ceramic, wear is low and cold and wet performance is excellent."

The company is currently in pilot production, manufacturing and supplying sample parts to customers. Patents have recently been granted and, says Dr White: "We have already had loads of enquiries."

Because the new material can incorporate ceramics, structural strength is greatly improved, opening up entirely new applications that take advantage of its light weight and thermal insulation properties. A dynamometer brake has been made and tested and one of the potential applications identified has been in lightweight heat shields. There is even a possibility that the material could find use as the soft part of lightweight sandwich armour.

As production increases, it is possible that an application could be found in rear wheel brakes for volume production front wheel drive cars. For the time being, though, the company is focusing on high-end applications, where sales should yield a better margin.

www.freno-huntercombe.eu

DESIGN POINTERS

- Process produces carbon-carbon fibre composite at a fraction of the cost required to make such materials by chemical vapour deposition
- Compressive strength is similar to that of conventionally-made materials
- Addition of ceramic improves wear resistance and improves performance in cold and wet conditions
- In addition to allowing the manufacture of cheaper, high-performance brakes, the material also has potential for use in heat shields and other structural applications

Stopping all danger

Tom Shelley reports on some of the materials and technologies involved in producing armour

The materials technologies developed to protect against weapons and explosive devices have become exceptionally sophisticated. Since attacks come in many forms, the ideal armour protection has to be able to cope with blast waves, as well as armour-piercing ammunition and projectiles associated with improvised explosive devices.

Clearly, though, the value of being able to absorb blast and impact is not limited to the military sector. Equally, the combination of protection and lightweight materials has many uses in, for instance, structural and automotive applications.

No one type of protection copes with all types of threat, with the result that successful armour protection combines a variety of materials to do different things. Britain's Chobham armour, for instance, is said to be based on ceramic tiles within a metal matrix, bonded to a backing plate with several elastic layers.

Considerable advantage can also derive from relatively simple innovations such as the steel cages placed around armoured vehicles to protect against improvised explosive devices. Equally, it was found in World War II that asphalt worked well on merchant navy ships in stopping projectiles because, unlike concret, it did not produce lethal splinters when struck.

Taking this idea a stage further, a coating of polyurea on the inside of a structure or armoured vehicle is invaluable in preventing spalling – the breaking off of splinters from the inside of the armour. Although the outer structure may fail, the polymer deforms plastically and retains the debris.

The idea comes originally from the US Air Force Research Laboratory, which in 1999 began evaluating a commercial spray-on truck bed liner on concrete walls. Pure polyurea worked best and this led to the development of Paxcon, which has since been applied to the insides of military vehicles and individual armour plates. It has also seen extensive use in civilian and industrial applications where blast mitigation is desirable.

Armour is not necessarily hard. Canadian Cymat Technologies promotes stabilised aluminium foam under the brand name SmartMetal. Also used in automotive applications to improve crashworthiness, this absorbs blast by progressively collapsing and compressing without failing. However, protection against fast moving projectiles does require something hard to shatter them, which is why Morgan Technical Ceramics makes ceramic rosettes for incorporation into personal body armour.

However, there must also be some means of absorbing impact energy, and many armour systems incorporate something relatively soft between layers that are hard and strong. The soft material may in some cases be rubber, although Barry Pegrum, who uses bullet absorbing systems in Sector Associates' training facilities, uses layers of different thickness steel and plywood. Permali in Gloucester, however, has developed a ceramic armour in which energy is absorbed by reinforcing fibres being pulled out of matrix.

The systems are too complex to model properly and everyone seems to have their own preferences, however. For example, one company selling multilayer titanium armour claims that an ideal combination is hard on the outside and tough and ductile on the inside, while an MSc thesis written by Min Huang, under Dr Tomasz Wierzbicki of the Impact and Crashworthiness Laboratory at MIT, recommends the opposite.

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www.morgantechnicalceramics.com
www.permali.co.uk

Design Pointers

- The ideal armour is made up of combinations of different materials to defeat different kinds of threats
- Lightweight materials capable of absorbing blast and impact have numerous non-military applications

Want to know more about advanced materials? www.eurekamagazine.co.uk

Analysis pushes the envelope

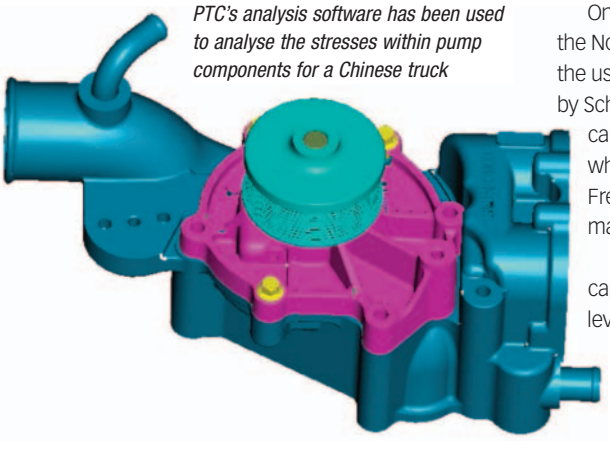
Tom Shelley reports on how advanced analysis has turned projects that might otherwise not be feasible into business successes

British-designed water pumps for Chinese trucks, 80mph model cars and a flying car are all projects that would be unlikely to succeed without use of advanced analysis.

Chinese trucks might be expected to use Chinese-designed water pumps, but they would not be as efficient as those designed by Haldex Concentric, which is based in Birmingham.

The pumps are being made in a Haldex Concentric's plant in Suzhou and supplied to the Chinese National Heavy Truck Group in Jinan. Key to best performance is the use of ProMechanica from PTC to analyse the stresses within pump components and also their natural frequencies to avoid engine-excited resonances.

Ansys CFX has been used for computational fluid dynamic (CFD) analysis in order to design an inlet that comes in from the side of the pump and achieve efficiency comparable to that of an inlet that comes straight into the impeller. In addition, CFD has been used to optimise the cavitation performance and impeller geometry, while AMESim, a one-dimensional modelling tool, has been used to design out any hydraulic resonance conditions and reduce pressure losses.



PTC's analysis software has been used to analyse the stresses within pump components for a Chinese truck

On a smaller scale, but no less important for the Northampton-based business concerned, is the use of Root Solutions-supported Pro/Engineer by Schumacher Racing Cars, which makes model cars that go at up to 80mph for customers in what Root Solutions' managing director Roger French describes as the 'high-end hobbyist market'.

The 80mph car has a 3.5cm^3 nitro engine capable of producing 2.85hp at 33,000rpm; a level of performance possible due to its level of engineering. Says French: "It uses Pro/Engineer Wildfire 4 for the work because it is multi-disciplinary, allowing the company to do mechanism design, interactive surface design and stress analysis." In other words, the model cars are engineered like full-sized racing cars.

Perhaps most extraordinary of all is the Terrafugia 'Transition Roadable aircraft'. The company, based in Woburn, Massachusetts, has demonstrated that a proof of concept machine can fly up to 450 miles at more than 115mph as well as drive at highway speeds on any road.

