Engineering Materials

Reaching 14,200 material specifiers and buyers

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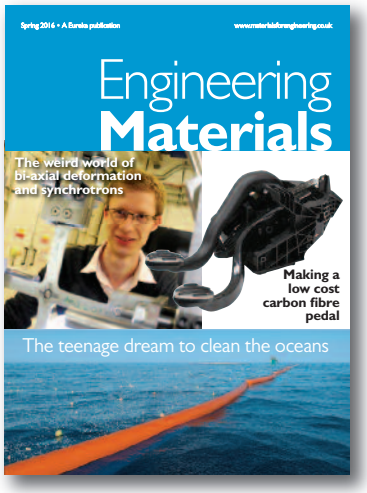
Sound advice on material selection

2016 MEDIA PACK

Engineering **Materials**



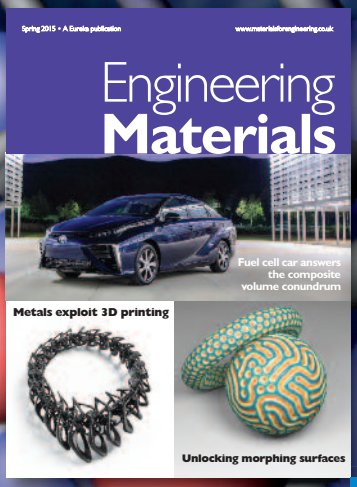
The UK is renowned for world-leading engineering design and innovation. At the heart of every product or design is the need to select materials, which means working with partners that have the right materials expertise and application knowledge early in the process. This is why *Engineering Materials* was launched.

We deliver focused and relevant content to a hard-to-reach audience of engineering designers in a number of different ways. A printed magazine; a range of digital, online and e-newsletter options and face-to-face events. *Engineering Materials* is able to deliver your message and influence buying decisions.

Engineering Materials is the only magazine that covers every type of material to give its readers the information they need to add value to their designs and continue to innovate. We cover the latest advances in materials, their application, processing and continue to talk to the leading experts in industry to ensure we deliver content that meets the needs of engineering designers and keeps our audience engaged.

We look forward to working with you.

Luke Webster - Publishing Director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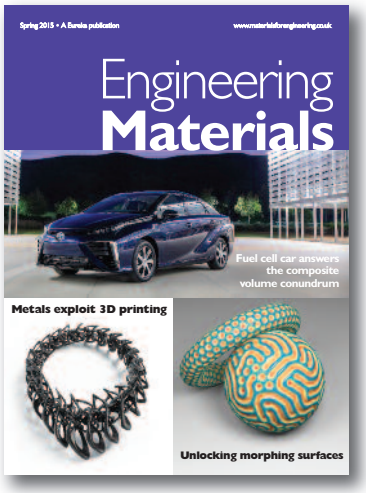
Editorial **Quality**



With many traditional engineering components reaching maturity, some of the greatest gains are now being made through smarter application of materials. *Engineering Materials* is the only magazine that is dedicated to embracing and following the multi-materials trend that is sweeping through industry. We strive to bring unbiased, relevant and informative editorial to engineers — to allow them to make more informed purchasing decisions.

Rather than preach to the converted by covering one type of material, *Engineering Materials* was launched to encourage the use of the right material for the right application. We want to facilitate a culture of innovation by comparing and contrasting all materials, and the innovative ways in which they are being brought together to enable step change improvements.

Engineering Materials brings readers the latest material developments and thinking from leading engineering companies and industry figures. Its articles give a practical and rounded view that reflect some of the biggest material issues of today. These include weight reduction, environmental considerations, joining and assembly, and the practicalities of adopting new materials.

There is no silver bullet and engineers must be smarter with the materials available. *Engineering Materials* is part of the solution.

Justin Cunningham - Editor

Waste not, want not

Carbon fibre remains a premium and expensive material, out of reach for most mainstream automotive manufacturers. However, recycling virgin fibres and mixing them with a thermoplastic offers an affordable alternative. Justin Cunningham reports.

Over the last decade, the cost of carbon fibre has come down, and the exotic material is finding itself beyond originally foreseen applications within aerospace and defence. Despite this, however, the material is still considered premium, and cars in what might be classed as the 'middle-income' bracket, are unlikely to consist of prepregs cured in autoclaves for some time yet.

