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DEPARTMENT OF ENGINEERING NEWS

UNIVERSITY OF CAMBRIDGE

In this issue

Cover photo: James Griffith: *Fractured Rainbows*
This image shows the edge of a Mode II crack; a phenomenon rarely seen in glass. It has developed due to shearing within a layer of glass.

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Welcome

As I took office in October last year, I thought the move of Engineering to West Cambridge was a really exciting project about creating world-class facilities for a world-class department. This, in itself, made it the largest building project in the University's history. Just a few months later, I am now surfing a huge wave of enthusiasm for re-imagining the discipline itself.

Engineering will always be built on the strength and depth of its core engineering disciplines: materials, design, electronics, control, etc. The new magic lies in combining those strengths with great agility to deliver results. Our strategy is evolving fast to create a new flexible structure for bringing teams to bear on today's challenges and adapt to face whatever challenges may come in the future.

We are not only consulting our staff and students, but going outside to build-in the latest ideas from our partners in industry, government and academia. The process of creating our strategy is already improving transparency, openness and channels of communication. We have only just started the journey and yet our early thoughts are already opening new doors.

As this thinking develops, it is shaking up our plans about facilities and the big move. The new site needs to enable the agility we are developing in our strategy. This means the site must work as one highly networked functional entity. Labs must be positioned in relation to one another to create loose overlapping clusters that can work together to deliver results. The fabric of the site must allow collaboration and change, so that the labs and clusters can grow and evolve. We have to make clever decisions about what is distributed through the site and what is centralised, so that we hit the right balance between convenience, cost and social mixing. This last point is crucial. We want everyone to feel a sense of being in one department, but maintaining a human scale in such a large site. This applies to our partners and visitors, too. We want them to feel they have arrived in one of the great centres of engineering in the world, but we also want to them to feel at home. As people walk through the site, they should see everything on display, both research and teaching, and see the best of both reflected in both current projects and the technology employed in the building itself. Everything should shine with our strategy of openness, partnership and engineering brilliance.

These are fine words, but I am all too conscious of the hard work ahead for all of us to make it a reality. We are currently testing our strategy in consultation, building our database of detailed requirements and serious planning is underway. Everything is shaping up for a busy summer. We will keep all our alumni and partners posted as the project progresses.

Meanwhile, the Department's research and teaching goes from strength to strength. I hope you enjoy reading the latest in this edition of the newsletter. Please drop us a line if you have any thoughts or feedback.

Professor David Cardwell FREng

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↑ Left to right: Owlstone Co-founders and Department of Engineering alumni Andrew Koehl, David Ruiz Alonso and Billy Boyle

ALUMNI UPDATE

Cancer breathalyser created by Cambridge spinout company

Owlstone, a detection technology company co-founded by Department of Engineering alumni Billy Boyle, David Ruiz Alonso and Andrew Koehl, has created a cancer breathalyser.

The detection technology specialist company has won £1 million funding from the NHS in the UK to develop the technology and help combat lung cancer.

Owlstone's LuCID project – a consortium made up of a number of leading academic institutions and clinical partners – aims to diagnose lung cancer at a stage when survival rates are dramatically better.

The LuCID (Lung Cancer Indicator Detection) project is researching the early, non-invasive diagnosis of lung cancer by measuring volatile organic compounds in patients' breath.

The vision is to save 10,000 lives and save the NHS £254 million by 2020, by increasing detection of lung cancer in its early stages.

Owlstone's co-founder Billy Boyle said stage one lung cancer had a 75 per cent survival rate compared to just a five per cent chance of survival for stage four victims.

Using leading-edge nanofabrication techniques, Owlstone has developed a complete chemical detection system on a chip: a 'dime size' Field Asymmetric Ion Mobility Spectrometer (FAIMS), with the ability to rapidly monitor a broad range of chemicals at very low quantities with high confidence.

Phase I of the LuCID project is already completed: 12 markers of lung cancer were shown to be detectable by Owlstone's FAIMS technology, which Billy says is a cheaper and smaller alternative to existing detection technologies.

The new funding for Phase II will be targeted towards the delivery of a breath sampler – a customised breathalyser suitable for use in a doctor's surgery or hospital, and clinical validation of the method.

Billy said: "If you could change only one thing in the fight against cancer it would be to detect the disease earlier where existing treatments are already proven to save lives."

FAIMS technology has the potential to bring a quick and easy-to-use breath test to a GP's office. Our team will not rest until we help stop the daily devastation that cancer brings to patients and their families."

The technology is being trialled around the world for different types of cancer and other diseases.

Billy lost his wife to cancer on Christmas day 2014. "When my wife was sick we talked about what motivated her, what motivates me. Knowing the conversations I had with her about how we can develop technology for the benefit of others is something that makes me walk into the office every day. It puts an extra spring into my step."

A community of researchers interested in breath-based diagnostics are jointly designing an open-source breath sampler that can be used with a range of analytical instruments. Join the Breathe Free community at www.breathe-free.org.

> You develop technologies for a reason. Sometimes it is for monetary gain. Other times it's to make a difference. And I think we have a real opportunity to try and improve the lives of patients.
>
> Alumnus Billy Boyle Co-founder of Owlstone

www.owlstonenanotech.com

Good vibrations for Forth Road Bridge

↑ Forth Road Bridge: Castaway in Scotland (Flickr)

As the Forth Road Bridge reached its 50th anniversary, a team of Cambridge engineers have deployed state-of-the-art self-powered wireless sensors which could help monitor and protect the Scottish landmark well into the future.

A team from the Cambridge Centre for Smart Infrastructure and Construction (CSIC) have designed vibration energy harvesters which convert ambient vibrations into electricity, eliminating the need for batteries and making remote monitoring of the long-span suspension bridge's health much easier.

The 2.5 kilometre-long Forth Road Bridge, which connects Edinburgh and Fife, now carries far more traffic than it was originally designed for. About 25 million vehicles cross the bridge each year, nearly ten times the number it carried when it opened in 1964. The increased strain that the additional traffic load has had on the structure became apparent during a routine inspection of the bridge's cables in 2004, when extensive corrosion was discovered in the strands making up the main suspension cables.

After the damage was identified, the decision was made to build a new road bridge alongside the Forth Road Bridge and Forth Rail Bridge. The Queensferry Crossing is due to open in 2016, and traffic on the Forth Road Bridge will then be limited to buses, taxis, cyclists and pedestrians. Although traffic load will be reduced significantly when the new bridge opens, there will still be a requirement for ongoing monitoring of the older structure.

Professor Campbell Middleton and a CSIC bridges team believe the work they are undertaking to develop and demonstrate wireless sensor network (WSN) technology may have a role to play in monitoring various key structural elements on the bridge. However, one of the problems holding back the adoption of WSN, particularly in difficult-to-reach areas such as underneath a busy bridge, is the need to change batteries on a regular basis. The issue is not the cost of the batteries themselves, but rather the cost of the human resource to replace the batteries.

In a bid to solve this issue, Dr Yu Jia and Dr Ashwin Seshia have developed a new vibration energy harvester based on a phenomenon known as parametric resonance, which amplifies vibrations. The device has the potential to harvest significantly more energy from ambient vibrations than previous designs, and vibration data collected from the Forth Road Bridge during a field investigation is now being used by Dr Jia to optimise the harvester for a trial deployment at this Scottish landmark.

"As vibration energy harvesting improves and the amount of energy available to power sensors increases, new radio technologies are emerging with lower power requirements," said Professor Middleton. "We may be approaching the point at which a vibration-powered wireless sensor network, with no need to change batteries, becomes a reality. This would be a world first."

> "We may be approaching the point at which a vibration-powered wireless sensor network, with no need to change batteries, becomes a reality.
>
> Professor Campbell Middleton

The low-cost, wireless, battery-free sensors will enable CSIC to measure the behaviour of key structural elements on this critical piece of infrastructure, giving its owners a far greater understanding of the actual capacity and level of safety of the bridge.

Professor Middleton continued: "The Forth Road Bridge offers a fantastic opportunity to test this innovative technology which will provide key information to the bridge owners and managers, leading to knowledge and reassurance of its ongoing safety performance, which could see the Forth Road Bridge surviving a further 50 years or more."

→ www-smartinfrastructure.eng.cam.ac.uk

Credit: Dr Paul Robertson

↑ Wing shot of the hybrid plane

Watts up

Aeroplanes go hybrid-electric

An aircraft with a parallel hybrid engine – the first ever to be able to recharge its batteries in flight – has been successfully tested in the UK, an important early step towards cleaner, low-carbon air travel.

Researchers from the Department of Engineering, in association with Boeing, have successfully tested the first aircraft to be powered by a parallel hybrid-electric propulsion system, where an electric motor and petrol engine work together to drive the propeller. The demonstrator aircraft uses up to 30 per cent less fuel than a comparable plane with a petrol-only engine. The aircraft is also able to recharge its batteries in flight, the first time this has been achieved.

The demonstrator is based on a commercially available single-seat aircraft, and its hybrid engine was designed and built by engineers at Cambridge with Boeing funding support.

The aircraft uses a combination of a 4-stroke piston engine and an electric motor/generator, coupled through the same drive pulley to spin the propeller. During take-off and climb, when maximum power is required, the engine and motor work together to power the plane, but once cruising height is reached, the electric motor can be switched into generator mode to recharge the batteries or used in motor assist mode to minimise fuel consumption. The same principle is at work in a hybrid car.

"Although hybrid cars have been available for more than a decade, what's been holding back the development of hybrid or fully-electric aircraft until now is battery technology," said Dr Paul Robertson of the Department's Electrical Engineering Division, who led the project. "Until recently, they have been too heavy and didn't have enough energy capacity. But with the advent of improved lithium-polymer batteries, similar to what you'd find in a laptop computer, hybrid aircraft – albeit at a small scale – are now starting to become viable."

The hybrid power system in the Cambridge demonstrator is based on a Honda engine, in parallel with a custom lightweight motor. A power electronics module designed and built in the Engineering Department controls the electrical current to and from the batteries – a set of 16 large lithium-polymer cells located in special compartments built into the wings. The petrol engine is optimally sized to provide the cruise power at its most efficient operating point, resulting in an improved fuel efficiency overall.

"Our mission is to keep our sights on finding innovative solutions and technologies that solve our industry's toughest challenges and continually improve environmental performance," said Marty Bradley, Boeing's principal investigator for the programme.

"Hybrid-electric is one of several important elements of our research efforts, and we are learning more every day about the feasibility of these technologies and how they could be used in the future."