Although the original design was done in SolidWorks, the design of the prototype is being assisted by the use of CATIA Analysis and CATIA Composites Design (CPD). Says Ben Zelnick, engineer at Terrafugia: "CATIA is a great complement to our SolidWorks solution. Being able to have a full digital model of a ply-by-ply layout will allow us to conduct accurate structural analyses, which is invaluable in reducing the weight of the Transition. In fact, we recently correlated an analysis of a CATIA model of a portion of the structure closely to a sample tested in our facility."

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Where low-cost CAD gives better value

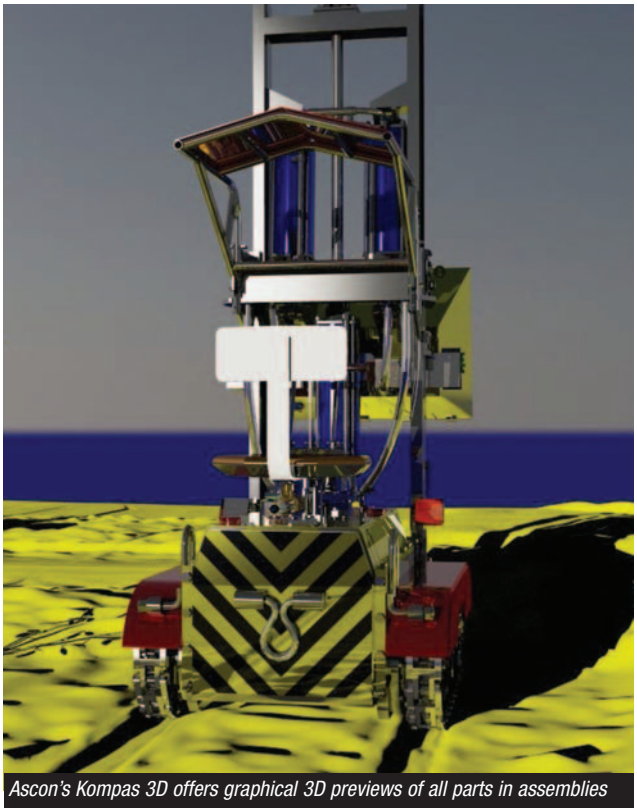
Tom Shelley reviews two low-cost CAD packages that offer good value for money

If 2D and isometric 3D is what you do, TurboCAD in its V16 embodiment represents a very good value purchase.

While there is no way of manipulating 3D models in space or taking measurements from them, when following the tutorial in the Professional version, it is reasonably easy for the non CAD expert to produce what is wanted. Indeed, Paul Tracey, the business development manager of UK agent Avanquest, claims one of the growing markets for this system is people buying a copy of it in order to learn how to drive a CAD system.

The big attraction in this case is the price: £30 for DesignCAD 2D; £79.99 for TurboCAD 16 deLuxe; and £995 for the Professional version, including Lightworks photorealistic rendering. One of the derivatives, for those who want to lay out offices or factories, is TurboFloorplan, which sells for £25. It is extremely easy to use and produces 3D renderings of the plans at the touch of a button.

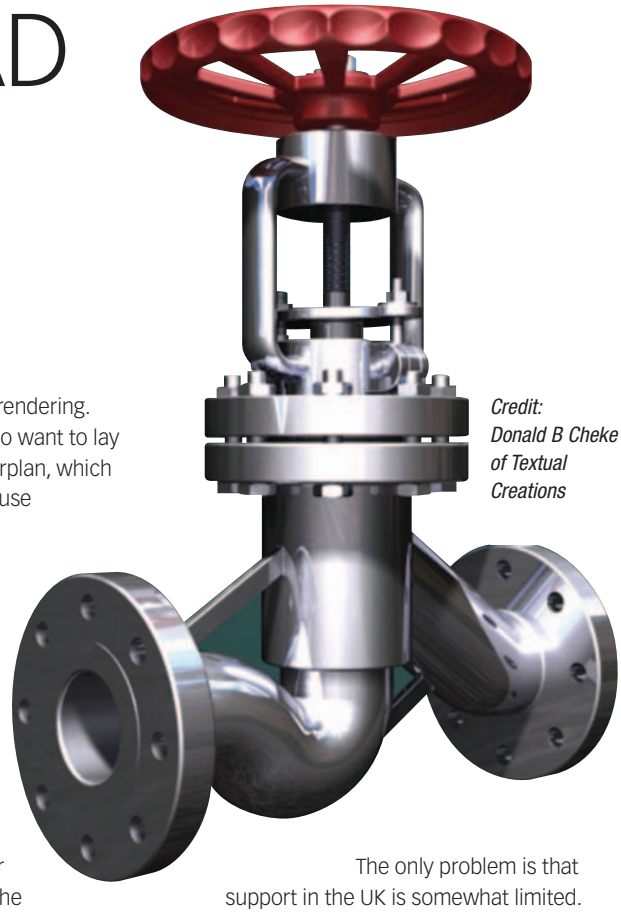
TurboCAD's main competitors are AutoCAD for 2D/3D and AutoCAD Lite for 2D. TurboCAD is cheaper than both and many of its users say they prefer it. However, working to British Standards requires the user to set up a template, as opposed to clicking an icon. The software can be bought in stores, or downloaded over the Internet, and a full working version can be trialled free for 30 days.



Ascon's Kompas 3D offers graphical 3D previews of all parts in assemblies

For those looking for an alternative modelling package that is truly 3D and parametric, Kompas-3D V11 SP1, produced by Russian company Ascon, is a vast improvement on Version 10. It has a list price of €2700 and is also available on a 30-day free trial.

The tutorials offer a lot of contextual help and there are graphical 3D previews of all parts in assemblies. English ISO is supported and the rotation operation is now much less clunky, only reducing the assembly to blocks if it is a really large file. Functions like explode and unexplode occur instantly, even on a modest laptop and, try as we might, we were unable to crash the software.



Credit: Donald B Cheke of Textual Creations

The only problem is that support in the UK is somewhat limited. The UK is currently being supported directly from Russia , but Ascon has made it known that it is looking for another UK company interested in taking it on as an alternative to UK listed agent Sprut Technology.

To put the quality of this package in context, Siemens PLM sees V10 as a serious competitor, especially in Germany and countries to the East, where it has a lot of established users.

