DEPARTMENT OF ENGINEERING

NEWS

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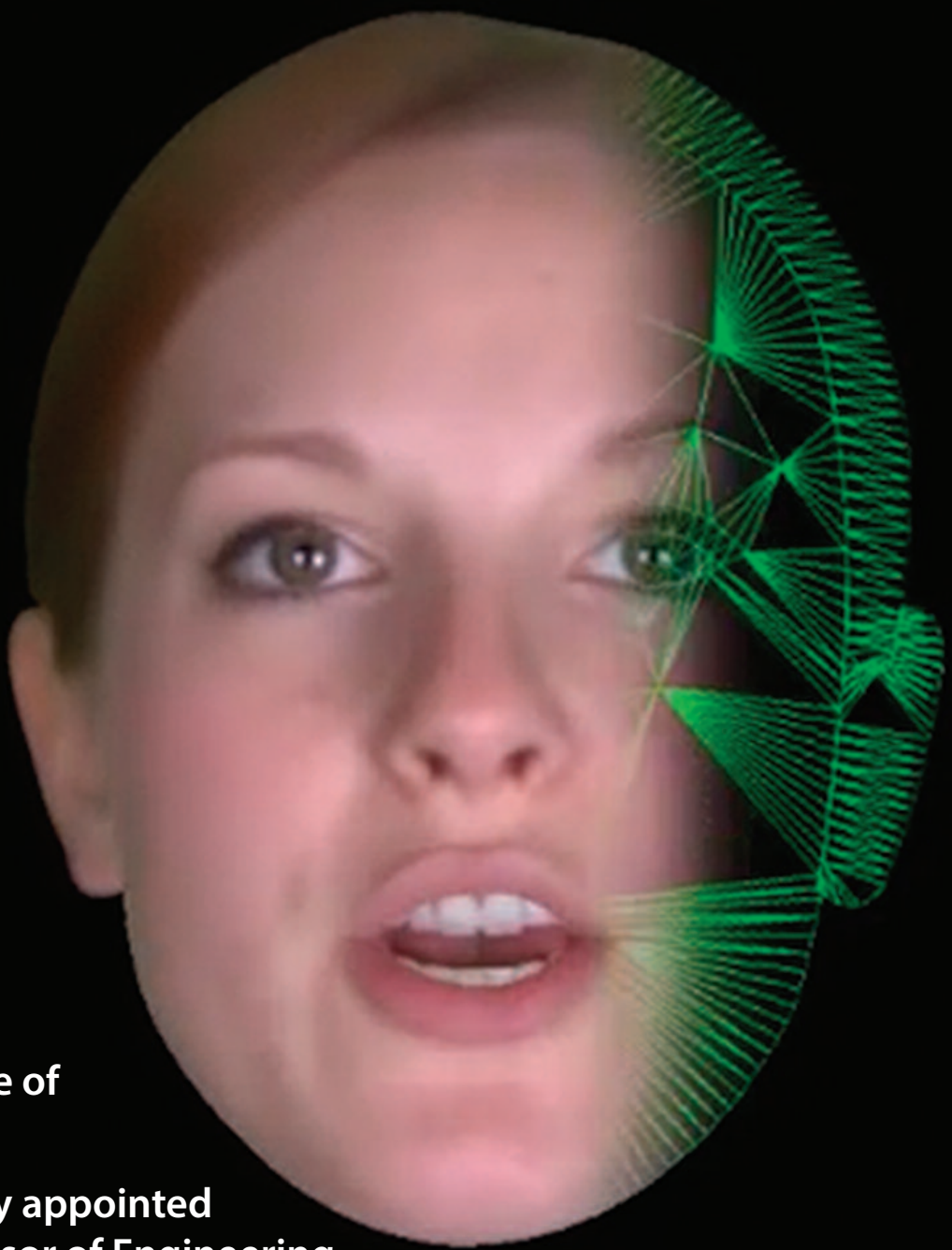

Is this the face of the future?