While the Cambridge demonstrator is an important step in the development of hybrid or fully electric aircraft, more research is required before commercial airliners will be powered entirely with electric motors. For example, if all the engines and all the fuel in a modern jetliner were to be replaced by batteries, it would have a total flying time of roughly ten minutes.

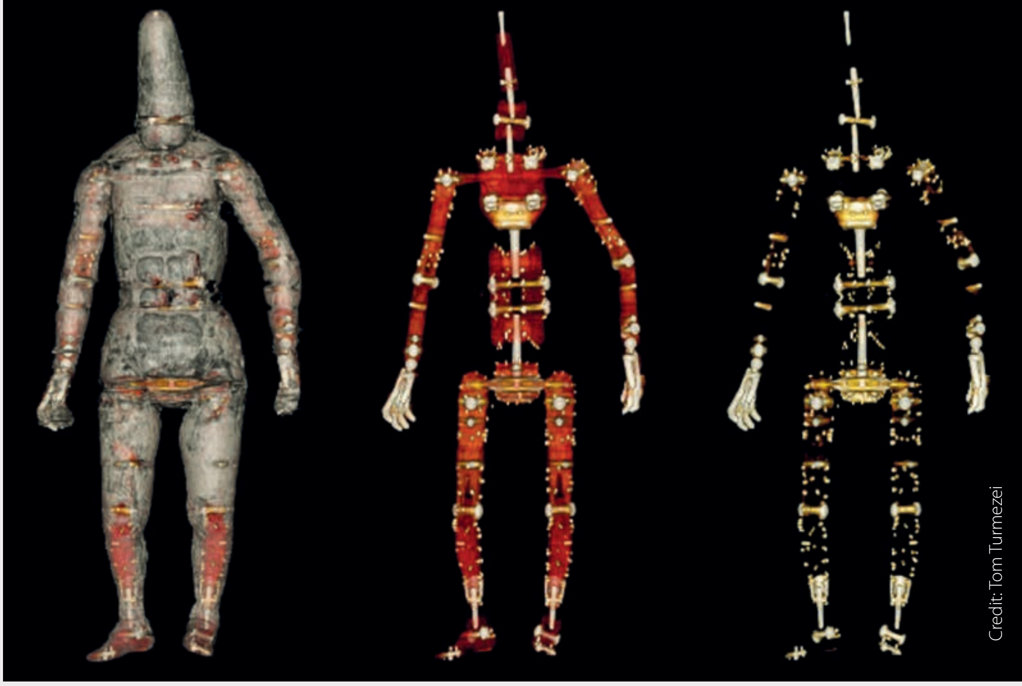
Test flights for the project took place at the Sywell Aerodrome, near Northampton. These tests consisted of a series of 'hops' along the runway, followed by longer evaluation flights at a height of over 1,500 feet.

Dr Robertson's team, which includes PhD students Christian Friedrich and Andre Thunot and MEng student Tom Corker, is conducting ongoing test flights to characterise and optimise the system for best performance and fuel economy.

The Intergovernmental Panel on Climate Change (IPCC) estimates aviation is responsible for around 2 per cent of global man-made carbon dioxide emissions. The aerospace industry made global commitments to take action that will see carbon neutral growth from 2020 and a net reduction in CO^2 emissions of 50 per cent by 2050 compared to 2005 levels. Boeing is a member of Sustainable Aviation (www.sustainableaviation.co.uk), which is responding to these goals in the UK.

www.eng.cam.ac.uk/profiles/par10

→ Scan images showing the interior of a jointed mannequin



Looking at artificial others

Mannequins with x-ray vision

The fascinating results of computerised tomography (CT) scans performed on two mannequins from the 18th and 19th centuries have revealed astounding stories which may impact the future of clinical practice.

The historic mannequins are from the exhibition Silent Partners, which was displayed to great critical acclaim at the Fitzwilliam Museum, Cambridge.

The scans were taken at Addenbrooke's Hospital, part of Cambridge University Hospitals, to discover the internal workings without damaging the mannequins. At the same time, radiologists and engineers were able to use the data from the non-human bodies to test not yet clinically approved software on the images, furthering research for potential clinical practice in the future.

The procedure was led by Dr Tom Turmezei, of the Department of Engineering's Medical Imaging Group. Tom said: "The mannequins contain both natural materials and worked metals, making for an interesting human analogue. Humans are getting more and more artificial metal parts in their bodies, for example in joint replacements, clips and plates. When these are scanned with the CT machine it creates a starburst effect in the final image, called an artifact, and this bright white flare-like trace obscures details in the surrounding tissue. Clinically this can be a big problem as it can make it difficult to perceive both damage to the metal part and any disease in the tissue around it, such as an abscess, blood clot or tumour. As we are moving towards more metallic, electronic and even robotic body parts, being able to reduce the artifact in the scan is ever more important."

Tom was assisted by Dr Tristan Whitmarsh, also of the Department's Medical Imaging Group, who used Metal Deletion Technique software from Revision Radiology on the scans to look at the effectiveness of the algorithm to reduce the artifact.

The two mannequins scanned were 'Child no. 98', a high-quality 19th century Parisian, stuffed, lay figure from the Hamilton Kerr Institute, and an 18th century, largely wooden mannequin, once belonging to Walter Sickert (1860-1942) from Bath Spa University.

> "Looking at these mannequins you can see the incredible drive to create a more accurate model of the human body and the developments that happened to allow this to take place.
>
> Dr Tom Turmezei

Alongside these mannequins, the exhibition tells the fascinating stories of two more historic figures: a 68cm tall figure from the Museum of London once belonging to the sculptor Louis-François Roubiliac (1695-1762), which was scanned separately to reveal an internal 'skeleton' made of iron, bronze and brass; and how three specialists restored a 19th century figure belonging to the artist Alan Beeton (1880-1942), which had tattered fingers and a broken nose. This included a textile conservator, a modeller of medical prosthetics and a sculptress specialising in papier mâché.

Artists' mannequins, although fascinating objects, were tools to be used in the studio: as such, their history was not always rigorously documented and today there are gaps in our knowledge about their exact manufacture. The CT scans also allowed documentation of their construction in detail, and uncovered hidden damages to the internal workings of the figures over time. A fractured left knee joint in the Bath Spa mannequin was noted so the object can now be moved safely in the future.

Tom added: "Above all, the purpose of doing these scans was art historical; to discover their material composition and construction in a non-invasive way and confirm suspicions art historians had about these objects. Looking at these mannequins you can see the incredible drive to create a more accurate model of the human body and the developments that happened to allow this to take place. The Bath Spa model is mostly wood. By the time Child no. 98 was made they had moved to a wooden skeleton and metal joinery, padded out with horse hair and hessian. A great deal of effort was taken to give Child no. 98 as accurate anatomy as possible: the body has padding inside for flank and abdominal muscles, there is padded material inside the chest to make lungs, a belly button and even glass beads under the chest 'skin' for nipples."

Silent Partners: Artist and Mannequin from Function to Fetish is now on display (until 12th July 2015) at the Musée Bourdelle, Paris.

mi.eng.cam.ac.uk/Main/MedIM
www.fitzmuseum.cam.ac.uk

↑ On-site consultation during construction

Constructionarium week
Putting theory into practice

A group of 33 third-year undergraduate Engineering students attended the residential construction week of the Constructionarium module.

This is a module offered primarily to Civil, Structural and Environmental Engineering students as one of the projects to be completed in the Part IIA tripos, and is run by the Constructionarium group at the National Construction College in Kings Lynn.

The principle of Constructionarium is that students are required to construct scaled-down replicas of real civil engineering projects such as bridges, buildings and dams. The project is carried out in conjunction with a contractor and civil engineering consultant to link academia to industry. This year, together with support from Laing O'Rourke as the contractor and Ramboll as the engineer, the students constructed replicas of the Ravenspurn Oil Platform in the North Sea and the Knightsgate Bridge in Durham.

Before the construction week, in the planning phase, students were required to develop project management plans, construction budgets, method statements and risk assessments; this exposed the students to the required safety and planning procedures conducted before the construction work. During the construction work itself, students were fully responsible for all aspects of construction, under supervision from Laing O'Rourke, and were responsible for the design of temporary works as well as the execution of quality control and safety procedures. Daily project meetings were held to report back on programme, budget, quality and safety to mimic a real-world construction project. On completion of the project, a final presentation was made and students were required to reflect on differences between what was envisaged in the planning stage and the actual construction experience.

Despite the tremendous amount of effort and planning required and long working days, the students who participated greatly enjoyed the learning experience and chance to put theoretical knowledge and design skills into practice! This module provides the opportunity for students to gain an in-depth understanding of what is required to design and execute a construction project successfully, the importance of planning and health and safety awareness. The reflection and reporting required after the successful completion of the projects provided valuable insight for future careers in the built environment industry.

Constructionarium also gave the students a wonderful opportunity to learn teamwork, communication and project management: core personal skills that are vital in any further study or career path that the students undertake. The practical and interactive experience, and engagement with fellow classmates and engineers and contractors from industry is a great leap in building confident and competent future engineers.

The organisers of the Constructionarium module at the University of Cambridge would like to thank Laing O'Rourke for their generous financial support of this module, as well as Ramboll for the donation of their time as the engineering consultants in this project.

Dr Mohammed Elshafie is a Laing O'Rourke University Lecturer in Construction Engineering and is the Constructionarium Course leader. Talia da Silva and Dr Waleed Hamad assisted in the course and are a PhD student in the Civil Engineering Division and research associate in the Mechanics, Materials and Design Division respectively.

www.constructionarium.co.uk

Credit: Pat (Cletch) Williams on Flickr

↑ Gesture keyboard technology can mean quicker and easier texting

Transforming text messaging

An Engineering Design Lecturer has been recognised for his research work which has revolutionised the way mobile telephone texting is carried out.

> The shapes of words build up in users' muscle memory which enables users to quickly recall the shapes for words without looking much at the keyboard – similar to how you remember your PIN.
>
> Dr Per Ola Kristensson

Dr Per Ola Kristensson, a Lecturer in Engineering Design and leader of the Department of Engineering's Intelligent Interactive Systems group, began his research into gesture keyboard systems as an MSc student in Sweden in 2001.

He explained: "My work on gesture-based text entry for touch-screen keyboards enables users to write quickly on their mobile phones by sliding or swiping the finger over a touch-sensitive on-screen keyboard.