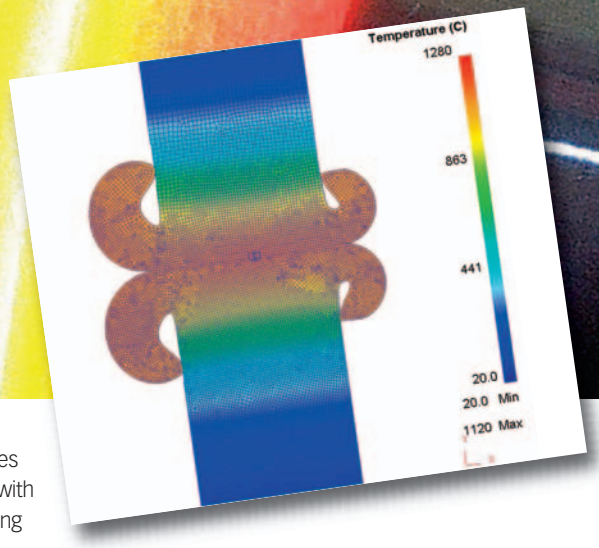
www.turbocad.co.uk
www.avanquest-solutions.co.uk
www.textualcreations.ca
http://ascon.net

Design Pointers

- Although TurboCAD is a lower cost package, working to British Standards requires use of a template, rather than simply clicking on an icon
- Ascon's parametric design package Kompas 3D – now in Version 11 – supports English ISO. Rotation is improved assemblies are only reduced to blocks if the file is really large

Process modelling improves aero engine design

Rolls-Royce uses modelling of aero engine disc manufacturing processes to enhance the understanding of process, material and component design interactions. Justin Cunningham reports.



Conventionally, gas turbine discs are either bolted or electron beam welded to each other to create a drum, which is then joined to one of the central shafts. However, due to the material that needs to be added to the discs in order to bolt through them, bolted joints are heavy, which compromises efficiency and costs airlines money during operation.

Being a fusion welding process, the conventional alternative of electron beam welding leaves a re-cast layer at the weld line with significantly different properties to the wrought parent metal. So, to achieve a high-integrity joint with close-to-wrought properties, Rolls-Royce uses a rotary friction welding, or inertia welding, process.

The process involves spinning one component, attached to a huge flywheel, and then bringing it into contact with the other component under a large axial load. Heat is generated at the contact interface due to friction and material at the interface is extruded out as flash. As the rotation slows to an eventual stop, an extremely high-integrity bond is formed without actually melting the parent material.

However, predicting the distortion, residual stress/strain state and material properties that result from this process combined with numerous heat treatments and machining operations is a significant challenge.

"The whole manufacturing route has an impact on the properties of the final part," says Paul Brown, team leader for process modelling at Rolls-Royce. "For example, the residual stresses that cause machining distortion come from the quench after the heat treatment. Some of this gets relieved when you start removing material by machining, and it causes the disc to distort. We need to be able to predict this distortion so that we can design a machining process accordingly."

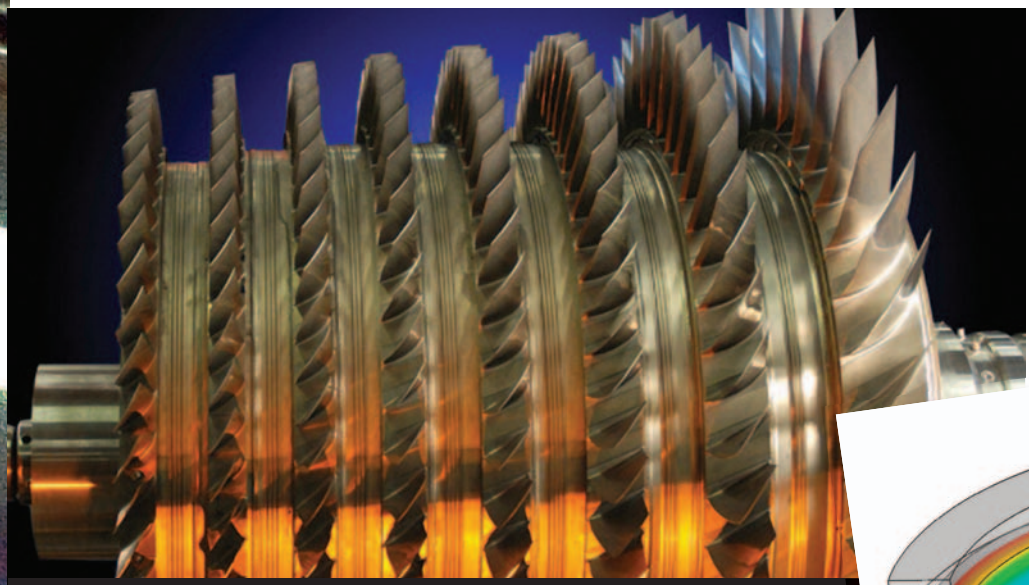
Optimising the manufacturing process using physical tests alone is extremely expensive and time-consuming, and often does not yield the required information due to the difficulty of making the appropriate measurements under extreme process conditions.

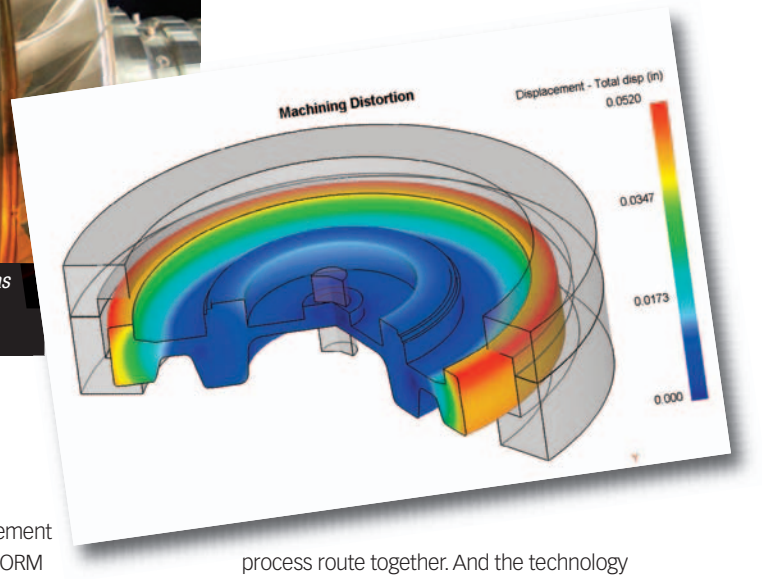
"It is, for example, very difficult to measure residual stresses in a real component, and impossible under most realistic thermal and mechanical loading conditions," says Brown. "Provided you do an appropriate amount of validation and you are confident it is predicting the right thing, you can get so much more information from a model."

Then there is also the issue of what to optimise for and when in the product introduction cycle to do it. "Manufacturing isn't a constraint on design, it is an opportunity to optimise the product, process and material," says Brown. "Trying to optimise a manufacturing process once a product design is fixed is an inefficient way of going about things."

Using a combination of targeted physical testing in conjunction with advanced materials and process modelling, the product design and manufacturing process can be optimised together at an early stage where the cost of design change is much lower.

Rolls-Royce wants to migrate the modelling capability from the small, specialist team to the numerous manufacturing, design and materials engineers in the company so this work can be done by the people who are making critical decisions. It hopes this approach will yield more optimal processes and ultimately improve overall





The use of FEA package Deform has allowed Rolls-Royce to predict the behaviour of materials as they go through the manufacturing process; capturing the entire process route, including the application itself

engine design.