David MacKay appointed Regius Professor of Engineering

Keep on trucking

Smarter infrastructure

The future of flying

UNIVERSITY OF CAMBRIDGE

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Cover photo: Zoe, the virtual "talking head" developed by researchers in the Department of Engineering in collaboration with Toshiba

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Published by Sterling

Our academic and alumni communities go from strength to strength

This year saw the appointment of Professor David MacKay as our first Regius Professor of Engineering. This is a landmark appointment, chosen by the Duke of Edinburgh himself to celebrate the end of his 34 year tenure as Chancellor of the University and, in particular, his close association with the Department of Engineering. This Professorship, created by the Queen, has raised the whole profile of the Department within academia and beyond. David Mackay's position is interesting because he's not doing academic research in a remote ivory tower. He is carrying out research of real social significance, looking at the whole energy challenge and collaborating with academics throughout the University. He is also the Chief Scientific Advisor at the Department of Energy and Climate Change (DECC) with influence on major policy issues and will continue to do so while working at the Department, channelling our research into the biggest issues on the energy agenda.

But our efforts to achieve prominence and impact extend beyond energy issues. Articles featured in this newsletter show that there are important ideas being promoted across the board in all areas of Engineering – in transport, infrastructure and new media to name just a few. The impact of our work can be seen spreading through the economy and beyond as our spin out companies continue to achieve great success in the global market.

Developments in the Department have achieved high-profile media interest with local, national and international coverage of such diverse projects as our student solar car team, the annual Carl Zeiss Photography Competition, the Dambusters anniversary and the launch of a virtual talking head.

We are also working hard to encourage a wider understanding of Engineering to bring forward the next generation of engineers. The exceptional work of alumnus Eben Upton on Raspberry Pie brings engineering computing into the classroom so that young people who are enthused by engineering in the media can easily experiment with high-tech engineering in the classroom.

Terence Cuneo's painting of Prince Philip's tour of the Baker Building, Department of Engineering, University of Cambridge, which he opened in 1952. The Regius Professorship, in part, marks his long-standing links with the Department.

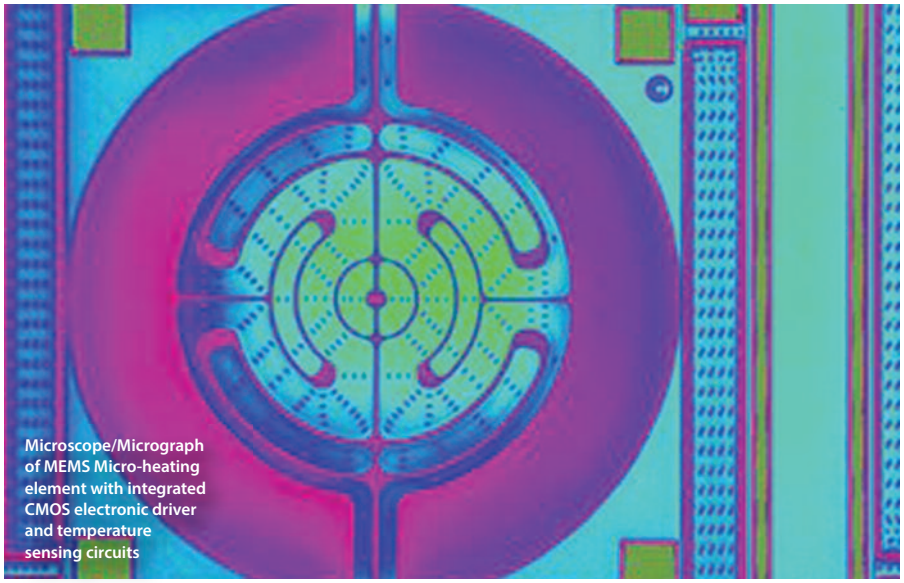
Our alumni, staff and students now stay connected in a number of ways using social media on sites such as Twitter, YouTube, Facebook and Flickr (links below). We also have a dedicated LinkedIn group for alumni of the Department which we would encourage you to join.
https://twitter.com/Cambridge_Eng
http://www.linkedin.com/groups?gid=127740
http://www.flickr.com/photos/cambridgeuniversity-engineering/
https://www.facebook.com/DepartmentOfEngineeringUniversityOfCambridge
http://www.youtube.com/user/EngineeringCambridge
http://www.eng.cam.ac.uk/