"For instance, to write the word "the" the user pushes down the finger on the T key, slides to the H and E keys, and then lifts up the finger on the E key. This input paradigm recognizes the shape of this gesture using a pattern recognizer. During practice, the shapes of words build up in users' muscle memory which enables users to quickly recall the shapes for words without looking much at the keyboard - similar to how you remember your PIN.

"Gesture keyboard technology is currently installed by default on all new Android and Windows Phone devices."

Per Ola's research resulted in a start-up called ShapeWriter, Inc., which he co-founded in 2007. This start-up released the first gesture keyboard app for iPhone and Android devices in 2008 and the app received several recognitions, including *Time* magazine ranking the iPhone app as a top-ten iPhone app and the Android app winning a Google Android Developer Challenge (ADC50) award.

He received the Association of Computing Machinery (ACM) User Interface Software and Technology Lasting Impact Award at the annual User Interface Software and Technology (UIST) symposium in Honolulu earlier this month.

The award is given annually to the authors of a research paper published at least ten years ago which has had a wide impact on not only the user interface technology research field but also the wider research community and society at large.

Per Ola co-wrote the award-winning research paper with his PhD supervisor Shumin Zhai who is also named on the award. Their citation reads:

"Awarded for its scientific contribution of algorithms, insights, and user interface considerations essential to the practical realisation of large-vocabulary shape-writing systems for graphical keyboards, laying the groundwork for new research, industrial applications and widespread user benefit."

→ www.eng.cam.ac.uk/profiles/pok21

➔ Driverless pod in Milton Keynes

Integrating driverless cars into everyday life

The University is a partner in a three-year, multi-million pound project which will test public reaction to driverless cars and conduct real-world testing on public roads around Milton Keynes and Coventry.

The UK Autodrive consortium was announced as the winner of the UK Government's £10 million 'Introducing Driverless Cars' competition in the 2014 Autumn Statement.

The aim of the project, which involves local authorities, technology and automotive businesses and other academic institutions, is to establish the UK as a global hub for the development of autonomous vehicle technologies, and to integrate driverless vehicles into existing urban environments by trialling them in two UK cities.

Not only will the programme help develop the new protocols and connected infrastructure required to deliver future autonomous mobility, it will allow the UK Autodrive team to test public reaction to both driverless cars and self-driving pods.

The funding, provided by Innovate UK, will be matched by the 12 consortium members to create a £19.2 million three-year project which will be led by design and engineering consultants Arup. The feasibility studies and practical demonstrations will take place in Milton Keynes and Coventry, where the city councils are taking the lead in developing the urban infrastructure technologies required to support driverless mobility.

The University's role involves looking at the feasibility of driverless public transport (L-SATS, or Low-Speed Autonomous Transport System), assessing the public's reactions to and perceptions of autonomous vehicles, and assessing their possible impact on congestion. The studies will provide insights for vehicle manufacturers, cities, commercial operators, legislators and insurers to develop the legal framework for the roll-out of autonomous mobility.

On-road testing will include the real-world evaluation of passenger cars with increasing levels of autonomy, as well as the development and evaluation of lightweight fully autonomous self-driving pods designed for pedestrianised spaces.

"Many cars which are available today already have some degree of autonomy, through technologies such as automatic parking," said Professor John Miles of the Department of Engineering, who designed the programme and established the consortium. "People are starting to accept many of these features as commonplace, and we will be testing some of the more advanced 'driver assist' technologies in the earlier part of the programme."

"As well as developing and testing the in-car, car-to-car and car-to-infrastructure technologies that will be required to drive cars autonomously on our roads in the future, the project will also place great emphasis on the role and perceptions of drivers, pedestrians and other road users," said Tim Armitage, the UK Autodrive Project Director at Arup.

The consortium's plans for the practical demonstration phases is to start testing with single vehicles on closed roads, and to build up to a point where all road users, as well as legislators, the police and insurance companies, are confident about how driverless pods and fully and partially autonomous cars can operate safely on UK roads.

"Cars that drive themselves would represent the most significant transformation in road travel since the introduction of the internal combustion engine," said Nick Jones, lead technologist at Innovate UK. "There are so many new and exciting technologies that can come together to make driverless cars a reality, but it's vital that trials are carried out safely, that the public have confidence in that technology and we learn everything we can through the trials so that legal, regulation and protection issues don't get in the way in the future."

The partners in the consortium are Arup, Milton Keynes Council, Coventry Council, Jaguar Land Rover, Ford Motor Company, Tata Motors European Technical Centre, RDM Group, MIRA, Oxbotica, AXA, international law firm Wragge Lawrence Graham & Co, the Transport Systems Catapult, the University of Oxford, University of Cambridge and the Open University.

www.energy.cam.ac.uk

Dial-b-for-Boeing

Duncan McFarlane, Professor of Industrial Information Engineering and head of the Distributed Information & Automation Laboratory (DIAL) at the Department of Engineering's Institute for Manufacturing (IfM), and members of his research team have been working with Boeing since 2005, finding intelligent solutions to some challenging industrial problems.

Boeing is the world's largest aerospace company, producing tens of billions of dollars-worth of commercial jets and defence systems for customers around the world. DIAL is the IfM's Distributed Information and Automation Laboratory, which specialises in using data more intelligently within factories and across the supply chain to develop more dynamic services and smarter products. Over the last nine years, DIAL has worked with Boeing on six major projects addressing three key challenges: how to manage supply chains more effectively, how to improve resilience and how to make airports more efficient. While these projects have addressed various aspects of Boeing's business they have one important thing in common – a commitment to applying research to solve real-world problems.

For Boeing, funding research is all about achieving competitive advantage. For DIAL, it is all about finding solutions which have a significant – and widely applicable – industrial benefit. These complementary aspirations underpin the relationship between DIAL and Boeing and is neatly illustrated by two of their current projects: ALADDIN (Achieving Leveraged Advantage from Distributed Information) and DisTAL (or Disruption Tolerant Automated Lean Factories).

ALADDIN is a collaboration with Boeing's Research & Technology team, looking at how the vast amounts of data Boeing deals with on a daily basis can be turned into a more valuable commodity for the business. Every time a Boeing 787 takes off it generates roughly half a terabyte of data. While some of it will be critical to the operation, much of it is not.

ALADDIN is particularly interested in the data associated with procurement which suffers from high levels of inconsistency, with the same part often described in a multitude of different ways by Boeing's many hundreds of suppliers. In a fast-paced manufacturing environment, this inconsistency has the potential to cause problems with shortages and disruptions which can only be averted by labour-intensive (and, therefore, costly) data management processes. But this could be avoided altogether if the data were intelligent enough to have organic awareness of its own value and be able to predict potential problems.

While this project is tackling what Bill describes as a 'Cambridge-hard' problem it is by no means a theoretical or speculative exercise. As Dr Philip Woodall, Senior Research Associate in DIAL and lead researcher on ALADDIN, emphasised: "At the end of the project the Cambridge team will be handing over working applications using real datasets, not research prototypes."

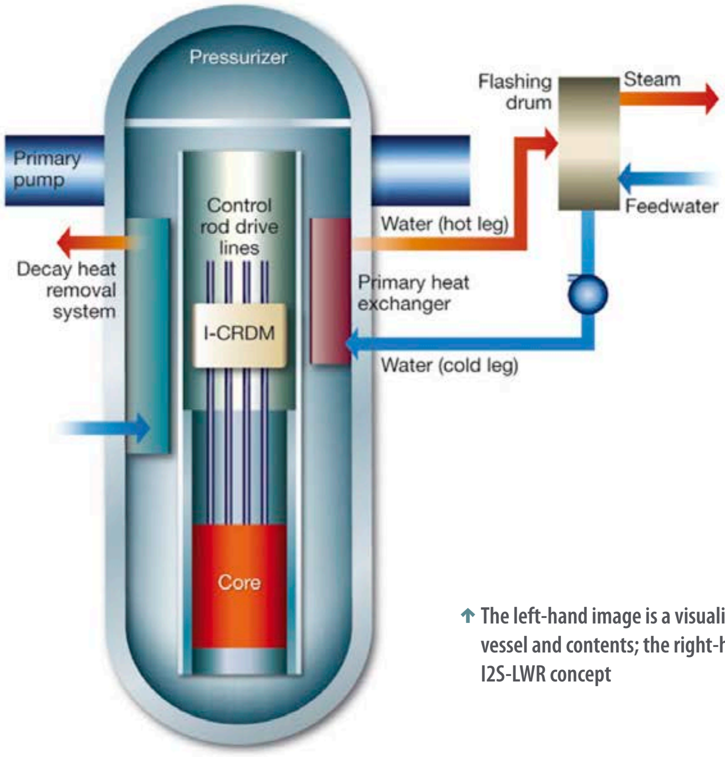
Like ALADDIN, the DisTAL project runs under the auspices of Boeing's research team but also involves a direct collaboration with Boeing's Interiors Responsibility Center (IRC) in Everett, Washington, where the interiors of all models of Boeing aircraft are designed and built. One of the challenges the IRC faces is that the interiors of planes are highly customised, with each of Boeing's airline customers having its own branding, and often with different branding for different routes. And the specification of interiors is becoming more and more sophisticated as new technologies emerge and airlines become more attuned to the psychological and physiological effects of flying. The ceiling of the new 787, for example, comes with blue LED lighting to mimic the sky and when the plane is approaching its destination the cabin lights turn from the purples and oranges of a sunrise to yellows, and eventually to white against the blue sky.

The IRC factory runs on 'lean' manufacturing principles but finds that variability in the composite components can cause disruption to the production line. Alan Thorne, who manages DIAL's automation laboratory at the IfM, and who, along with Duncan McFarlane, is heading up the DisTAL project, explained: "Lots of companies implement lean but when you 'lean' a process and have product variability you can become very vulnerable to disruption. The trick is to find the right balance between being lean and being resilient."

From the IfM's perspective, one of the additional benefits of its work with Boeing is that it gives the undergraduate MET (Manufacturing Engineering Tripos) students an opportunity to get some invaluable hands-on experience, working on very real and very challenging industrial problems. There are currently two student projects tackling aspects of the DisTAL project, one of them concerned with offline programming of robots and the other with understanding the costs of reconfiguring production control code.