To achieve this, Rolls-Royce has teamed up with Wilde FEA, the University of Birmingham and the University of Nottingham and set up a project called PROMOTE (Process Modelling for Tomorrow's Engines). The project, which is part funded by the Technology Strategy Board (TSB), will further develop and then capture the fundamental modelling expertise within Rolls-Royce and the University of Nottingham and wrap this in to a user interface that is both useful to, and usable by, non-specialist engineers.

"We don't want non-specialists to have to worry about a lot of the modelling specific terminology like boundary conditions, which material models to use, how to set up the meshes," says Brown. "So we try to standardise and automate as much of that as possible and develop software tools to handle complex or repetitive tasks for them."

Inertia welding can be expensive and without computer modelling it takes a long time to develop components and materials suitable for the process. And aside from speed and cost considerations, models can actually tell you a great deal more information about the real manufacturing process than the physical tests.

As well as designing new products, modelling can also be used to investigate potential new materials, or even process equipment. Using modelling, engineers can potentially test materials and equipment that either aren't available yet or are very expensive, prior to committing to physical prototypes.

The project is structured around the use of a finite element analysis package called DEFORM distributed by Wilde FEA. DEFORM is a high-end, specialist simulation tool that was developed by US company Scientific Forming Technology Corporation. It can be used to predict the behaviour of materials that go through a chain of manufacturing processes; from forging to machining, heat treatment, quenching, joining and so on. It is then very good at predicting the residual stress and microstructure of the finished product or component.

"You can use DEFORM at the front end of the design to simulate the processes that develop the microstructure," says James Farrar, business development manager at Wilde. "The vision that DEFORM has is to capture this whole process route including the product application. This project is looking at taking that to the next level of integration. Whereas an expert user in DEFORM can do this now, what this programme is looking at is delivering that capability to a non-specialist."

There is, of course, a whole chain of processes where the microstructure is evolving. What the designers are interested in the microstructure at the end of the process, as that ultimately determines the mechanical properties. "It is the whole process sequence that we are interested in," says Brown. "By developing a tool for accurately predicting the as-manufactured state of the material and the as-manufactured properties of the material, we can help improve the design analysis for aero engine lifing and performance."

Says Farrar: "The existing inertia welding process might be OK, but if I can optimise my heat treatment process beforehand, which has an effect on how it is welded, I can perhaps improve it still further. So it is trying to tie that whole process route together. And the technology specialists in companies like Rolls-Royce are interested in this entire process route in addition to the technology. They want to find out what is the best route to achieving design objectives whilst minimising or controlling other outcomes such as distortion."

It is not just Rolls-Royce engines that could potentially benefit from this technology. "The bigger picture [within PROMOTE] is the more efficient use of aerospace engines," says David Deakin, managing director of Wilde FEA. "But the direct spin-offs are to other companies that are doing inertia welding; that could be aerospace, military, automotive, construction equipment, oil and gas, and those sorts of industries."

"The other spin-off area is to anyone that wants to have non-specialists using a very advanced code in a user-friendly environment. Anyone that does heat treatment and then machining has the problem of residual stress and distortion. This project ties all these things together."

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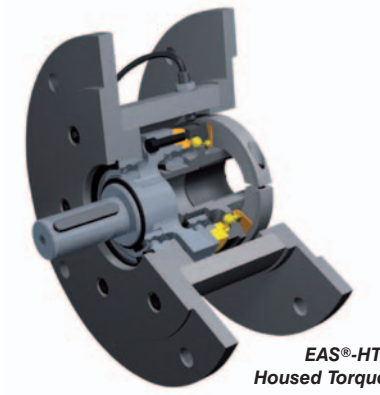

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Industry wakes up to carbon fibre drive shafts

Paul Fanning looks at the potential of carbon fibre driveshafts for large-span industrial power transmission applications.

The benefits offered by carbon fibre drive shafts have long been known in the marine sector, where large, single-span shafts have eliminated the need for intermediate bearing support and offered greater speed for large boats, such as fast ferries.

This is especially true in narrow-hulled catamarans, where each hull contains a staggered diesel engine. Long, but lightweight, shaft lines are needed, with the result that all sizeable fast catamarans are now equipped with carbon fibre tubes (CFT) for transmitting power from engine and gear and gear to water jet.

The loss of weight (carbon fibre shafts are typically 70% lighter than solid steel) also means considerable savings in terms of fuel, while the removal of high-maintenance bearings has obvious benefits in terms of wear and tear and overall costs. Equally, carbon fibre's much higher critical speeds allow much longer spans between the bearings. What this means for the application is fewer bearings, fewer bearing pedestals, less power loss, less maintenance, less noise and easier installation.

However, the emphasis on the use of carbon fibre shafts in marine applications has tended to obscure their suitability for other sectors. In fact, in many applications where there is a requirement for long-span drive shafts, carbon fibre may offer an effective solution.

Nigel Smith, sales manager for Centa, which has been at the forefront of this technology for some years, is enthusiastic about the possibilities. "Marine is the primary application for carbon fibre driveshafts, but it's not the only one," he says. "In Germany, for instance, they use cooling towers with motor-driven fans in them. As a result, they've got a gearbox in the centre of the cooling tower, the fan going round inside and the motors outside. Traditionally, they've had a corrosion issue because the shaft is exposed to a considerable amount of water. As a result, they've used carbon fibre drive shafts, which don't have that problem."

Another instance where this technology has transferred to industry is in at least one pumping station, where there the pump is situated on the floor of the pumping house, but the motor is in the roof. The traditional method of connecting the motor to the pump would be to run a universal joint (UJ) shaft all the way down the wall to another at the other end. Centa, however, has been able to span this with a single carbon fibre shaft from the pump straight up to the motor.

Carbon fibre shafts are typically 70% lighter than solid steel

As well as delivering a lightweight and less cumbersome solution, this also offers considerable safety benefits. Smith explains: "If there's a failure of the UJ shaft, there's this thing flailing around on the end of the electric motor and it will destroy anything in its path. There are normally metal stairwells around the sides of these sites and it has been known for the shaft to flail the stairwell out. With the plastic carbon fibre shaft, if it breaks – which is unlikely in the first instance anyway – all you've got going around is that bit of plastic."

The use of carbon fibre driveshafts in this context is obviously far from traditional, but that doesn't alter their potential. Says Smith: "One of the things people really don't appreciate about carbon fibre is just how much torque you can transmit with it. The smallest shaft we've provided is 250hp and the biggest we've built is 23MW. The biggest we've quoted for is 60MW."