There are exceptions, but for the vast majority that haven't or can't, other options are becoming available. Here, there is substantial innovation and development to tick both the lightweighting and processing boxes.

One solution that combines the use of carbon fibre, but goes some way in trying to democratise its use, comes from engineering thermoplastic specialist, KD Feddersen. It wants to offer the market carbon fibre... but not quite as we know it.

The Staffs based material firm is supplied preprocessed carbon fibre off cuts and unused fibres, which it then repurposes. These virgin dry fibres are conditioned and chopped in a proprietary process, where they are then combined and compounded with a variety of possible thermoplastics. The result is carbon fibre loaded pellets that can be dropped in to standard injection moulding machines.

"It's a lower cost alternative for those that want to lightweight, don't want to go to glass or want improvement from glass, but don't want the cost of virgin carbon fibres," says Ian Nott, managing director of KD Feddersen UK. "It answers many of the lightweighting questions and challenges engineers have."

Unlike traditional carbon fibre manufacture, the material is not woven, laid up, and does not use a thermoset resin that needs to be cured. Instead, the short fibres are combined with any number of thermoplastics such as Nylon, Polyketone, and Polypropylene.

It has led to a project to make a clutch pedal out of the material to see how effective it can be at replacing parts made from metal, glass fibre, or even engineering plastics. The clutch pedal was made using a AKROMID B3 ICF 15, the company's Nylon 6 product, which has been loaded with 15% by weight of chopped carbon fibre.

Pellets of the material are then fed in to a moulding machine that uses a water-injection process to hollow out the centre, and save further weight. The moulded component is nearly 10% lighter and 25% stiffer than the same component made using a 30% glass fibre reinforced PA6.

Martyn Jocelyn, a technical sales manager at KD Feddersen, says: "This is offering a lot of the benefits of carbon fibre in terms of lower density and stiffness, but it is also giving improved cycle times and throughput."

The superior stiffness of carbon fibre means, as a rule of thumb, half the fibres by volume need to be used compared to glass. For automotive applications, like the clutch pedal, the stand out product is indeed the B3 ICF 15. Though the cost of the material is more than a glass fibre equivalent, it is not as simple as a straight like-for-like comparison.

"It's not just about the cost per gram of carbon vs glass," says Jocelyn. "It's a stiffer material so you can reduce the wall section and therefore you use less material. With a thinner wall section you can run it faster in the machine, so you reduce cycle time and reduce production costs. So you claw back some of that extra cost."

The cost of carbon fibre has been a prohibitive factor for years. At more than £15 a kg and some of the most labour intensive processes needed to manufacture it, the material is still out of reach for many.

However, pellets of repurposed chopped fibres combined with thermoplastic sit at around a third of that price. But, it is not just a straight cost benefit, but the elimination of multiple processing stages including weaving, laying up, machining moulds, wetting out, and curing. Feddersen's ICF pellets by comparison can be used in a normal moulding machine as a straight drop-in replacement. The material is starting to build a cumulative case of advantages for automotive manufacturers.

"We would be able to come along with our material and put it in the same machine that's making glass parts, and give you a weight saving," says Jocelyn.

The materials currently being distributed by KD Feddersen UK have carbon fibre contents between 10% and 40%. And the results are impressive with the numbers speaking for themselves. For example, the AKROMID B ICF 40, a PA 6-based compound with a 40% loading of carbon fibre, achieves a tensile modulus of 30,000MPa, a flexural strength of 320MPa and has a breaking elongation of 1.8%. The AKROMID A3 ICF 40, a PA 66 based derivative compound achieves an even higher 33,000MPa and flexural strength of 370MPa.

The automotive industry is having to go beyond its comfortable cost envelope and is increasingly willing to pay more for lightweight material, especially if there are cost benefits to be gained elsewhere during manufacture. Other components being targeted include centre consoles, activated charcoal filters and control unit brackets.

The automotive sector at large is being pushed on all fronts and it is beginning to yield some impressive results. While this material alone is unlikely to lead to the holy grail of lightweighting – a low cost carbon fibre body in white – it certainly goes someway to enabling injection moulded parts to be made lighter.

"Our material isn't going to compete against laid up carbon fibre structures because of the crash testing and the impact performance that's needed," says Jocelyn. "That is not really the target area. Where there is already an injection mouldable part and glass filled nylons, we can demonstrate a weight saving and an increase in stiffness."

www.kdfeddersen.co.uk

An ENGEL moulding machine was used to produce a carbon fibre reinforced thermoplastic pedal

Comment

Prepare for the mud...