This article originally appeared in the *Institute for Manufacturing Review*.

www.eng.cam.ac.uk/profiles/dm114



The left-hand image is a visualisation of the I2S-LWR pressure vessel and contents; the right-hand image is a schematic of the I2S-LWR concept

Credit: The Georgia Institute of Technology

Cambridge fuels drive to design new type of nuclear power station

The University of Cambridge is playing a key role in an international project to develop a radical new type of nuclear power station that is safer, more cost-effective, more compact and much quicker and less disruptive to build than any previously constructed.

With Engineering and Physical Sciences Research Council (EPSRC) funding, a team at Cambridge University is exploring whether the element thorium could help to meet the new design's fuel needs. As well as being three to four times more abundant than uranium, thorium could potentially produce electricity more fuel efficiently and therefore more cheaply.

The aim of the overall project, initiated by the US Department of Energy and led by Georgia Institute of Technology, is to design a power plant whose size would be reduced and safety enhanced by breaking with convention and integrating the main heat exchangers inside the secure pressure vessel where the nuclear reactions take place. This innovation gives the design its name: Integral Inherently Safe Light Water Reactor (I2S-LWR).

The I2S-LWR, which could also be built module by module off-site and then quickly assembled on site, would be suitable for deployment worldwide. In this country, it could contribute to a new era of nuclear power that helps the UK meet its carbon reduction targets and energy security objectives; no new nuclear power station has been built here since Sizewell B began generating in 1995. With a power rating of around 1GW, the output from the I2S-LWR would be comparable with Sizewell B's 1.2GW rating, but the station should be significantly less costly in real terms.

The EPSRC-funded part of the project will help the UK reinvigorate its technical expertise in civil nuclear power and attract a new generation of engineers and scientists to the field. Expertise of this kind will be crucial to securing the UK's nuclear future but has significantly diminished during the 20 year 'nuclear hibernation' where no new nuclear power stations have come on stream in this country.

The Cambridge team will focus on how thorium, which can be converted into the isotope uranium-233, could be used alongside uranium silicide to fuel the I2S-LWR. The team will assess the question not just from the perspective of fundamental nuclear reactor physics but also in terms of the scope to achieve high fuel-to-power conversion efficiency and to recycle spent nuclear fuel – key issues impacting the cost-effectiveness of the thorium fuel option.

The Department of Engineering's Dr Geoff Parks, who is leading the Cambridge team, says: "The fact that we are part of such a pioneering international project not only reflects the UK's enduring reputation in nuclear science and engineering – it also provides a platform for the UK to develop a new suite of relevant, globally marketable skills for the years and decades ahead. If all goes to plan, construction of the first I2S-LWRs could begin in around 10 years, making deployment of nuclear power more practical, more cost-effective and more publicly acceptable worldwide."

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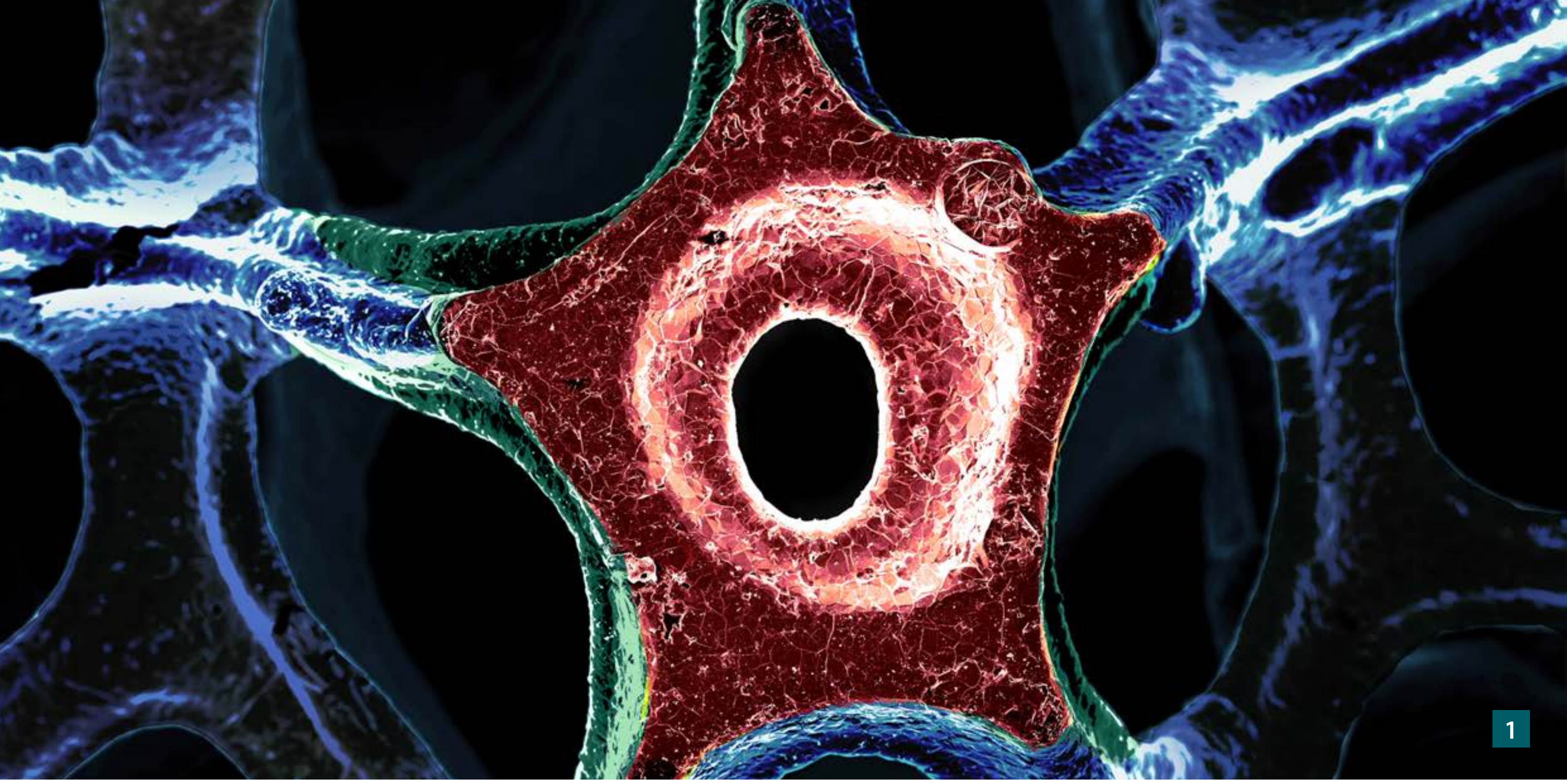
www.eng.cam.ac.uk/profiles/gtp10



1

The art of engineering
Images from the frontiers of technology

From the kaleidoscopic swirl of a neural network, to ribbons of crystals unfolding like sheets of wrapping paper, to the relief on the faces of villagers in Malawi after their local well was repaired, the breadth of engineering research is reflected in the images produced by the winners of the Department of Engineering photo competition.

The annual competition aims to show the breadth of engineering research at the University, from objects at the nanoscale all the way to major infrastructure.

The competition, sponsored by ZEISS, international leaders in the fields of optics and optoelectronics, had five categories this year; alongside those for first, second and third place, prizes were awarded for a micrograph captured using an electron microscope, the ZEISS SEM prize, and a Head of Department's prize for the photo or video with the most innovative engineering story behind it.

Philip Guildford, Director of Research for the Department, said that entries for this year's competition had once again impressed the judging panel: "We continue to be blown away by the beautiful images produced by our students and researchers for this competition.

"But more than just pretty pictures, these images also show how engineering is helping to solve problems, big and small, all over the world."

First prize was awarded to Indrat Aria, for his image entitled Asteroidea Electrica. The image is a false-coloured low-magnification electron micrograph of free-standing graphene foam, which is made by growing layers of graphene on the surface of a porous metal foam skeleton using chemical vapour deposition.

Second prize was awarded to Yarin Gal, a PhD student in the Machine Learning group, for his image of extrapolated art, extending past the edges of paintings to see what the full scenery might have looked like.

Third prize went to undergraduate student Anthony Rubinstein-Baylis. A group of people crowded around a broken village well await the one person who can help, Francis the Engineer. Despite a lack of formal training, Francis has brought water to scores of local villages through ingenuity and hard graft.

The Electron Microscopy Prize was awarded to Tanvir Qureshi for his image of a bridge forming in self-healing concrete.

Finally, the Head of Department's prize went to Andrew Payne for his video of the rise and fall of liquid crystal 'mountains'. The video shows the slow growth of liquid crystal structures under the influence of an alternating electric field, and their rapid collapse as the field is reversed.

Other outstanding images from the competition can be seen on the Department's Flickr pages: www.flickr.com/photos/cambridgeuniversity-engineering