This remains far from being a common industrial solution, however. "We haven't broken into that market yet by any means," Smith concluded. "We've supplied a couple of shafts, but it's certainly not a core application as yet…people aren't resistant to the idea as such, they just don't know. about it. I don't think there's any resistance to the idea once it's presented to the right people."

www.centa.info

Design Pointers

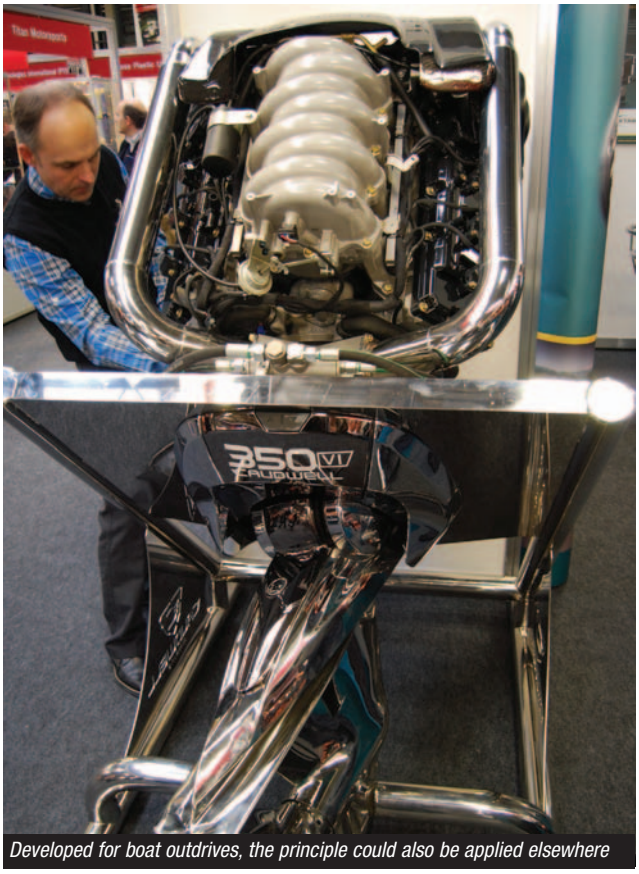
- Carbon fibre drive shafts can offer benefits in any application where power needs to be transmitted over a long distance.
- The larger the diameter of the tube (within reasonable values), the better its ratio of weight to stiffness and the more advantages it will confer.

Off-axis power delivered without loss

Tom Shelley reports on a gearbox transmission that transmits power efficiently through angles

A transmission has been developed that works with an engine at 45° to the normal propeller axis and allows turning and variable trim that outperforms conventional Z drives and constant velocity joints in terms of compactness and efficiency.

Although developed for boat outdrives, this principle could also be applied to land vehicles and industrial power transmissions. Certainly, motorsport is the more usual target environment for designer and manufacturer Xtrac, which demonstrated the new transmission at the recent Autosport Engineering show.



Developed for boat outdrives, the principle could also be applied elsewhere

Developed for South African company Caudwell Marine, the concept is the brainchild of entrepreneur Mike Beachy Head, who wanted something that would combine the best features of stern drives and outboards and would be relatively simple to install.

Having the engine at 45° reduces the space taken up by the engine within the boat. It also avoids the need for large, overhung outboards, which get in the way of other things that are done from the stern, like getting on and off the boat.

The transmission and propeller can be lifted up and down, as outdrives are designed to allow access to deal with fouling. It is also possible to pitch outdrives up and down, allowing them to work horizontally, regardless of the trim of the boat and its angle in the water. In addition, outdrives are designed to be steered, which greatly increases the manoeuvrability relative to fixed propellers and rudder. In the case of the new design, the propeller axis is steered in a manner similar to leaning a motorcycle, to a maximum deflection of 32° each side, which also aids boat handling.

This is achieved by turning the transmission path around bevel gears in the turn axis nearest the engine and around helical straight gears in the trim axis. In this way, there is no change in the direction of transmission of torque when angles change. It thus avoids the power loss and reliability problems associated with constant velocity joints, which despite their almost universal use in front wheel drive cars, have never been found to be totally satisfactory.

As well as transmitting power in whatever direction is required, the gearbox also includes forward and reverse and undertakes gear reduction from a maximum of 2.683:1 to 1.876:1. Gear shifting is by an electrohydraulic cone clutch. The stainless steel drive assembly only projects out of the stern of the boat a little. This compares favourably with conventional outdrives that are slung on the back, with rams and hoses that are vulnerable to damage and must be protected against corrosion by sacrificial anodes.

While there are no plans to transfer the design ideas to motor vehicles, there is no fundamental reason why this could not be done. It does open up some interesting possibilities, such as inclined engines in smaller spaces.

www.xtrac.com
www.caudwellmarine.com

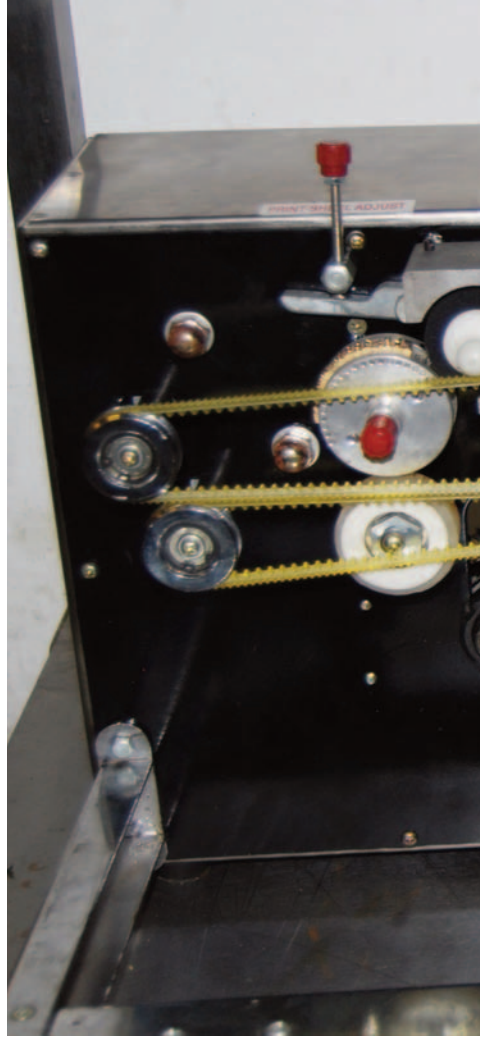
Design Pointers

- Design allows engine to be inclined at 45° to the normal propeller axis and to allow turning and tilting relative to the engine, without need for any coupling that turns torque though an angle
- More compact and efficient than conventional z drives and constant velocity joints, the principle could be applied to land vehicles or industrial power transmission if constraints on space require power to be delivered efficiently at an angle

How are your power transmission requirements changing?
www.eurekamagazine.co.uk

Designing safety with accessibility

Tom Shelley finds out what it takes to ensure safety in machines that require frequent access



Machines that require frequent access for cleaning or clearing blockages pose a particular design problem from a safety perspective. Since operators cannot be protected by locking the machines in cages, guards have to be placed over potentially dangerous parts and either welded firmly in place, or, if used in the food industry, equipped with interlocks capable of surviving cleaning chemicals.