Baton down the hatches and tie them tight. There is a storm coming and it's going to hit everyone. It's a political storm of course, so expect copious mudslinging from all sides.

Justin Cunningham
Editor

The storm is not named Desmond or Imogen, but is the breakfast bar sounding Brexit, the UK's exit from the European Union. Engineers and manufacturers can expect to be at the cliff face of many arguments, with both the for and against camps claiming it will lead to copious job losses and general doom.

The problem with all of this is the lack of actual data. Real facts are hard to come by. If it was a court case, most evidence would be dismissed as hearsay. As engineers, we like those tangible things that we can weigh up, trade off, work around and figure out. The problem is that Brexit is as much about egos as it is anything else.

The arguments and headlines are full of 'could' and 'might', and are bursting with journalistic bias, with everyone from the BBC to the Telegraph going predictably to the left or right, depending on the employer. I, for one, have no idea who or what to believe.

In the coming months, however, like most I will be keeping an eye and ear on developments and will be trying to talk to as many engineers and UK manufacturers about their concerns and views to try and get some balance. While UK manufacturers do an immense amount of trade with the EU, the barriers of trade with other nations – notably the US – are hardly prohibitive, are they?

The UK should also not underestimate its influence on the EU either. As a nation, on the whole, we have been a positive and level headed player that has helped bring about many positive changes in EU countries. And the EU has done the same for us. Not the cucumbers of course, but nothing's perfect.

Science and engineering in the EU are, however, perhaps the strongest in the world, and any Brexit would be a loss for the UK in that respect. It is just another thing to consider, and one of many that will be used to sway opinion, sling mug and make you eat that politically infused Brexit bar in the coming months, whether you want to or not.

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Materials update

Best plain sliding bearing ever?

Bowman International has launched a range of rolled bearings, it claims is the biggest advance in plain sliding bearings in more than 70 years. Its BowMet bearing says it offers higher load capacity and longer life than comparable bearings.

It is manufactured in ToughMet alloy, developed by Materion in the USA, to withstand corrosion, hydrogen embrittlement and chloride stress corrosion cracking.

With a static load of 820N/mm² and a pressure velocity (PV) value of 9.6MPa·m/s, BowMet is ideally suited to harsh industrial applications including mining and quarrying, heavy construction, motorsport, offshore oil and gas, materials handling and marine. In addition, the rolling process ensures virtually no wastage and flexibility with no minimum quantity.

The bearings are available as plain or flanged in a variety of standard wall thicknesses from 0.75mm to 3mm or above, and are also available in imperial sizes.

The range can also be customised to include lubrication grooves, location slots, tabs, holes and pockets.

www.bowman.co.uk

Reducing aircraft wing drag

GKN Aerospace has joined forces with Durham University to develop and implement a method to accurately measure improvements in airframe drag performance. The test is being used to identify surface coatings that will reduce drag by 25% when compared to traditional aircraft surfaces in typical cruise conditions. These coatings must also demonstrate the ability to maintain this level of performance over five years, which is the lifetime of an aircraft's external paint system.

Russ Dunn, senior vice president of engineering and technology at GKN Aerospace, said: "Through the application of advanced low drag surface coatings we aim to improve the efficiency of our customers' aircraft, providing significant financial and environmental benefits. Working together, our team and the experts at Durham University are beginning to see early results from this research activity."

www.gkn.com/aerospace

Bike from made from a solid aluminium billet... really!?

Machinist Stewart Palmer from North Bucks Machining has spent the last 18 months designing and machining a downhill mountain bike from solid aluminium billets. He swapped F1 components and high performance engines and began working on his idea to improve the strength and structural integrity of a mountain bike.

"Standard bikes are produced from hollow tubes that are fabricated together," he said. "This design automatically has weak points on every weld seam. To reduce weight, we realised we couldn't machine hollow tubes, so we used solid aluminium billets to scallop out the sides of the frame and reduce mass."