1. First Prize. Adrianus Indrat Aria *Asteroidea Electrica*.
2. Third prize. Anthony Rubinstein-Baylis *Francis the Engineer*.
3. Ian Hosking *Soldering on*.
4. Rose Spear *5Fibrin II*.
5. Second prize. Yarin Gal *Extrapolated art III*.
6. Calum Williams, Yunuen Montelongo & Jaime Tenorio-Pearl *A contrasting landscape*
7. Christian Hoecker *Garden of Eden I*
8. Matthew Wilcock *Crossrail C510*
9. Nikhil Tiwale and Stanko Nedic *The nanowire firecracker*
10. Calum Williams, Yunuen Montelongo & Jaime Tenorio-Pearl *Armageddon holography II*
11. Alexander Macfaden *Coiled Light*
12. The Electron Microscopy Prize. Tanvir Qureshi *Concrete Crack Bridge for Self-Healing II*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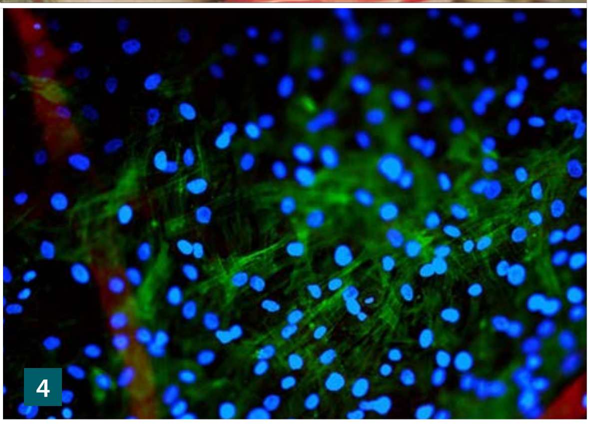
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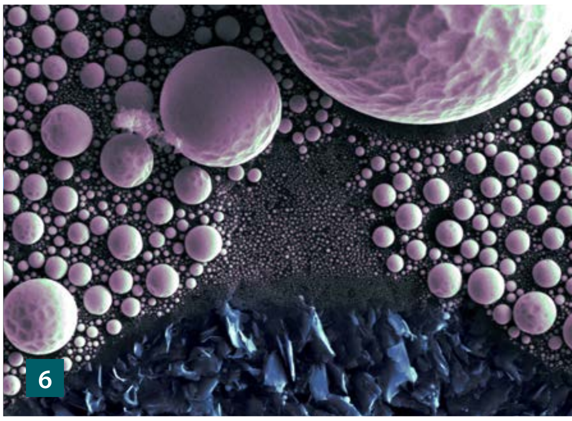
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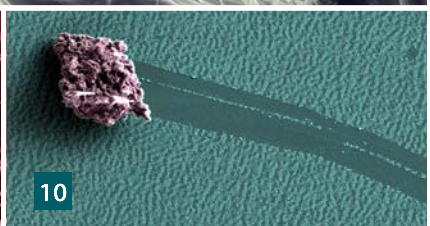
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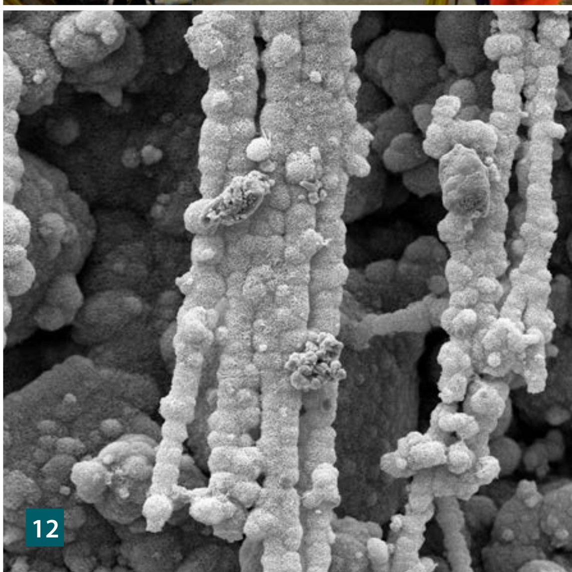
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New institute for Big Data research

The University of Cambridge has been announced as one of five key partners in the new national Alan Turing Institute.

The Alan Turing Institute will promote the development and use of advanced mathematics, computer science, algorithms and 'Big Data' – the collection, analysis and interpretation of immense volumes of data – for human benefit. Located at the British Library in London, it will bring together leaders in advanced mathematics and computing science from the five of the UK's most respected universities – Cambridge, Edinburgh, Oxford, UCL and Warwick – and partners.

In making the announcement, the Rt Hon Dr Vince Cable, Secretary of State for Business, Innovation and Skills, said: "Alan Turing's genius played a pivotal role in cracking the codes that helped us win the Second World War. It is therefore only right that our country's top universities are chosen to lead this new institute named in his honour.

"Headed by the universities of Cambridge, Edinburgh, Oxford, Warwick and UCL, the Alan Turing Institute will attract the best data scientists and mathematicians from the UK and across the globe to break new boundaries in how we use Big Data in a fast-moving, competitive world."

The delivery of the Institute is being coordinated by the Engineering and Physical Sciences Research Council (EPSRC), which invests in research and postgraduate training across the UK. The Institute is being funded over five years with £42 million from the UK government. The selected university partners will contribute further funding. In addition, the Institute will seek to partner with other business and government bodies.

Professor Philip Nelson, EPSRC's Chief Executive said: "The Alan Turing Institute will draw on the best of the best academic talent in the country. It will use the power of mathematics, statistics, and computer science to analyse Big Data in many ways, including the ability to improve online security. Big Data is going to play a central role in how we run our industries, businesses and services. Economies that invest in research are more likely to be strong and resilient; the Alan Turing Institute will help us be both."

The University of Cambridge has a strong historical association with Alan Turing, who studied as an undergraduate from 1931 to 1934 at King's College, from where he gained first-class honours in mathematics. Research at Cambridge continues his legacy of groundbreaking work in mathematics and computer science, extending into many areas that he helped pioneer, including mathematical biology, language modelling, statistical inference and artificial intelligence.

Researchers from the Department of Engineering will be amongst those playing a critical role in shaping the research agenda for the Alan Turing Institute, bringing in world experts in mathematics, statistics, computer science and information engineering, and linking to the research challenges of the future, such as the study of huge genomic datasets, or the development of the world's largest radio telescope, the Square Kilometre Array.

In 2013, the University created Cambridge Big Data, a cross-School strategic initiative bringing together experts in a number of themes. These range from the fundamental technologies of data science, to applications in disciplines as diverse as astronomy, clinical medicine and education, as well as experts exploring the ethical, legal, social and economic questions that are critical to making data science work in practice. The research developed at the Alan Turing Institute will link to these themes, allowing for a rich exchange of ideas within a broad researcher community, and a joined-up and multidisciplinary approach to the big data challenges of the future.

Professor Paul Alexander, who heads Cambridge Big Data, said: "Modern technology allows for the collection of immense volumes of data, but the challenge of converting this 'Big Data' into useful information is enormous. The Alan Turing Institute is an immensely exciting opportunity for the collective expertise of Cambridge and its partners to rise to this very important challenge and make a huge contribution to the future success of the UK economy, our ability to provide health and societal benefits and the ability of British universities to remain at the cutting edge of research."

www.bigdata.cam.ac.uk

First graphene-based flexible display produced

A flexible display incorporating graphene in its pixels' electronics has been successfully demonstrated by the Cambridge Graphene Centre and Plastic Logic, the first time graphene has been used in a transistor-based flexible device.

The partnership between the two organisations combines the expertise of the Cambridge Graphene Centre (CGC), with the transistor and display processing steps that Plastic Logic has already developed for flexible electronics. This prototype is an example of how the partnership will accelerate the commercial development of graphene, and is a first step towards the wider implementation of graphene and graphene-like materials into flexible electronics.

Graphene is a two-dimensional material made up of sheets of carbon atoms. It is among the strongest, most lightweight and flexible materials known, and has the potential to revolutionise industries from healthcare to electronics. The new prototype is an active matrix electrophoretic display, similar to the screens used in today's e-readers, except it is made of flexible plastic instead of glass. In contrast to conventional displays, the pixel electronics, or backplane, of this display includes a solution-processed graphene electrode, which replaces the sputtered metal electrode layer within Plastic Logic's conventional devices, bringing product and process benefits.

Graphene is more flexible than conventional ceramic alternatives like indium-tin oxide (ITO) and more transparent than metal films. The ultra-flexible graphene layer may enable the development of a wide range of products, including foldable electronics. Graphene can also be processed from solution. This brings inherent benefits of using more efficient printed and roll-to-roll manufacturing approaches.

The new 150 pixel per inch (150 ppi) backplane was made at low temperatures (less than 100°C) using Plastic Logic's Organic Thin Film Transistor (OTFT) technology. The graphene electrode was deposited from solution and subsequently patterned with micron-scale features to complete the backplane.

For this prototype, the backplane was combined with an electrophoretic imaging film to create an ultra-low power and durable display. Future demonstrations may incorporate liquid crystal (LCD) and organic light-emitting diodes (OLED) technology to achieve full colour and video functionality.

↑ A flexible display incorporating graphene in its pixels' electronics

Lightweight flexible active-matrix backplanes may also be used for sensors, with novel digital medical imaging and gesture recognition applications already in development.

"We are happy to see our collaboration with Plastic Logic resulting in the first graphene-based electrophoretic display exploiting graphene in its pixels' electronics," said Professor Andrea Ferrari, Director of the Cambridge Graphene Centre. "This is a significant step forward to enable fully wearable and flexible devices. This cements the Cambridge graphene-technology cluster and shows how an effective academic-industrial partnership is key to help move graphene from the lab to the factory floor."

"The potential of graphene is well-known, but industrial process engineering is now required to transition graphene from laboratories to industry," said Indro Mukerjee, CEO of Plastic Logic. "This demonstration puts Plastic Logic at the forefront of this development, which will soon enable a new generation of ultra-flexible and even foldable electronics."

This joint effort between Plastic Logic and the CGC was also recently boosted by a grant from the UK Technology Strategy Board, within the 'realising the graphene revolution' initiative. This will target the realisation of an advanced, full colour, OLED based display within the next 12 months.

The project is funded by the Engineering and Physical Sciences Research Council (EPSRC) and the EU's Graphene Flagship.

> "This is a significant step forward to enable fully wearable and flexible devices.
>
> Professor Andrea Ferrari

youtu.be/f4JIlSi5hVs

Credit: British Cycling

Sports calibrated

↑ The view from the top of the stands of Lee Valley VeloPark, London.

New methods of gathering quantitative data from video – whether shot on a mobile phone or an ultra-high definition camera – may change the way that sport is experienced, for athletes and fans alike.

The bat makes contact with the ball; the ball flies back, back, back; and a thousand mobile phones capture it live as the ball soars.

But what to do with that video of a monster home run or a spectacular diving catch once the game is over? What did that same moment look like from the other end of the stadium? How many other people filmed exactly the same thing but from different vantage points? Could something useful be saved from what would otherwise be simply a sporting memory?

Dr Joan Lasenby of the Department's Signal Processing and Communications Group has been working on ways of gathering quantitative information from video, and thanks to an ongoing partnership with Google, a new method of digitally 'reconstructing' shared experiences such as sport or concerts is being explored at YouTube.

The goal is for users to upload their videos in collaboration with the event coordinator, and a cloud-based system will identify where in the space the video was taken from, creating a map of different cameras from all over the stadium. The user can then choose which camera they want to watch, allowing them to experience the same event from dozens or even hundreds of different angles.

But although stitching together still images is reasonably straightforward, doing the same thing with video, especially when the distance between cameras can be on a scale as massive as a sports stadium, is much more difficult.

"There's a lot of information attached to the still images we take on our phones or cameras, such as the type of camera, the resolution, the focus, and so on," explained Joan. "But the videos we upload from our phones have none of that information attached, so patching them together is much more difficult."

Using a series of videos taken on mobile phones during a baseball game, the researchers developed a method of using visual information contained in the videos, such as a specific advertisement or other distinctive static features of the stadium, as a sort of 'anchor' which enables the video's location to be pinpointed.