An analysis of injuries in the food and drink industries over a four-year period investigated by the Health and Safety Executive showed that the worst culprits (30% of injuries) were conveyors, followed by forklift trucks (12%) and bandsaws (5%).

Some 90% of conveyor injuries occurred on belt conveyors, of which 90% involve hazards such as in-running nips, transmission parts and trapping points between moving and fixed parts. In addition, 90% of accidents occur during normal operations.

Good, clear advice on how to design out such hazards can be found in HSE Food Information Sheet No. 25, 'Safeguarding flat belt conveyors in the food and drink industries', which may be downloaded, free of charge from the HSE web site. Another good source of information on all matters concerning automated food production is the Centre for Food Robotics and Automation in Doncaster. One of its particular capabilities is the use of computer simulation technologies with which it can create interactive 3D layouts of whole factories.

Of course, there are regulations that must be conformed to in any such design process. These include the Supply of Machinery (Safety) Regulations 1992 (SMR), the Provision and Use of Work Equipment Regulations 1998 (PUWER 98) and the Machinery Directive.

However, these standards pose a number of problems themselves. Although the Machinery Directive covers safety requirements in machines supplied to the whole of Europe, there is no definitive interpretation of what is required, with individual health and safety officers in both official bodies and companies often applying their own interpretations.

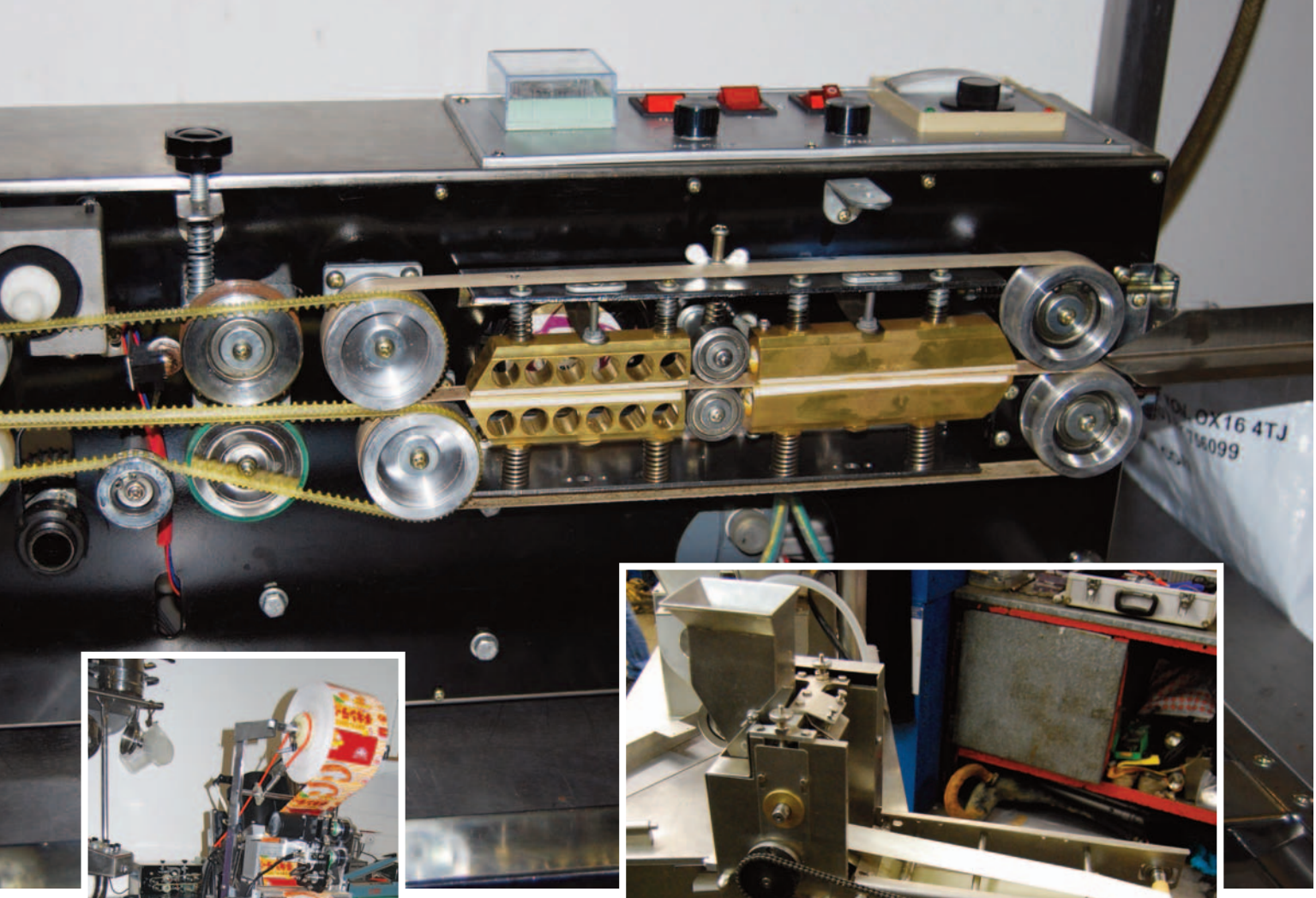
As Mike Wilkinson, managing director of The Food Machinery Company, puts it: "Each country in Europe has its own bodies that interpret and enforce the Machinery Directive in their own way."

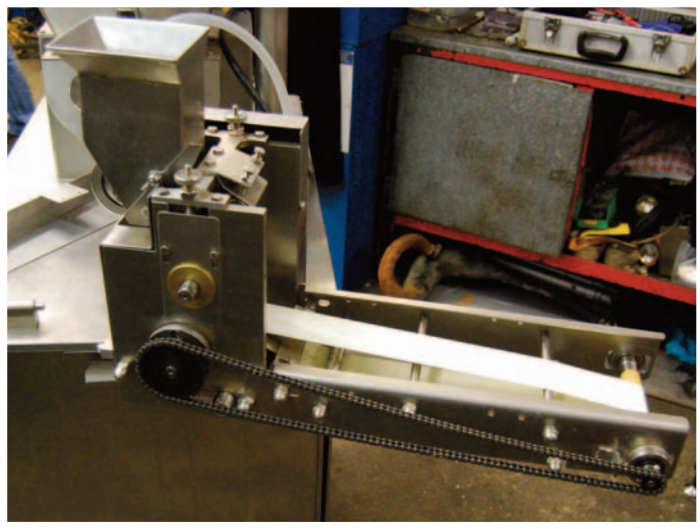
Wilkinson is well-placed to assess the problem, as his company imports machines from all over the world and then remodels them to ensure they meet UK requirements. He has therefore seen most of the pitfalls into which companies fall when designing and building such machines.

He undertakes much of the design work himself using AutoCAD 2010 and either adds guards and interlocks in his workshop for small numbers of machines, or contracts this out for large orders.