The main frame is machined from a 100kg aluminium billet down to a 4.5kg frame. The seat post starts as a 15kg billet and ends as a 250g part and the swing arm is machined from a 50kg billet down to a 2kg part. This leaves an aluminium frame of less than 7kg from an overall billet weight of 165kg. As an engineer with a pedigree in F1 design and production, getting the frame to shed a few grams as it progresses is second nature, unfortunately so is its premium price tag of £10,000.

www.northbucksmachining.co.uk

Polymer aerogel to optimise oil and gas pipelines

Blueshift International Materials, the University of Strathclyde and the Oil and Gas Innovation Centre (OGIC) have collaborated to develop an aerogel product, composed of up to 99.98% air by volume, for applications in oil and gas pipelines.

It is said that the development of cleaner and more durable aerogel blankets will improve insulation of deep sea pipe-in-pipe oil and gas pipelines by improving pipeline compression resistance, reducing the amount of steel in pipeline constructions, and consequently increasing oil and gas flow.

Blueshift's initial product is AeroZero, a polyimide aerogel provided in tough and highly flexible thin films, semi-flexible wafers and thicker monoliths that are claimed to be at least 500 times stronger than conventional silica aerogels. The product's 100% polymer construction also produces no dusting, negating the production of dangerous particulates and resultant dangerous materials handling protocols. Blueshift also engaged with OGIC, which provides a single access point to the knowledge and capabilities of Scottish universities, to support the development of the polymer aerogel blanket.

The work proposed and executed by Strathclyde focussed on the blanket and validation of the selected design.

Bulletproof aesthetics

UK product design consultancy 3form Design has designed a helmet for US ballistic protection equipment manufacturer United Shield. The helmet known as RAID needs to carry and hold numerous pieces of equipment, meet ballistic requirements while also 'looking good'. It should be so cool, says 3form, that Tom Cruise will be wearing it in his next movie.

United Shield, based in the State of Michigan with offices in the UK, supplies equipment to special forces teams and law enforcement agencies around the globe. It wanted to develop a new helmet and approached 3form with a brief that included being, 'a cool, appealing, exciting design that soldiers will want to wear. The design needs to look forward to the future and put United Shield ahead of the curve'.

The helmet comes fitted with a universal NVG mount and Picatinny rails, which provide a solid platform for torches, cameras and other gear.

It is made from advanced Aramid composites to provide impressive protection from ballistic and fragmentation projectiles, as well as being lightweight and practical enough for field operations. The large helmet weighs just 1.2kg.

The helmet includes the latest impact absorption system, which can stop projectiles within the V50 category, travelling up to 450m/s. The harness has a split suede chin strap along with a X Style suede neck pad, which can be easily removed for cleaning or replacement.

There was also significant focus on increasing the wearers sight, allowing a greater field of view when the helmet is on as well as offering a more adjustable strap and harness.

www.3formdesign.com

The nano benefit

The use of graphene balls in oil could yield significant engine efficiency improvements in coming years. Justin Cunningham finds out how.

Despite improvements to lubricates such as engine oil, the average car uses 15% of its fuel consumption overcoming friction within the engine and gearbox. It is a prime area for improvement with nano materials potentially offering significant gain. However, in practice, problems with dispersion means nano-lubricants can create more issues than they solve.

"Every year, millions of tons of fuel are wasted because of friction," says Jiaxing Huang, an associate Professor of materials science and engineering at Northwestern University near Chicago. "It's a serious problem."

Developers of lubricants have long searched for nano-additives that enhance oil performance, with carbon nanoparticles trialled on numerous occasions. The particles, however, tend to clump together, which makes them less effective. The particles may also jam between surfaces causing severe aggregation that actually increases friction and wear.

To overcome the problem, past researchers have modified the particles with extra chemicals, called surfactants, to make them disperse in a more uniform manner. However, this still doesn't entirely solve the problem.

"Under friction, the surfactant molecules can rub off and decompose," says fellow researcher Yip-Wah Chung, a professor of materials science and engineering at the university. "When that happens, the particles clump up again."

Huang and his collaborators decided upon trying crumpled graphene balls – novel ultrafine particles that resemble crumpled balls of paper – to see what affect the material would have on the tribological property of oil.

Graphene balls are made by drying tiny water droplets with graphene based sheets inside. Capillary force generated by the evaporation of water crumples the sheets into miniaturised balls.

In a series of tests, oil modified with crumpled graphene balls outperformed some commercial lubricants by 15%, both in terms of reducing friction and the degree of wear on steel surfaces.

The *Eureka* moment came at a lunch when Huang showed the principles of graphene balls to a colleague, by screwing up a napkin and throwing it on the table. "When [I saw a paper] ball land on a table, it rolled," says fellow researcher Yip-Wah Chung, a professor of materials science and engineering at the university. "It reminded me of ball bearings that roll between surfaces to reduce friction."