We are also delighted to tell you that this newsletter, which is currently sent out to nearly 18,000 alumni worldwide, can now be emailed to you as a web link rather than a traditional paper copy. If you would prefer to receive your newsletter in this way please contact engineering@admin.cam.ac.uk

An integrated engineering department founded on core strengths spanning all engineering disciplines and also cross-connected by an integrated undergraduate course and four strategic research themes:
- **Energy, transport and urban infrastructure**
- **Uncertainty, risk and resilience**
- **Bioengineering**
- **Inspiring research through industrial collaboration.**

Diagnosing disease could be as simple as breathing

A range of diseases and conditions, from asthma to liver disease, could be diagnosed and monitored quickly and painlessly just by breathing, using gas sensing technology developed by a Cambridge spin-out.



CAMBRIDGE CMOS SENSORS

Microscope/Micrograph of MEMS Micro-heating element with integrated CMOS electronic driver and temperature sensing circuits

The highly sensitive, low-power, low-cost infrared emitter developed by Cambridge CMOS Sensors (CCMOSS) is capable of identifying more than 35 biomarkers present in exhaled breath in concentrations as low as one part per million, and is being developed for use as a non-invasive medical testing device and other applications.

In addition to nitrogen, oxygen and carbon dioxide, we exhale thousands of chemical compounds with every breath: elevated acetone levels in the breath can indicate poorly-controlled diabetes, asthmatics will exhale higher than normal levels of nitric oxide, and glucose is a sign of kidney failure.

"Non-invasive breath analysis is an area of great potential for diagnosing and monitoring a wide range of medical conditions," said Professor Florin Udrea of the Department of Engineering and CCMOSS's CEO and co-founder. "Testing is easy and painless, and can be repeated as often as needed."

A number of breath analysis tests are currently in the research and development phase, most of which use mass spectrometry or lasers to analyse the breath for specific compounds. These tests can only detect a small range of compounds however, meaning that different devices are needed to detect different conditions.

The technology developed by CCMOSS is different in that it uses broadband infrared radiation to make the detection of a wide range of biomarkers possible in a single device. The company's miniature heaters, or microhotplates, can be heated from room temperature to 700°C in a fraction of a second, a temperature high enough to emit infrared radiation and allow the sensing material to react with gas molecules.

Many gas molecules absorb infrared. The amount of radiation absorbed allows the gas to be identified and its concentration calculated – this is the basic principle behind the roadside breathalyser test. CCMOSS's technology however, is far more sensitive. Using broadband infrared, the company's gas sensing technology can detect wavelengths between two and 14 microns, corresponding to a wide range of biomarkers. In order to detect different wavelengths, a filter is applied on top of the detector, meaning that only infrared radiation of a particular wavelength can get through.

CCMOSS's devices are based on complementary metal-oxide semiconductor (CMOS) technology, a low-power type of semiconductor which is widely used in microprocessors and battery-operated devices. Using CMOS processes results in miniaturised ultra-low power devices that can be produced at higher volume and lower cost than current state of the art gas sensing devices.

Because the CMOS process is highly reproducible, all the parameters can be very tightly controlled. The manufacturing process is highly scalable and cost-effective, with yields above 99 per cent.

In addition to medical applications, the company is developing their technology for use in consumer electronics, industrial security and automotive applications. It currently has a range of products on the market and is actively involved in leading-edge research and development projects for the next generation of micro and nanosensors.

The company, which spun out from the Department of Engineering in 2009, was founded by Professors Florin Udrea and Bill Milne of Cambridge, along with Professor Julian Gardner of Warwick University. CCMOSS has been supported by seed funding from Cambridge Enterprise, the University's commercialisation arm, and was named Cleantech Business of the Year at the 2013 Business Weekly awards.

ccmoss.com

Dr Alan Reece

The University is sad to report the death of one of its benefactors.