The requirements for designing guards for food machinery are more demanding than for other manufacturing machines, since food processing machines have to be stripped down and cleaned every day, whereas metal manufacturing machines might only need to be accessed once in several months for maintenance or on developing a fault. Total enclosing cages are therefore not an option.

An interesting example at The Food Machinery Company was a Taiwanese machine for manufacturing samosas and wontons, to which the makers had affixed a prominent CE mark in the belief that the enclosures protected users from all working parts. However, Wilkinson pointed out that the chain guard could be lifted off and accessed by fingers from underneath. For use in the UK, says Wilkinson: "We will weld on a guard that totally encloses the chain and prevents finger access."





Another machine highlighted another problem. Says Wilkinson: "It had a specific pinch area, but the guard allows fingers to get in. As the mechanism has to be accessed for cleaning, we will add a cage and a safety switch." It is worth noting, in this regard, that The Machinery Directive requires the use of safety switches that cannot weld themselves into the closed position.

Even in the food industry, machines fall into different safety categories and, while a Category 1 machine only requires the use of simple safety switches (Switching A relays), Category 3 requires two safety circuits going through stop switches and the use of a suitable safety relay. Says Wilkinson: "You need to think of all the ways in which the machine can be party to an accident", a point he underlines with reference to a machine that had a large section that had to be swung out for cleaning, which in some circumstances could still be connected to a live feed.

Wilkinson showed a Chinese-made packaging machine as an example of a Category 3 device. This had a number of opening and closing mechanisms, but only a lift-off guard with no interlock. This will be equippedwith an interlocked cage and safety relay.

However, he was careful to point out that it is not just Chinese or other far eastern machines that require adaptation; a significant number of machines made in EU countries also require attention. Wilkinson says: "This is a major issue that nobody seems to have thought about, since it makes something of a nonsense of the single market."

How acute this problem is can be demonstrated by a number of machines at the site. Some, like a bag-sealing machine and a Danish-made cooking kettle, did not require much work. However, as Wilkinson pointed out, they still needed some. He says: "A bit of forward thinking makes something perfectly safe."

A German-made vegetable preparation machine with fast-moving chopping blades brought to light another issue. Although it came with interlocks needed to meet the German interpretation of the Machinery Directive, as well as full European CE Approval, it was still potentially problematic in the UK. Says Wilkinson: "You could still access the blades if you put your hand in from underneath. [In Germany] this isn't considered to be a problem. But large companies in the UK that employ semi-skilled labour have to prevent people from hurting themselves."

www.hse.gov.uk/food/machinery.htm
www.cenfra.co.uk
www.foodmc.com
www.autodesk.co.uk

Ensuring machines comply with safety requirements is made difficult by the fact that the health and safety bodies of the different European Union member countries interpret the requirements of the Machinery Directive differently

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READER INTERVIEW

TREVOR CHURCHILL
DEVELOPMENT ENGINEER
MG ELECTRIC (COLCHESTER)

60 SECOND

Q How did you get into the engineering industry?

A That was the direction I naturally went in when I left school. I was always more suited to the crafts than I was to the arts.

Q What does your role with MG Electric involve on a day-to-day basis?

A On a day-to-day basis? Are you sure you've got enough time? Development work, really. We produce a range of equipment and I'm involved in its design, development and everything that may entail, right from the beginning all the way through to production. It depends what's going on – and there's always something going on!

The process usually starts with an idea put forward from management. So then you get the thought processes going into it and, depending on its complexity – whether it's a total project, an amendment or a customer request – a certain amount of time is put into it to bring about a developed result and then hopefully we can build a prototype.

After that we'll do test work and then hopefully it will be put into production. That all makes it sound very simple, of course, but then once it goes into production, I have to make sure that the production drawings, documentation, manuals and everything else are all done. We used to have a team to do these things, but these days, with the economic situation being what it is, I do it all.

Q What are some of the projects that you are currently working on?

A Mainly at the moment it's a question of extending our current range. Developing and upsizing things, as it were. That generates odd little quirks and problems that need to be resolved and those get sorted out as we progress or dictate the direction we go in.

Q What is the most interesting project/piece of engineering you've been involved in?

A I used to be in the construction industry, which was always interesting. I've been involved with things like backhoe loaders and piling machines, which are great big monsters, so it's interesting to get involved with building them and then getting on there and pushing the button. That was always the fun bit. Now it's all electromechanical components. So you push a button and nothing happens except that hopefully a motor might run. It's not quite the same. To be honest, though, the best thing is making sure that, whatever you're doing, it works at the end of it.

Q Has the industry changed much since you joined?

A Yes, hugely. The main thing being that it's gone from mechanical to electromechanical to electronic, really. It hasn't affected me a great deal, because the industries I've always dealt in have tended to be mechanically-biased. But then one or two things that come in mean that we have to deal with PLC controls, so that's been something of a stepping stone.

Q What are the big issues facing your industry?

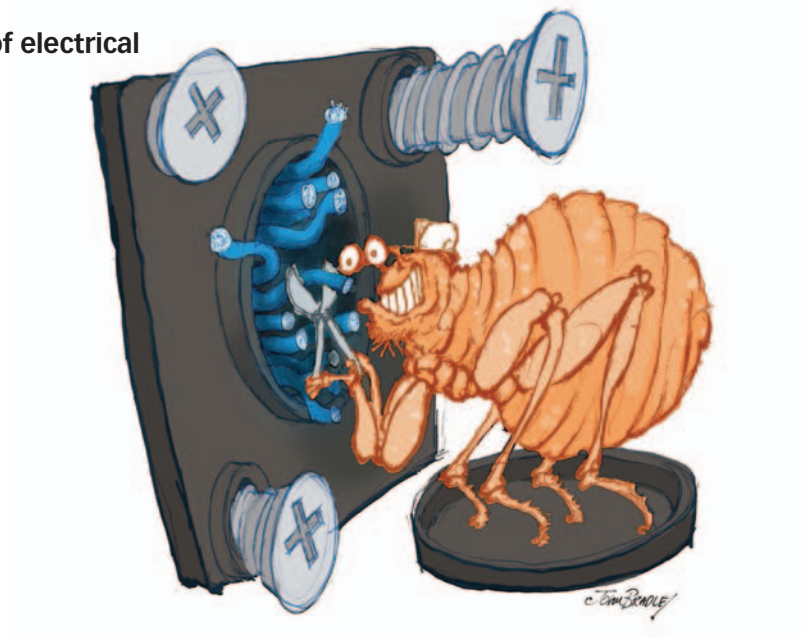
A Maintaining competitiveness and costs while still producing a worthwhile product. It's like everything these days, customers want it for nothing and they want the best.

Q How do you see the industry going forward?

A It's going to go even further away from mechanical to electronic. There's going to be a very small percentage that's mechanical, because it's all electronically-controlled. And, of course, the CE requirements coming in are just going to reinforce that even further.

Wires and wherefores

Ever tried to reassemble a piece of electrical equipment and found the wires getting trapped?