The unique shape of crumpled graphene balls mean they self-disperse without needing any surfactants. Their pointy surfaces mean they are unable to make close contact with other graphene balls. Even when they are squeezed together, they easily separate again when disturbed.

Huang and his team also found that the performance of crumpled graphene balls is not sensitive to their concentrations in the oil.

"A few [graphene balls] are sufficient, and if you increase the concentration by 10 times, performance is about the same," says Huang. "For all other carbon additives, such performance is very sensitive to concentration. You have to find the sweet spot."

Next, the team plans to explore the additional benefit of using crumpled graphene balls in oil as they can be used as carriers. Because the ball-like particles have high surface area and open spaces, they are good carriers for materials with other functions, such as corrosion inhibition. The research continues.

The ugly plastic problem

The oceans do a good job at hiding rubbish, but they are struggling with the overwhelming quantity being dumped in them. Tackling the problem over such a vast area is a mind boggling challenge. So, who better, than a teenager to try and tackle it. Justin Cunningham reports.

It is dubbed the largest clean up in history, but this project may also be one of the most ambitious. The Ocean Cleanup has one simple aim; remove plastic from the oceans.

Given the scale of the problem, it is perhaps not surprising that the drive to fix it comes from a teenager. Boyan Slat, now 21, brings fresh ideas, the arrogance of youth, a determination to change the world and the self belief to do it.

Here, the lack of life experience is his advantage. He has not been around long enough to be convinced by established experts that a cleanup is impossible. There will always be smart people and good engineers, however, dreamers with drive are harder to come by.

"It amazed me that in the middle of the ocean, a thousand miles offshore, you can find six times more plastic than plankton," he says. "It absolutely shocked me that entire species are threatened by it. But what astounded me was that most people involved in the topic were absolutely certain a cleanup would be impossible."

Going viral

Slat, CEO and founder of The Ocean Cleanup rose to prominence several years ago when he spoke at a TEDx event about his ideas to cleanup the ocean. It went viral.

The concept is to build massive boom arms that capture floating plastic within the ocean's gyres. These naturally circulating currents have concentrated plastic debris in areas of the oceans known broadly as ocean garbage patches. Of the five that exist, all are problematic, but none more so than the 'Great Pacific Garbage Patch'.

"The conventional idea of extracting litter is to have a vessel with nets on either side, and you go fishing for plastic," he says. "But, why move though the oceans if the oceans can move through you. Instead of going after the plastic, you can simply wait for the plastic to come to you."

Slat wants to build and deploy an array of 100km long floating barriers that will be moored in place. Underneath hangs a submerged non-permeable screen to form a barrier against plastic that is suspended under the surface. The design will make entanglement impossible and allow sea life to easily pass underneath. However, all sizes of lighter-than-water plastic, from particulates to larger items, will be trapped, and with the help of the currents debris will gradually move along the V-shaped boom arms to the barrier's centre, to a collection platform.

The non-permeable screen forms a barrier against plastic suspended under the surface, but makes entanglement 'virtually impossible'

A sample of plastic found in open waters: it's estimated by 2050 there will be more plastic in the ocean than fish

Green sky thinking

Nasa targets some ambitious reductions in aircraft emissions and has piloted some seemingly bizarre to outright amazing concepts. In all cases, materials innovation remains key, as Justin Cunningham reports.

The automotive industry tends to grab the headlines at the moment, at least when it comes to emissions. However, putting the VW scandal to one side, massive improvements have been made as the 2020 fleet reduction in CO_2 targets loom ever closer. Credit where credit is due. Auto engineers have already delivered massive tailpipe emission reductions, with further efficiency improvements destined to come. So, could similar ambitious targets be applied to aircraft manufacturers?

Though unofficial, there are some that believe obligatory targets will motivate change in the same way as it has for cars makers. Like automotive, the aviation sector is set for massive expansion and more flights. But, it is in an unsustainable environmental position.

Figures vary, but one potential target that seems to be gathering pace, at least with industry pundits, is a 75% reduction in engine emissions by 2050. Though that seems a long way out, given the longer design cycles, production runs and corresponding engine developments of aircraft, it would certainly be suitably ambitious.