"Another problem we had to look at was a way to separate the good frames from the bad," said Dr Stuart Bennett, a postdoctoral researcher in Joan's group who developed this new method of three-dimensional reconstruction while a PhD student. "With the videos you take on your phone, usually you're not paying attention to the quality of each frame as you would with a still image. We had to develop a way of efficiently, and automatically, choosing the best frames and deleting the rest."

To identify where each frame originated from in the space, the technology selects the best frames automatically via measures of sharpness and edge or corner content and then selects those which match. The system works with as few as two cameras, and the team has tested it with as many as ten. YouTube has been stress testing it further, expecting that the technology has the potential to improve fan engagement in the sports and music entertainment sectors.

Joan's group is also extracting quantitative data from video in their partnership with British Cycling. "In sport, taking qualitative videos and photographs is commonplace, which is extremely useful, as athletes aren't robots," said Professor Tony Purnell, Head of Technical Development for the Great Britain Cycling Team and Royal Academy of Engineering Visiting Professor at the Department of Engineering. "But what we wanted was to start using image processing not just to gather qualitative information, but to get some good quantitative data as well."

Currently, elite cyclists are filmed on a turbo trainer, which is essentially a stationary bicycle in a lab or in a wind tunnel. The resulting videos are then assessed to improve aerodynamics or help prevent injuries. "But for cyclists, especially sprinters, sitting on a constrained machine just isn't realistic," said Joan. "When you look at a sprinter on a track, they're throwing their bikes all over the place to get even the tiniest advantage. So we thought that if we could get quantitative data from video of them actually competing, it would be much more valuable than anything we got from a stationary turbo trainer."

To obtain this sort of data, the researchers utilised the same techniques as are used in the gaming industry, where markers are used to obtain quantitative information about what's happening – similar to the team's work with Google. One thing that simplifies the gathering of quantitative information from these videos is the ability to 'subtract' the background, so that only the athlete remains. But doing this is no easy task, especially as the boards of the velodrome and the legs of the cyclist are close to the same colour. Additionally, things that might appear minor to the human eye, such as shadows or changes in the light, make the maths of doing this type of subtraction extremely complicated.

Working with undergraduate students, graduate students and postdoctoral researchers, Joan's team has managed to develop real-time subtraction methods to extract the data that may give the British team the edge as they prepare for the Rio Olympics in 2016.

→

www.eng.cam.ac.uk/profiles/jl221

A success in Managed Pressure Drilling

Alumnus, Mohamed Mashaal, Lead Engineer at BP, was part of a team who, following three failed attempts, successfully managed to drill an extended reach well from the Harding Platform in the North Sea.

As one of BP's top 40 wells globally (and the only UK well qualifying for that category in 2012), the successful delivery of the Harding field's 'Producer North East 2a' well (referred to as PNE2a) was crucial to the business. Three previous attempts had been made to drill an extended-reach well from the Harding Platform, in the centre of the field, to hydrocarbon-rich reservoir targets several kilometres away, but all ended without success. Mohamed was the operational drilling engineer during the execution of the third attempt in 2011, when the well reached 15,248ft measured depth before suffering formation fracture and total losses of the drilling fluid.

Using a technology that was relatively new to BP's North Sea operations, Mohamed and the rest of the Harding drilling engineering team redesigned the well using an innovative Managed Pressure Drilling (MPD) method. This allowed the use of a lighter-density drilling fluid, thus reducing the risk of formation fracture of the sandstone reservoir and subsequent losses, but compensated by applying a varying surface back-pressure (SBP) to maintain a constant bottom-hole pressure sufficient to prevent collapse of very unstable shale mudstones. The system consisted of a rubber sealing element fitted around the drill pipe, software-controlled automatic chokes, and an auxiliary pump – all of which combine to apply SBP as required.

After six months of intensive planning work, the offshore team executed the PNE2a admirably, overcoming many challenges along the way, from getting the 12-1/4" drilling assembly stuck and having to spend over a week patiently working it free, to suffering over 10 days of non-productive time due to MPD equipment failure. Fortunately the team had appropriate back-up and contingency plans which were prepared in advance. "When a rig costs around £150,000 per day, a few weeks lost due to problems can easily cost millions of pounds, with no guarantee of achieving the objective," recalls Mohamed.

Fortunately, the well did deliver a successful outcome, securing over 400ft of high quality sandstone and producing over 4,000 barrels of oil per day when initially brought online. The success was not just confined to the PNE2a well, but by demonstrating the successful implementation of MPD to deliver what could not be achieved conventionally, the future exploitation of the remaining field reserves would now be possible. It is no wonder why TAQA Bratani purchased the field from BP in 2013.

When a rig costs around £150,000 per day, a few weeks lost due to problems can easily cost millions of pounds, with no guarantee of achieving the objective.

Alumnus, Mohamed Mashaal,
Lead Drilling Engineer, BP

Mohamed was elected a Member of the Institution of Mechanical Engineers as a Chartered Engineer (IMECHE) in 2012. He now mentors two developing engineers at BP towards Chartership with IMECHE, an initiative fully supported by BP. "I find it thoroughly rewarding to be able to help the next generation of engineers to develop their professional skills and qualifications, and they may not believe it, but I learn more from them than they do from me."

BP Drilling Engineer Mohamed Mashaal has presented at the Society of Petroleum Engineers' 2013 Annual Technical Conference as co-author of a paper on the successful implementation of Managed Pressure Drilling, and in May 2014 an article summarising the work was published in the Journal of Petroleum Technology.

He was assigned as Lead Drilling Engineer for the Quad 204 project in July 2014.

Mohamed was a student of Corpus Christi College and graduated from the University of Cambridge with a degree in Mechanical Engineering in 2007.

www.bp.com

↑ Xiaowan Dam in China

UK and China collaboration on sustainable materials for infrastructure

World-wide collaboration on the development of sustainable construction materials is set to be led by engineers and scientists in Britain and China.

Professor Abir Al-Tabbaa and Dr Janet Lees from the Department of Engineering and Dr Yun Bai from Civil Engineering at University College London (UCL) have been successful in the first ever joint Engineering and Physical Sciences Research Council (EPSRC)/National Natural Science Foundation of China (NSFC) call for a collaborative UK/China research project on Sustainable Materials for Infrastructure.

Together with their collaborators, Professor Jueshi Qian from Chongqing University (academic visitor in 2009/10) and Professor Liwu Mo from Nanjing Tech University (RAEng Fellowship Exchange with China Scheme in 2012/13), they will lead global efforts to develop magnesia-bearing construction materials for future energy infrastructure. The project named 'MagMats' (with a grant of GBP 1M from EPSRC and NSFC) also includes collaborators from international academic centres: University of Toronto (Canada), Federal University of Minas Gerais (Brazil) and NTU (Singapore); a number of UK and Chinese industry partners: Laing O'Rourke, Shell, Lafarge Group, China Three Gorges Corporation, Yunnan Institute of Building Materials and China Energy Conservation DADI as well as global magnesia producers: Premier Magnesia, Lehmann & Voss, Magnesita and Silver Peak Haicheng Magnesium Products Co.

The objective of the MagMats project is to integrate the unique and complementary expertise within the team to collectively address major material-related challenges facing future energy infrastructure. The focus will be on performance, durability and low carbon footprint. The development of a suite of magnesia-bearing construction materials compositions for the different anticipated challenges and scenarios will be a key deliverable.

By 2020, both the UK and China plan to produce 15% of their primary energy mix from renewables, with both oil and gas and nuclear power continuing to play a major part in their future energy security. As the world's second highest energy consumer and largest source of carbon emissions, China's resulting environmental crisis (air pollution and devastation in land and resources) is one of the most pressing challenges to emerge: costing the country 3.5% of gross national income with life expectancy decreasing by 5 years in some regions. Nuclear and wind power have been proposed as clean energy sources for both China and the UK, while hydropower will also be a major player in China.

Many infrastructure-related material challenges have emerged as a result of the need to explore offshore marine environments for wind power generation; for deeper and more complex underground wellbore systems for new oil and gas explorations; for robust containment and shielding structures for new nuclear power plants and for larger dam structures for future hydropower generation. Specific challenges include: thermal crack prevention in mass concrete used in super-large dam structures and nuclear shielding structures to guarantee structural integrity and safety; durable performance in aggressive marine environments for deeper water off-shore platforms and wind-farm foundations; long-term and safe encapsulation systems for the increasing radioactive wastes produced in nuclear power plants; durable and designable performance in increasingly aggressive environments (higher temperatures, pressures, chloride and sulfate attack) and more complex constrained zonal isolation conditions for deeper oil and gas exploitations.

Addressing these challenges requires a fundamental re-evaluation of the most appropriate construction materials for energy infrastructure.

www.eng.cam.ac.uk/profiles/aa22


Credit: Keith Heppell

The future of robotics based on biological principles

The International Myorobotics Winter School and Workshop on the *Future of Robotics Based on Biological Principles* was held at the Department of Engineering.

The event was organised by Dr Fumiya Iida, Lecturer in Mechatronics (a multi-disciplinary form of engineering) who recently joined the Department.

“We're trying to learn from the natural world,” said Fumiya. “We look at what animals are good at and how we can link these things into technological development.”

Myorobotics is about musculoskeletal robotic design. Funded by the European Union, the collaborative project also partners with TU München, ETH Zurich, University of the West of England, Fraunhofer IPA and the University of Bristol.

Speakers at the workshop included the most advanced and active researchers of bio-inspired robotics in the world including the Department's Professor Daniel Wolpert and Professor Roberto Cipolla.

“Robots have been very useful in industry, but they usually can't come out of factories,” Fumiya said.

Talk of musculoskeletal robots may sound like we are straying into 'Terminator' territory, but Fumiya explains that the next generation of robots are designed to work in specific environments, and if we want to have robots that can be used in health care and will therefore be coming into contact with humans, they will need to be lighter and more flexible. The design will have to be completely different.

He added: “If you're going to have a robot sitting next to you helping with your medical treatment, you don't want it to be huge and weigh 100kg. I think patients would find that very scary.”

mi.eng.cam.ac.uk/Main/CVR

The Richard Norman Scholarship

The Richard Norman Scholarship Fund has been established by Mrs Dorothy Norman in memory of her late husband, for the benefit of postgraduate students in the Department of Engineering undertaking research in electrical engineering.

Rachel Hyman is the first holder of the Scholarship. She met Mrs Norman and presented her with a copy of her first article and explained the nature of her research in optics and photonics. Rachel is researching materials for liquid crystal devices that create images by diffraction. She aims to improve their performance and increase their range of uses.