Anyone who has ever had to take the back or lid off a piece of electrical or electronic equipment will be aware of the problem of trapped wires. While most of the conducting paths use PCB tracks, power at any significant number of amps usually has to come down cables and, even where it doesn't, there are usually wires to the battery contacts.

As more and more functionality tends to be put inside pieces of equipment, the enclosures become smaller and more fiddly – and there seem to be more and more wires.

These wires have to be kept free of being trapped when the enclosure lid or back is put back on, whether this happens during assembly, when some repair has to be made, or merely to change a battery.

Trapping a wire between lid and enclosure can result in a cut wire, rendering the device inoperable, or worse, reduce the number of functioning conductors adjacent to plastic that can start a fire when full current is passed.

The Challenge

The challenge this month is to come up with a simple means of ensuring that cables carrying power inside a piece of equipment can in no way become caught between the different parts of the enclosure body when they are rejoined.

There are engineers who carefully bundle cables together with cable ties, but it is still possible to trap individual cables between the ties, as the tie ends can also get trapped in the gap.

What is really needed is some small creature inside that is willing to hold the cables together when the lid is put on, but even if such an animal could be found and trained, how would it get out?

The solution we will offer is simplicity itself and the cost is trivial. Once you see it, you will consider it obvious. The solution and its application will be described fully next month. See if you can come up with anything better.

The answer to last month's Coffee Time Challenge, how to design a better jar opener, can be found in our Technology Briefs section on page 9

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Location: South East (Oxfordshire) Salary: £27000 - £28000 per annum

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Flowmeters

Flow measurement of hot beverages

Titan Enterprises are an established supplier of flow measurement sensors to vending machine manufacturers. The latest 800 Series turbine flowmeter is a low cost, non-metallic meter with a PVDF body. The electronic output gives NPN or PNP transistor output pulses to drive a remote counter or logger, with 0.1% repeatability over a 30:1 flow range. The 800 Series is suitable for hot water vending applications, up to 125C, for flow rates of up to 15L/min, or for flow failure alarms.

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Infrared Thermometers

Ircon® Announces Advanced Features for Modline® 6 Series Fibre Optic Infrared Thermometers

Ircon®, the worldwide leader in infrared (IR) noncontact temperature measurement, has introduced the new Modline® 6 Series of infrared thermometers. The new line of high performance sensors features advanced signal processing and background-reflected energy compensation capabilities, and includes one-and two-colour fiber optic IR devices designed for harsh operating environments.

The rugged Modline 6 Series thermometers deliver the best value in terms of price, performance, features and ease-of-use of any available fiber-optic infrared thermometer. They are used in a variety of demanding industrial applications, including metal heat treating, steel production, foundries, and primary and secondary glass.

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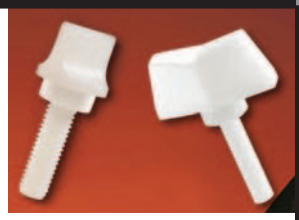

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Optical Sensing

Ocean Optics XR-Series Spectrometers Cover ~200-1050 nm Wavelengths

Miniature spectroscopy pioneer Ocean Optics, has expanded the wavelength capabilities of several of its popular miniature fibre optic spectrometers. The XR-Series, available for the USB2000+, JAZ-EL2000, and USB4000, covers all wavelengths from ~200-1050 nm with the convenience and affordability of a single, monolithic spectrometer.

The new XR-1 grating option developed by Ocean Optics overcomes the traditional challenges of providing broad UV-NIR coverage in a single miniature spectrometer. With a 500 lines/mm density, the grating delivers high performance at a budget-friendly price, without increasing the system footprint. The XR-1 grating is available pre-configured in the USB2000+, JAZ-EL2000, and USB4000 and may also be added as an option to custom-built systems

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Precision Measurement

Cropico measures up in anti-corrosion testing

A company manufacturing overhead transmission and distribution power line equipment has used a Cropico high performance microhmmeter for accurate resistance measurement during an anti-corrosion product testing programme.

Overhead Line Fittings (UK) works with the National Grid, power distribution network operators and their contractors to provide bespoke insulators, fittings and conductor accessories used in the installation and maintenance of overhead power cables.

As part of the services provided to customers, the company operates an in-house test facility at its head quarters in Atherstone, Warwickshire.

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www.cropico.co.uk

Pressure & Temperature Measurement

SA-11 pressure transmitter, now also available with Neumo BioControl® process connection

It therefore offers all possibilities of dead space free instrumentation: alongside the BioControl, there are also clamp, threaded and connections to DIN 11864-1. With this, and pressure ranges from 0…250 mbar to 0…25 bar, it ideally satisfies the high requirements of sanitary applications.

The SA-11 pressure transmitter was specifically developed for applications in the food and beverage industry as well as for pharmaceuticals and biotechnology. It is certified to EHEDG and fulfils the 3-A Sanitary Standards, while the pressure transmission fluid also conforms to FDA requirements.

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www.wika.co.uk

Sensors & Systems

New website for Ixthus Instrumentation Ltd

Ixthus Instrumentation Ltd, the experts in non-contact position and force measurement has launched a new website at www.ixthus.co.uk showcasing its complete range of measurement sensors and transducers, weighing controllers, and vibration monitoring.

As well as PDF downloads for many individual products, there are also direct links to specific and related pages on Ixthus' partners websites where complete product and technical specifications are available.

The 'Complete Measurement Solutions' section provides a catalogue of some of the many and varied customised applications that Ixthus Instrumentation regularly undertakes for its customers.

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Sensors/Switches

Pressure level temperature and flow

Applications Engineering Ltd holds a comprehensive range of pressure, vacuum, level and flow switches. We provide 'tailor made', custom designed products, accessories and associated product lines including the Jetcleaner hose and pipe cleaning system.

We offer a 30 day sale or return sample service on our standard products. That way, you only buy when you are satisfied that the product suits your application.

More often than not, we are able to get a product to you within 24 hours of you making your first enquiry.

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Temperature Measurement

Temperature measurement mysteries explained with new ABB handbook

A comprehensive new handbook covering all aspects of temperature measurement in industrial applications is now available from ABB. The Industrial Temperature Measurement Practice handbook provides a detailed explanation of the key areas that users need to consider when implementing and operating temperature measurement technology.

Divided into nine chapters, the handbook explains the basics of temperature measurement, covering topics such as the thermoelectric effect and temperature dependent Ohmic resistance.

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www.abb.com/instrumentation

Test & Measurement

Mecmesin Launches New Force & Torque Test Solutions Website

A specialist in force and torque measurement, Mecmesin has launched a new international website www.mecmesin.com. With over 30 years experience providing force and torque test solutions to companies large and small in numerous industries worldwide, the website offers a comprehensive insight into force and torque measurement, as well as Mecmesin's extensive range of test equipment.

The website is designed with a simple, and easily navigable, layout. Emphasis has been placed on providing visitors with information related directly to their specific industry and type of test, enabling straightforward assessment of solutions relevant to their application

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