Though tough, the industry would not have to start from scratch. Nasa has a history of developing novel and unusual technologies, and its blue skies approach to aviation has recently taken on a green hue.

It has published a number of studies and results from its ongoing Environmentally Responsible Aviation (ERA) project. Like automotive, much of the reduction will come from the use of innovative materials used to lighten aircraft.

First, is the work involving stitching together large sections of lightweight carbon fibre to create a damage tolerant structure known as PRSEUS (Pultruded Rod Stitched Efficient Unitized Structure).

The technique hopes to offer a distinct advantage: stop cracks forming and spreading. However, in terms of fuel reduction, another motivator is that stitching does away with rivets and fasteners. This could save weight and also help realise unique aircraft geometries such as the blended wing body.

Nasa's Virginia based Langley Research Center put the theory to the test and made up a large composite structure that consisted of 11 panels stitched together. The part measured 9.1m long and 4.3m high. It was installed at Langley's Combined Loads Test System (COLTS), a large hydraulically powered test fixture that essentially serves as an aircraft torture chamber, where parts are bent and twisted to breaking point. Nasa technicians even intentionally damaged critical parts of the PRSEUS composite structure to see if cracks and damage grew under stress.

The tests followed a step-by-step evolution in which first, many panels were manufactured and tested using the PRSEUS technique, and then a cube structure was assembled and tested. At each step, the idea had to prove itself and provide a number of lessons about the material's behaviour and how best to manufacture increasingly larger structures.

"We're still compiling all the data we gathered during the tests, but just visually you can see instances where we intentionally damaged the structure and the damage stopped where it was supposed to," says Dawn Jegley, a senior aerospace engineer at Nasa's Langley Research Center. "And then having covered all the tests we intended to, we did some bonus tests to find out what the ultimate limits of the structure were by exposing it to levels you would never see in flight, and even as it finally failed it still worked like a charm."

The structure eventually suffered a tear but demonstrated it could sustain the loads and forces it would experience in flight, including those in the most extreme cases of violent turbulence.

A bug's life

Nasa has a long history of looking at the stranger / more alternative end of aircraft research, and this part of the ERA project was no exception. It involved bugs, specifically stopping them from reducing aircraft efficiency. Bug residue has been a long standing challenge for the aviation community. Insect debris builds up on the leading edge of wings, which creates drag and increases fuel consumption. So, Nasa is looking at various types of non-stick coatings to reduce the build up. However, before Nasa engineers could develop and test non-stick coatings, the researchers had to study bug chemistry.

"We learned when an insect hits [an aircraft at high velocity] its body ruptures and the blood starts undergoing some chemical changes to make it stickier," says Mia Siochi, a senior materials scientist also at Langley. "That's basically the survival mechanism for the bug."

The work is related to what is often

Manipulated steel

Recreating the bi-axial deformation experienced by steel during stamp forming is allowing researchers to engineer the microstructure and yield lighter parts. Justin Cunningham finds out more.

As the low hanging lightweighting fruits are picked, automotive manufacturers have to now work that bit harder to shed the pounds. BMW is perhaps one of the more progressive examples of a manufacturer driving composite R&D in a major way. However, it is not simply abandoning metal, and like many others, it is seeking out ways to lightweight vehicles using conventional steel.

This has led to BMW Mini initiating a project between The University of Oxford and Diamond Light Source – the UK's national synchrotron science facility located at the Harwell Science and Innovation Campus in Oxfordshire. The facility harnesses the power of electrons and x-rays to help scientists and engineers gain new insight and understanding in to the microscopic and internal structures of materials.

BMW Mini wants answers to a phenomenon that has been witnessed, more broadly, since the 1950s. It is seen when parts are stamp formed, a common automotive process, to make everything from bonnets to doors.

The problem is, for any stamping process that is completed in more than one stage, the deformation becomes highly complex, particularly for a pressed part with strain applied in two-axes. This results in a non-homogeneous arrangement of the crystalline and microscopic defect structures.

While it may sound arbitrary, the affect can influence grain morphology, crystal orientation and distribution – all of which have significant impact on mechanical properties, including most importantly, how much the material will stretch before it fractures.

Leading the work is Dr David Collins, a researcher at the University of Oxford, who explains the problem. He says: "They can't stamp form stronger steels at the moment because of this affect. The metals they use on body panels are actually quite weak, say 10% as strong as the strongest steels on the market. Stronger metals are not ductile and can't be stamped into the complicated shapes needed."