Richard (Dickie) Edward Norman CBE studied electrical engineering at King's College and went on to have a major influence on consumer electronics. He left university in 1943 and went to work at the company which soon became the Ferguson Radio Corporation (FRC Ltd) going directly into the Electrical Laboratory to work on Military Radio Equipment.

When television restarted after the war in 1946, Richard was in the team that designed the electronic circuitry of Ferguson's first-ever TV receiver, quickly becoming in charge of all circuit development for the Company. Soon thereafter he became responsible for its mechanical engineering as well.

Under his guidance the company continued to grow, exploiting every technical innovation, consequently expanding into worldwide export sales of radio, unit audio, hi-fi and television. It was during Richard's time that the company took the biggest gamble possible by introducing its first colour TV in a totally new form – modular and all solid state, containing no valves. In its time revolutionary technology.

After the takeover of EMI by Thorn Electrical Industries, Richard became a member of the main board, and Chairman of the Ferguson R&TV subsidiary. He was also Chairman of the British Retail Electrical Manufacturers Association (BREMA) and the European Association of Consumer Electronics Manufacturers (EACEM) and worked closely with Lord Thorneycroft to ensure the future of the electronic industry.

Alumnus Phil Sorrell helps revolutionise high street banking with mobile innovation

At the beginning of 2015 Metro Bank opened its Cambridge store – the first new high-street bank in the UK for over 100 years. For Cambridge Engineer, Phil Sorrell, this was also a significant landmark.

Over a decade earlier, Phil set up FE-Mobile and with colleagues created the world's first highly secure downloadable mobile banking platform, a solution that is now being used by millions around the world. Metro Bank became the first UK bank to benefit from the smart app's advanced features, for example enabling the temporary blocking and un-blocking of payment cards direct from the mobile handset. Now these features are available to current students at the university.

Phil Sorrell graduated in 1981, the second year of what is now the MET Tripos – a course that fostered an entrepreneurial spirit from the outset. In early 2002 when the first mobile phones were launched that could download Java programs over-the-air, Phil and colleague Steve Limb had the vision that mobile phones could be used by the masses for making secure payments. Mobile phones have screens, keyboards and were always connected. With the right security, the mobile handset would become a mobile authentication device in one's pocket that when connected to a source of funds – e.g. a wallet or bank account – could eventually obviate the need for ATMs and point-of-sale terminals. FE-Mobile created a highly scalable software platform that enabled secure banking and payment applications to be delivered over-the-air.

Phil initially took the FE-Mobile vision to financial institutions in the UK. Egg was the first UK visionary bank to take the product but its sale by Prudential in 2006 to Citigroup led to the cancellation of a number of part-implemented projects, including mobile banking. With a shift in strategy, Phil secured partnerships with banking software vendors Misys and Temenos who had thousands of banks as clients worldwide. The company proceeded to license its software to banks on other continents.

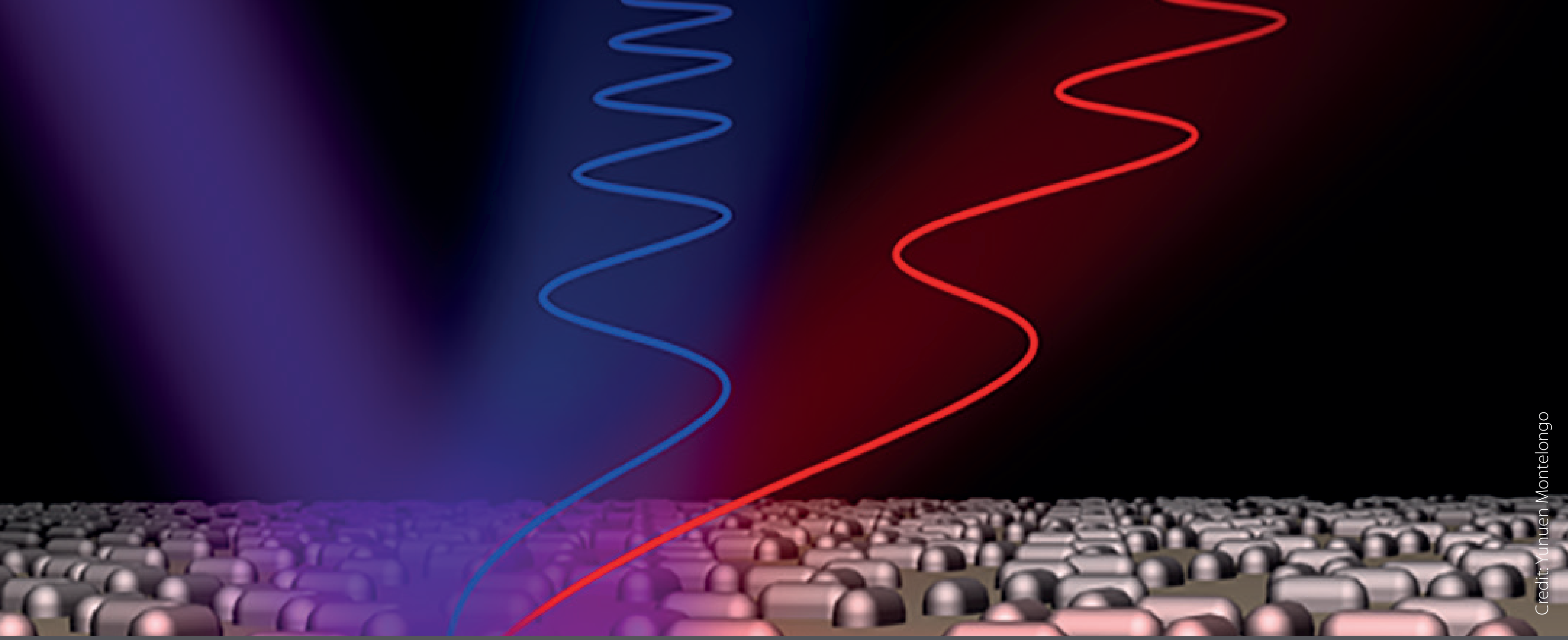
As the market took off, countries around the world that had been slow to embrace the internet were able to leapfrog technology as their customers move straight to the mobile channel. In 2010, as the demand for direct mobile channels accelerated and smart phones took off, FE-Mobile was acquired by one of its distribution partners, Temenos.

Phil ran mobile banking at Temenos for three years before founding his latest venture, Fintech-labs, with fellow colleague Parinda Kularatne. Fintech-labs continues to work with Metro Bank as well as creating more innovations in the mobile arena. Of its latest products, Remote Deposit Capture (RDC) enables banks to process cheque images captured on smartphone cameras so cheques can be paid-in without visiting a branch – a key requirement for their customers in the North American market. In emerging markets this capability is used during the registration process for capturing photos, ID documents and signatures during customer onboarding as part of their Agent Banking module.

Customer channel banking has come a long way. Phil's contemporaries will remember banking in Cambridge during the early 80s when branches were closed all weekend and the ATMs of a certain bank during the anti-apartheid era were frequently superglued shut. Although Metro Bank opening in Christ's Lane and offering mobile banking to current students is a significant personal milestone, Phil has other reasons to come back to Cambridge. Whilst he is pleased to see his metaphorical baby launching in Cambridge, one of his daughters is now reading history at Jesus College.

↘ Phil Sorrell (right) with Fintech-labs colleague Parinda Kularatne

www.fintech-labs.com



Multi-coloured holograms

Nanotechnology used to create next-generation holograms for information storage

Holograms made of tiny particles of silver could double the amount of information that can be stored in digital optical devices, such as sensors, displays and medical imaging devices.

Researchers from the Department of Engineering have developed a new method for making multi-coloured holograms from a thin film of silver nanoparticles, which could greatly increase the storage capabilities of typical optical storage devices.The interference produced by the interaction of light with the nanoparticles allows the holograms to go beyond the normal limits of diffraction, or the way in which waves spread or bend when they encounter an opening or obstacle. The results were recently published in the journal *Proceedings of the National Academy of Sciences*.

When metallic particles have dimensions on the nanoscale, they display iridescent colours. A noted example of this phenomenon is the Lycurgus cup, which was made in the 4th century during the Roman Empire, and changes colour when held up to the light. An optical phenomenon, known as dichroism, occurs when the colour of the cup changes from green to red according to the position of the light source.

Roman artisans made the cup by incorporating nanoparticles into glass, although they would have been unaware of the specific physical characteristics responsible for the colours observed in the cup. Only in the last 20 years have scientists begun to understand this phenomenon, but they have not been able to utilise its effects in currently-available technology.

To apply this phenomenon in modern optics, an interdisciplinary team of researchers have created nanoscale metallic nanoparticle arrays that mimic the colour effects of the Lycurgus cup, to form multi-colour holograms. This breakthrough could lead to the shrinkage of standard bulky optical devices. "This technology will lead to a new range of applications in the area of photonics, as conventional optical components simply cannot achieve this kind of functionality," said Yunuen Montelongo, a PhD student from the Department of Engineering, who led the research. "The potential of this technology will be realised when they are mass produced and integrated into the next generation of ultra-thin consumer electronics."

Using a single thin layer of silver, Yunuen and his colleagues patterned colourful holograms containing 16 million nanoparticles per square millimetre. Each nanoparticle, approximately 1,000 times smaller than the width of a human hair, scatters light into different colours depending on its particular size and shape. The scattered light from each of the nanoparticles interacts and combines with all of the others to produce an image. The device can display different images when illuminated with a different colour light, a property not seen before in a device of this type. Furthermore, when multiple light sources are shone simultaneously, a multi-colour image is projected.

> "Conventional optical components simply cannot achieve this kind of functionality.
>
> Yunuen Montelongo

These holographic devices are between 10 and 100 times smaller than just one of the millions of pixels used to produce a colour image on a typical laptop screen, yet they project a complete multi-colour image to the eye. This is possible through plasmonics: the study of how light interacts with metals on the nanoscale, which allows the researchers to go beyond the capability of conventional optical technologies.

"This hologram may find a wide range of applications in the area of displays, optical data storage, and sensors," said PhD student Calum Williams, a co-author of the paper. "However, scalable approaches are needed to fulfil the potential of this technology."

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Alumna, The Rt Hon Baroness Platt of Writtle 1923-2015

Alumna, The Rt Hon the Baroness Platt of Writtle, CBE, DL, FREng, has died.