" He provided a splendid example for the next generation of engineers."
Professor Sir Mike Gregory

Dr Alan Reece (above), who donated £5 million to the Institute for Manufacturing (IfM) for their new home at West Cambridge, which is named The Alan Reece Building, passed away on New Year's Eve aged 85.

One of the North East's most successful businessmen, he was the man behind engineering business The Reece group which has a turnover in excess of £211 million and 450 employees.

He only embarked on his business career at the age of 55 after 30 years teaching mechanical engineering at Newcastle University where he had studied as an undergraduate.

One of his companies, Pearson Engineering, is focused on the design and development of countermine and counter Improvised Explosive Devices (IED) equipment that increases the capability of armoured fighting vehicles.

In 2012 the company won a Queen's Award for Enterprise in Innovation for its "SPARK" mine rollers which have been used in Iraq and Afghanistan and have been responsible for saving hundreds of soldiers from death and injury.

In 2011 Alan Reece was named the third biggest philanthropist in the UK. His Reece Foundation has given millions of pounds to support engineering education.

Professor Sir Mike Gregory, Director of the IfM, said: "Alan Reece was a pioneering engineer and business man who had the rare ability to develop radical engineering ideas through to successful business enterprises.

"He provided a splendid example for the next generation of engineers and his generosity to the IfM made possible our new building which is providing a vibrant focus for manufacturing, education, research and practice."

www.ifm.eng.cam.ac.uk

Building Bridges with Higher Education Partnership

Students from an East of England community school competed to build the best bridge during a visit to the Department of Engineering.

The visit (pictured above) was the first of many which the young pupils from Cromwell Community College will be making over the next few years as they take part in the University's Higher Education (HE) Partnership programme.

Working in teams of five, the students designed and built truss bridges out of paper tubes, nuts and bolts. The bridges were tested for load capacity and also scored for visual appeal.

Students were assisted with their designs by Maria Kettle, the Department's Outreach Officer, and by Matt Diston, HE Partnership co-ordinator.

Maria also led a tour of the Department, including the CAD workstations, wind tunnels, mechanical and electrical workshops, and the language unit, where students can study Chinese, French, German, Japanese and Spanish, equipping themselves to work in many parts of the world.

"School students don't study engineering," Maria said, "and if they don't know any engineers they don't get many chances to see the creativity and teamwork involved in an engineering career.

"We hope that this visit has given a small taste of the range of activities which engineers carry out in their work."

Jonathan Fox, Co-Ordinator of Cromwell Community College's "Succeed" programme, said: "Events like these are important because they help to widen our pupils' awareness of why they are at school, and of what can be available to them in the future.

"One of the best bits about the day for me is actually the bus ride home – I hear conversations start about university, about future plans, and about what big brothers and sisters are doing. These things don't come up in the course of a standard school day."

www.eng.cam.ac.uk/outreach

Quantum cryptography goes mainstream

Researchers from Toshiba and the Department of Engineering have perfected a technique that offers a less expensive way to ensure the security of high-speed fibre-optic cables, protecting communication networks from unauthorized snooping.

The Cambridge Research Laboratory of Toshiba Research Europe Ltd, working in collaboration with Professor Richard Penty and his team in the Department, has succeeded in extracting the very weak signals used for quantum cryptography from ordinary telecom fibres transmitting data traffic. This means that existing telecom networks can now be secured with this ultimate form of encryption.

Quantum cryptography can be used to distribute the secret digital keys important for protecting our personal data, such as bank statements, health records, and digital identity. Its security relies upon encoding each bit of the digital key upon a single photon (particle of light). If a hacker intercepts the single photons, they will unavoidably disturb their encoding in a way that can be detected. This allows eavesdropping on the network to be directly monitored.

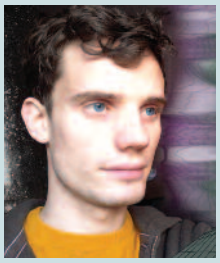
Up until now it has been necessary to send the single photons through a dedicated fibre that is distinct from the fibres carrying the ordinary data signals in the network. The data signals are much more intense than the single photon signals used for quantum cryptography: in fact one bit of data is carried by over 1 million photons. The disparity in the intensity of the signals means that scattered light caused by the data signals would contaminate and overwhelm the single photon signals if sent along the same fibre.