It means thicker sections have to be used, so panels end up weighing more. It's something BMW is keen to understand so it can ultimately reduce the weight of steel chassis.

The problem is complex, meaning testing and analysis is far from straightforward. The deformation is biaxial, meaning any obvious traditional solution is not suitable. It led to Dr Collins applying to use the synchrotron to carry out tests and shed new light, or x-rays in this case, on the problem. However, he soon faced another problem, the Shimadzu AGS-X 10kN load frame that was available, was a single axis machine.

Dr Collins decided to do what so many engineers have done before him – innovate. He designed a mechanism to generate the bi-axial deformation needed, which also bolts straight on to the Shimadzu machine.

"I've built a mechanism that uses the power of the load frame to generate the

The Engineer's Puzzle

The balls up!

Dave, the engineer, is a clumsy kind of fellow. Whilst walking around the factory floor one day, he turns and inadvertently knocks something over. When he turns around to see what he has done, he realises he's knocked a loose tungsten ball bearing in with some steel ones.

He looks down and sees nine bearings staring back at him. He knows there should only be eight, as they are prearranged ready for assembly. The problem is they're all the same size, and look exactly the same. He see's Charles Clutterbuck, the MD approaching, and not wanting to expose his clumsy ways, he comes up with a plan to right the situation quick sharp!

He grabs some old fashioned balancing weighing scales and making just two measurements isolates the tungsten bearing. He quickly puts it back in its rightful place, just in time to shake hands with Charles and pretend to be interested in his weekend. Good old Dave.

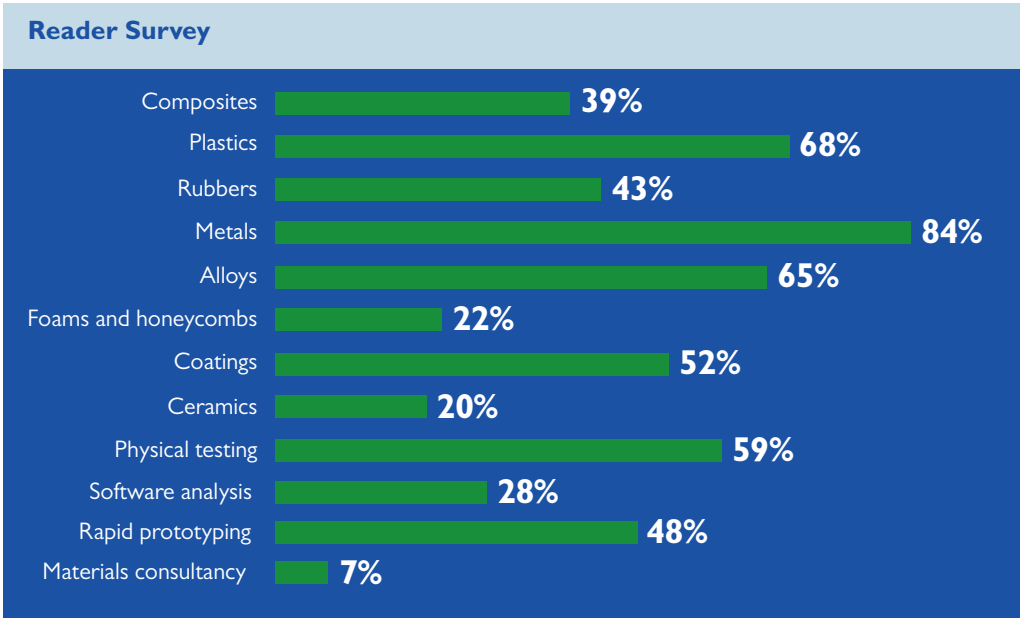
So the question is, how did he do it? And can you beat Dave's time of just 60 seconds? Go!

For the Engineer's Puzzle answer visit www.materialsforengineering.co.uk

Readers with **Purchasing Power**

The *Engineering Materials* Reader Survey shows we have an audience with the authority, the need and budget to purchase materials. Almost 90% of readers said they are responsible for buying or specifying, and 78% saying they have made purchasing decisions based on what they have read/seen in *Engineering Materials*.