One of the first female aeronautical engineers, who went on to chair the Equal Opportunities Commission, Baroness Platt was known for being a wartime aeronautical engineer and a Conservative politician as well as for her drive to change people's attitudes towards women.

Born Beryl Catherine Myatt in Leigh-on-Sea on April 18, 1923, she distinguished herself at Westcliff High School in Southend. She read huge tomes and used her all-guns-blazing character to convince her parents to pay for university education after they initially resisted. She was going to read maths at Cambridge but changed to aeronautical engineering – making her one of the first women to do so – after the Government announced a state bursary to engineering undergraduates.

At Cambridge she was one of only five women among 250 men doing Mechanical Sciences. Since women were not then awarded degrees, she emerged with a "title of degree" in 1943.

She worked for Hawker Aircraft Company, working on their Hurricane, Typhoon and Tempest fighter planes. Beryl Platt brought forward across the generations the determination that in the Second World War helped produce the Hawker Hurricane fighter aircraft. War needs gave her the chance to be an aeronautical engineer, working with the brilliant and difficult Sydney Camm, the Hurricane's designer, in the Hawker company's experimental flight test department at Langley, Berkshire.

Despite Sydney Camm offering her a permanent role after the war, she left to work in aviation safety for British European Airways.

She married Stewart Platt in 1949 in Leigh-on-Sea and gave birth two years later to Roland. The family made Writtle their home in early 1953, and their daughter Vicky was born later that year.

After realising there wasn't much need for aeronautical engineers in the small Essex village, she decided to pursue a career in local government.

As chairman of Essex County Council's education committee between 1971 and 1980, she rose to vice-chairman of the authority between 1980 and 1983.

She was made a life peer by Margaret Thatcher in 1981 and in May 1983 she was appointed chairman of the Equal Opportunities Commission. She remained in that post until 1988. As a life peer and frequent speaker in House of Lords debates into her nineties she championed the breaking-down of barriers to women pursuing careers once considered the preserve of men.

Baroness Platt was a prominent campaigner for careers in science and technology for women. Her engineering background drove the campaign that would be her longest-lived legacy: the Women Into Science and Engineering initiative (WISE). WISE's first chair, she remained an attentive patron until her death.

She wrote to David Willets MP, then Minister of State for Universities and Science, urging the Government to allocate funding so that WISE could continue its activities promoting engineering careers to girls by giving them access to young female role models. She warned that the shortage of skills in key areas of industry would increase if young people – boys and girls of all academic abilities – were not encouraged to take up training and careers in science, engineering and technology (SET). She commented:

"Our quality of life and the success of our economy depend on these vital skills so we must persevere with encouraging over 50 per cent of the population – girls – to enter SET in the future."

Her daughter Vicky Platt, said: "She was an absolute gale force, a totally feisty and energetic woman. She only knew one mode of living and that was full steam ahead.

"She wanted to change people's attitudes to women. She lived just long enough to see the first woman bishop appointed to the Church of England, which delighted her."

Honours, awards and prizes

University of Cambridge spin-out **Reduse**, which has developed a technology to remove print from paper allowing it to be reused several times before being recycled, has won the Venture Competition, organised by the Climate-KIC UK, the EU's main climate innovation initiative.

Stefania C. Radopoulou, PhD student at the Construction Information Technology Laboratory (CIT) lab, and Dr Ioannis Brilakis, Laing O'Rourke Lecturer of Construction Engineering, have been awarded the best paper award at the 21st International Workshop: Intelligent Computing in Engineering (EG-ICE2014) which was held in Cardiff. The paper is entitled *Improving Patch Defect Detection using Vision Tracking on Video Data* and is part of a project working towards the automation of pavement surface and monitoring, the results of which will be of interest to road owners and authorities responsible for pavement maintenance.

Dr Mauro Overend has been appointed visiting Professor for 2014 at the Steel Structures Laboratory (ICOM) at EPFL, Switzerland. He will be hosted by Dr Christian Louter who leads the Structural Glass team at ICOM. Mauro is Senior Lecturer in Building Engineering Design at the Department of Engineering and leads the Glass & Facade Technology Research Group. The group undertakes research on the structural and environmental performance of glass and building envelope systems.

Two distinguished alumni from the Department of Engineering have been elected to the Fellowship of the Royal Academy of Engineering.

A former Director of Research in the Department, **Professor Malcolm Macleod** has worked in digital signal processing, image processing and mathematical analysis for over 30 years.

Malcolm began his career with Cambridge Consultants before joining the Department in 1988. He held a number of college and university appointments here prior to his move to the British multinational defence technology company QinetiQ where he is now Senior Fellow and Chief Scientist.

Cambridge technology entrepreneur, **Dr Shaun Fitzgerald**, Co-Founder and Chief Executive Officer of CleanTech business Breathing Buildings, is an Engineering Teaching Fellow and delivers lectures for the Department on various courses including the Masters in Construction Excellence.

Dr Colm Durkan, a Reader in Nanoscale Engineering, has been elected to the Fellowship of the Institution of Engineering and Technology (IET). Colm is the founder and head of the Applied Nanoscience and Nanoscale Engineering research group at the Department of Engineering's Nanoscience Centre.

The Government is funding a further 19 EPSRC Centres for Doctoral Training (CDTs). **Cambridge Nuclear Energy Centre** members from the Departments of Engineering, Earth Sciences and Materials Science collaborating with Imperial College London and The Open University have secured funding for a joint CDT in Nuclear Energy that will train approximately 60 PhDs in Nuclear Energy over the next 8 years (5 cohorts beginning from October 2014). This is a new Nuclear CDT and complements the existing Nuclear CDT led by the University of Manchester, which was also renewed in the current round. Thus, it represents a significant increase in training capacity for Nuclear PhDs in the UK.

Professor Gary Hunt, the Dyson Professor of Fluid Mechanics, has received the Telford Gold Medal for his work on the influence of room geometry on the overturning of smoke owing to a floor fire.

Gary's paper was published in *Proceedings of the Institution of Civil Engineers* (ICE) vol. 166, issue 2 and was voted the overall best ICE paper of 2014.

A book co-authored by academics from the Department of Engineering has earned a Texty Award from the Text and Academic Authors Association (TAA).

Materials: Engineering, Science, Processing and Design, authored by **Professor Mike Ashby**, **Dr Hugh Shercliff** and **Professor David Cebon**, takes students through the world of materials and the processes that can shape, join and finish them.

Department of Engineering Librarian **Niamh Tumelty** has received the 2014 Bonnie Hilditch International Librarian Award in recognition of her professional achievements.

A benefactor of the University of Cambridge, **Leonard Blavatnik**, has made a multi-million pound pledge to provide funding for Israeli scientists of outstanding ability to study in Cambridge.

The Funding will be provided by the Blavatnik Family Foundation and the first three Fellows will research in the areas of Engineering, Genetics and Physics.

Fellows will receive an annual stipend of £30,000, and Fellowships will be tenable for up to two years. It is planned that there will be at least three Fellows appointed each year, although it is anticipated that this number may increase in future years.

ALUMNI UPDATE

From smoothies to Star Wars

Alumna Georgina (George) Rose graduated with an MEng in Manufacturing Engineering from the Department in 2010. She is now working with LEGO at their London headquarters. In this interview, Manufacturing Engineering Tripos (MET) student James Hutchings charts George's progress from smoothies to Star Wars.

How did you find school?
I went to an all-girls school where the pinnacle of my future career prospects was seen as going into the City and becoming a banker. I did design and technology at GCSE because I loved it and out of the 26 girls doing it, only six of us took Resistant Materials with the other 20 opting for graphics. My other favourite subject at school was physics which was also hands-on and experiential.

Why did you choose to do Engineering at university?
I was interested in it and wanted to do something that I enjoyed. In my final year I applied to innocent drinks, an ethical company specialising in the production of smoothies and vegetable pots, and started with them as soon as I graduated.

Why did you choose MET?
When I applied to Cambridge I hadn't heard of the Manufacturing Engineering Tripos (MET) but in my first two years, even though I had been pretty good at maths at school, I found the maths content of the engineering course hard going. In the second year, James Moultrie did a module on design which really sparked my interest and when I started thinking about my third and fourth year options, all the management and process stuff made MET seem so much more exciting and really relevant and applicable to a wider range of future careers.

What were you doing at innocent drinks?
I was lucky enough to have three different jobs in four years. I started off as an Ingredients Planner, managing the stock levels of the raw materials (by which I really mean fruit!) mainly for our manufacturing partner in Holland. My next job was further down the supply chain as Juice Production Planner, managing the production of smoothies and juices at their production site, ensuring that enough bottles were being filled with the right products to guarantee availability on the supermarket shelves.

My final role was as 'End-to-end Project Manager' in the finance department, looking at how to make cost-savings across the entire value chain, from sourcing the ingredients to sales and distribution.

And what are you doing now?
After much soul-searching about leaving innocent, I decided I needed to broaden my experience and applied to The LEGO Group. So I'm now working at their new European headquarters in central London as one of four managers in the supply and inventory planning team. I've got two roles: I'm Inventory Lead for Europe but I'm also European Supply Manager for the LEGO Technic, Star Wars and Castles themes. LEGO is a fantastic place to be with incredible supply chain management and manufacturing processes. And, of course, it's really cool to make the things that kids make things with.

How has MET helped you in your career so far?
The key skill that I got from MET was problem-solving. A lot of that came from Warsthe projects, when we were sent off to a factory, not knowing what we were going to find, and then having to apply our knowledge, first of all to work out what the problem was and then come up with a solution. This has been fundamental to what I've been doing in the last four years. The other massively important skill was learning to work as a team, not just with other students but also with a wide range of people from senior management to people on the factory floor. The course also taught me to constantly look for ways to improve things and add value – even when there is no apparent problem things can always be done better.

When I was working on the cost-savings project at innocent all the value stream analysis and everything I had learnt about 'lean' and 'kaizen' was invaluable and gave me such an advantage over other people who didn't have the same theoretical background. Choosing MET was absolutely the right decision for me. I loved the course and it has set me on a great career path.

MET is an option for the final two years of the Cambridge Engineering degree that develops and applies engineering knowledge in a business context. Based at the Department's Institute for Manufacturing, the course prepares students to be leaders of business and technology firms. It provides a grounding in management and manufacturing technologies, together with an understanding of the full range of industrial activities: from product design, component manufacture, industrial engineering, factory and business management through to how firms work in the economy. A core message throughout the programme is to understand how firms can grow sustainably.

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