Dr Andrew Shields, of Toshiba Research Europe Ltd, explained: "The requirement of separate fibres has greatly restricted the applications of quantum cryptography in the past, as unused fibres are not always available for sending the single photons, and even when they are, can be prohibitively expensive. Now we have shown that the single photon and data signals can be sent using different wavelengths on the same fibre."

www.toshiba.eu/eu/Cambridge-Research-Laboratory

Matthew Henderson receives 2013 Google PhD Fellowship: 5 Years of Supporting the Future of Computer Science

Matthew Henderson, a Statistical Dialogue Systems PhD Student, has been selected as a 2013 Google Europe Doctoral Fellow. A group of 39 PhD students have been selected from around the globe, recognised by Google researchers and their institutions as some of the most promising young academics in the world.



Matthew's research is in the spoken language side of Artificial Intelligence, looking at the challenging problem for a computer of maintaining a natural conversation with a person. Using probability theory, statistics and modern machine learning, he hopes to improve the performance and extend the scope of dialog systems. This topic is relevant to Google as its voice search is becoming ever more popular, and it releases its new 'conversational search' interface. After completing a BA in Mathematics at Cambridge, Matthew obtained an MSc in Speech and Language Processing at the University of Edinburgh. Now he is working for a PhD in Cambridge under the supervision of Steve Young in the Engineering Department's Dialogue Systems Group. Google will provide generous funding for the rest of Matthew's PhD, pair him with a mentor working at Google, and encourage him to do an internship with them, which he plans to do next summer.

http://blog.matthen.com

Professor Robert Mair is interviewed for the BBC Radio 4 programme *The Life Scientific*

Each week, Professor Jim Al-Khalili talks to leading scientists about their life and work, finding out what inspires and motivates them and asking what their discoveries might do for mankind. In conversation with Robert Mair, Professor of Civil Engineering at the Department of Engineering, he discussed Robert's life as an engineer in academia and industry and world expert on finding innovative solutions to the problems of building tunnels under already congested cities.

They talked about Robert's innovative technique of 'compensation grouting'. This prevented Big Ben from tilting, or even cracking and coming away from the Houses of Parliament, during the tunnelling and 40m deep excavation for Westminster station. The excavation was the deepest in London and just 28 metres from Big Ben.

Robert chaired the report by the Royal Society and Royal Academy of Engineering, commissioned by the government, into the safety of 'fracking' (hydraulic fracturing), where water and chemicals are pumped, under pressure, into shale rock to release gas. The technique has hit the headlines amid concerns about the risks of its use causing earthquakes and contaminating water supplies. Robert explained why, with the best practice and strong regulation, the technique could be safely used in the UK.

PERRY HASTINGS

Listen to the interview at: www.bbc.co.uk/programmes/b01pth0t

Cambridge Engineering Design Centre's new book on the challenges older users have with digital technology

Dr Anna Mieczakowski and Professor John Clarkson from the Department of Engineering's Engineering Design Centre have launched a book *Ageing, Adaption and Accessibility: Time for the Inclusive Revolution!* It brings together opinions and insights from 21 prominent thought leaders from government, industry and academia. The topics include ageing, people's adaption to the ever changing world of technology and insights into better ways of designing digital devices and services for the older population.

Modern Information and Communication Technology (ICT) has, in the last few years, enriched the lives of many individuals and society as a whole. With all the benefits afforded by this new-found capability, however, come challenges for an ageing population. Why do we continue to digitally disfranchise older people in the modern era, especially given that the world's population is ageing at an unprecedented rate and there is an increasing focus on the sustainability agenda?