The readers of *Engineering Materials* will be buying and specifying in the following areas during the next 12 months:



84% of readers would choose Engineering Materials as their preferred materials magazine

96% of readers would recommend Engineering Materials as an information source for other engineers

89% of readers are responsible for buying or specifying materials

78% of readers made purchasing decisions based on what they have read/seen in Engineering Materials

Source: 396 respondents – Benchmark Research Survey

Targeted **Circulation**

The *Engineering Materials* circulation is taken from MA Business, (formerly Findlay Media) market leading database. This database, with coverage of all manufacturing and design sites within the UK, is updated continuously by our specialist data research team.

Our terms of control:
Engineering Materials is a magazine for engineering designers, purchasing managers and production engineers who directly control or influence the selection, specification and purchasing of engineering materials.

With its quality editorial content and database of highly relevant customers, *Engineering Materials* is **the** publication for materials buyers and specifiers, and the companies trying to reach them.

Analysis by Supply Chain (multi-response analysis)	
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Consultants/Other Executives	460
Total Circulation	**14,200**

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Whatever your preferred choice of media, *Engineering Materials* aims to provide you with a range of channels to your target audience.

PRINT

Display Advertising		**Advertorial**		**Series Discounts**	
Double Page Spread	£4,000	Double Page Spread	£4,000	x 2 insertions	15% discount
Full Page	£2,990	Full Page	£2,990	x 4 insertions	25% discount
Half Page	£1,785				
Quarter Page	£1,070	**Inserts**	£1,500		

ONLINE

Advertising on *materialsforengineering.co.uk* provides a measurable and flexible way for you to get your message across to the engineers, designers, material specifiers and buyers. Whether you are promoting a launch of a product, want to re-brand or have an upcoming event, *materialsforengineering.co.uk* can put your message in front decision makers and potential customers.

The banner advertising elements of the website can be positioned on the home page or any subsequent sections, providing a strong branding opportunity.

Leaderboard	£1,500 per month (728 x 90 pixels)	**Premium Message Panel**	£1,000 per month (300 x 200 pixels)
Banners	£1,000 per month (468 x 60 pixels)	**Page Peel**	£2,000 per month (150 x 150 pixels expanding to 500 x 500 pixels)
Small Message Panel	£250 per month (300 x 100 pixels)		
Large Message Panel	£500 per month (300 x 200 pixels)		

e-newsletters

Engineering Materials sends regular e-newsletters to opt-in subscribers, providing an opportunity for you to advertise directly into their inbox. Advertising and advertorial content on the e-newsletters are both tracked and provide you with access to soft leads for your sales team to follow up and as a measure of return on your investment.

Technology Spotlight	£700 per insertion
Banner	£1,000 per insertion
Small Message Panel	£500 per insertion
White Paper of the Week	£700 per insertion
Video of the Week	£700 per insertion
Sponsor News	£700 per insertion

Engineering Design Show

Launched in 2012, the Engineering Design Show has rapidly become the must-attend event for anyone involved with engineering design.

More than 4,000 design engineers attend each year from all UK industries to hear from inspirational speakers in the conference, learn from practical workshop session and most importantly to do business with more than 200 exhibitors.

Exhibitor packages can be created for either shell scheme or space only bookings, with additional sponsorship opportunities available to maximise your impact on visitors at the event and raise your profile.

Just like the markets it serves, the Engineering Design Show continues to evolve and innovate to meet the needs of its audience and exhibitors for years to come.

www.engineeringdesignshow.co.uk

British Engineering Excellence Awards

Launched in 2009, the British Engineering Excellence Awards were created to celebrate and promote the innovation within the UK's engineering and electronics design communities.

Organised by MA Business, the publisher of Engineering Materials, Eureka and New Electronics magazine brands, the BEEAs have become an important event on the calendar of design engineers throughout the UK and features a category to recognise the innovative use of materials.

Judged independently by a panel of senior design industry executives and directors of design focused industry associations, the British Engineering Excellence Awards are a great opportunity to align your brand with design innovation, benefitting from a 12-month marketing campaign delivered through Engineering Materials, Eureka and New Electronics readers to more than 106,000 design engineers.

Category Sponsorship Package = £8,000 per annum (equates to £667 per month for 12 months)
Categories include:
Consultancy of the Year
Design Engineer of the Year
Design Team of the Year
Materials Application of the Year
New Product of the Year (Electronic)
New Product of the Year (Mechanical)
New Product of the Year (Medical)
Small Company of the Year
Start Up of the Year
Young Design Engineer of the Year

For more information visit:
www.beeas.co.uk

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