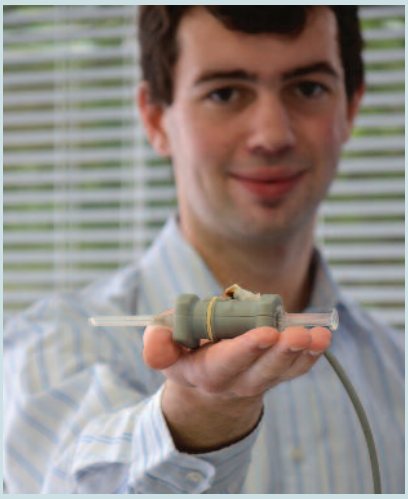
The Engineering Design Centre (EDC), in partnership with BT, have produced a book of thought pieces investigating these questions. Importantly, this work was aimed at stimulating a debate based on research and practice that has been taking place in many industrial studios, government chambers and academic centres.

Internet use among the ageing population, as for all other user groups, is essentially about empowerment. Combined and responsible efforts of business, government and education could bring about significant change and ultimately improve the sustainability of the modern world.

www-edc.eng.cam.ac.uk

Exceptional students receive engineering and technology scholarships

Several students from the Department of Engineering have been recognised by the Institution of Engineering and Technology (IET) as outstanding, and have received a number of awards and scholarships.



Belling Engineering Scholar Archie Lodge holding an early prototype of the piOna device

The Belling Engineering Scholarship was awarded to Archie Lodge. The scholarship is worth £12,000 (£3,000 per year for four years).

The IET Jubilee Scholarships were awarded to Daniel Eatough, Luke Godfrey, and Daniel Jones. Each Jubilee Scholarship is worth £2,000.

IET FUSE Scholarships were awarded to Seema Kapacee, Edward Phillips, Daisy Prior and Helen Sheehan. Each FUSE scholarship is worth £4,000 (£1,000 per year for four years).

Jakub Sanak was awarded an IET Grant worth £1,000.

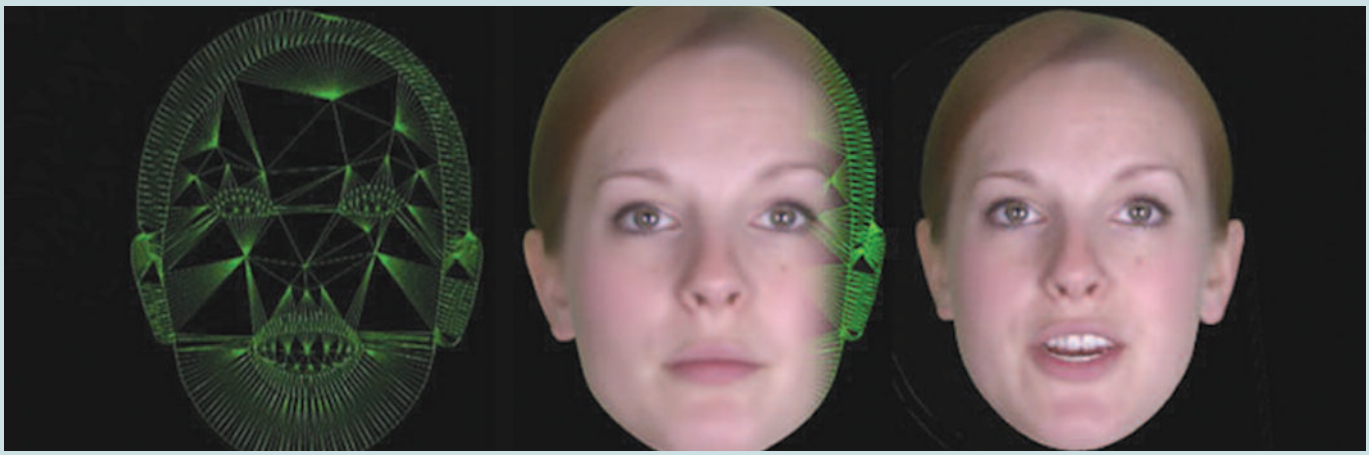
Chairman of the Scholarships Committee, Trevor Grimshaw said: "The IET Scholarships Committee is proud to recognise such outstanding talent and I hope these awards help each and every recipient to continue their excellent work. I would like to congratulate the recipients for the contribution they have made, and will make, to improve the lives of those around us and the world in which we live."

Winners formally received their awards and scholarships at the IET Ambition and Achievement Awards at The Brewery, London.

www.theiet.org

Is this the face of the future?

A virtual "talking head" which can express a full range of human emotions and could be used as a digital personal assistant, or to replace texting with "face messaging", has been developed by researchers in the Department of Engineering in collaboration with Toshiba's Cambridge Research Lab.



The virtual talking head, "Zoe", uses a basic set of six simulated emotions which can then be adjusted and combined to create hundreds of others.

The lifelike face can display emotions such as happiness, anger and fear, and changes its voice to suit any feeling the user wants it to simulate. Users can type in any message, specifying the requisite emotion as well, and the face recites the text. According to its designers, it is the most expressive controllable avatar ever created, replicating human emotions with unprecedented realism.

The face is actually that of Zoe Lister, an actress perhaps best-known as Zoe Carpenter in the Channel 4 series, *Hollyoaks*. To recreate her face and voice, researchers spent several days recording Zoe's speech and facial expressions. The result is a system that is light enough to work in mobile technology, and could be used as a personal assistant in smartphones, or to "face message" friends.

The framework behind "Zoe" is also a template that, before long, could enable people to upload their own faces and voices – but in a matter of seconds, rather than days. That means that in the future, users will be able to customise and personalise their own, emotionally realistic, digital assistants.

If this can be developed, then a user could, for example, text the message "I'm going to be late" and ask it to set the emotion to "frustrated". Their friend would then receive a "face message" that looked like the sender, repeating the message in a frustrated way.

The team who created Zoe are currently looking for applications, and are also working with a school for autistic and deaf children, where the technology could be used to help pupils to "read" emotions and lip-read. Ultimately, the system could have multiple uses – including in gaming, in audio-visual books, as a means of delivering online lectures, and in other user interfaces.

"This technology could be the start of a whole new generation of interfaces which make interacting with a computer much more like talking to another human being," said Professor Roberto Cipolla, Professor of Information Engineering.

"It took us days to create Zoe, because we had to start from scratch and teach the system to understand language and expression. Now that it already understands those things, it shouldn't be too hard to transfer the same blueprint to a different voice and face."

> ***"This technology could be the start of a whole new generation of interfaces which make interacting with a computer much more like talking to another human being."***
> **Professor Roberto Cipolla**

As well as being more expressive than any previous system, Zoe is also remarkably data-light. The program used to run her is just tens of megabytes in size, which means that it can be easily incorporated into even the smallest computer devices, including tablets and smartphones.

It works by using a set of fundamental, "primary colour" emotions. Zoe's voice, for example, has six basic settings – Happy, Sad, Tender, Angry, Afraid and Neutral. The user can adjust these settings to different levels, as well as altering the pitch, speed and depth of the voice itself.

By combining these levels, it becomes possible to pre-set or create almost infinite emotional combinations. For instance, combining happiness with tenderness and slightly increasing the speed and depth of the voice makes it sound friendly and welcoming. A combination of speed, anger and fear makes Zoe sound as if she is panicking. This allows for a level of emotional subtlety which, the designers say, has not been possible in other avatars like Zoe until now.

To make the system as realistic as possible, the research team collected a dataset of thousands of sentences, which they used to train the speech model using actress Zoe. They also tracked the actress' face while she was speaking using computer vision software. This was converted into voice and face-modelling, mathematical algorithms which gave them the voice and image data they needed to recreate expressions on a digital face, directly from the text alone.

The effectiveness of the system was tested with volunteers via a crowd-sourcing website.

Volunteers who only had video and no sound only successfully recognised the emotion in 52% of cases. When they only had audio, the success rate was 68%. The two together, however, produced a successful recognition rate of 77% – slightly higher than the recognition rate for the real-life Zoe, which was 73%! This higher rate of success compared with real life is probably because the synthetic talking head is deliberately more stylised in its manner.

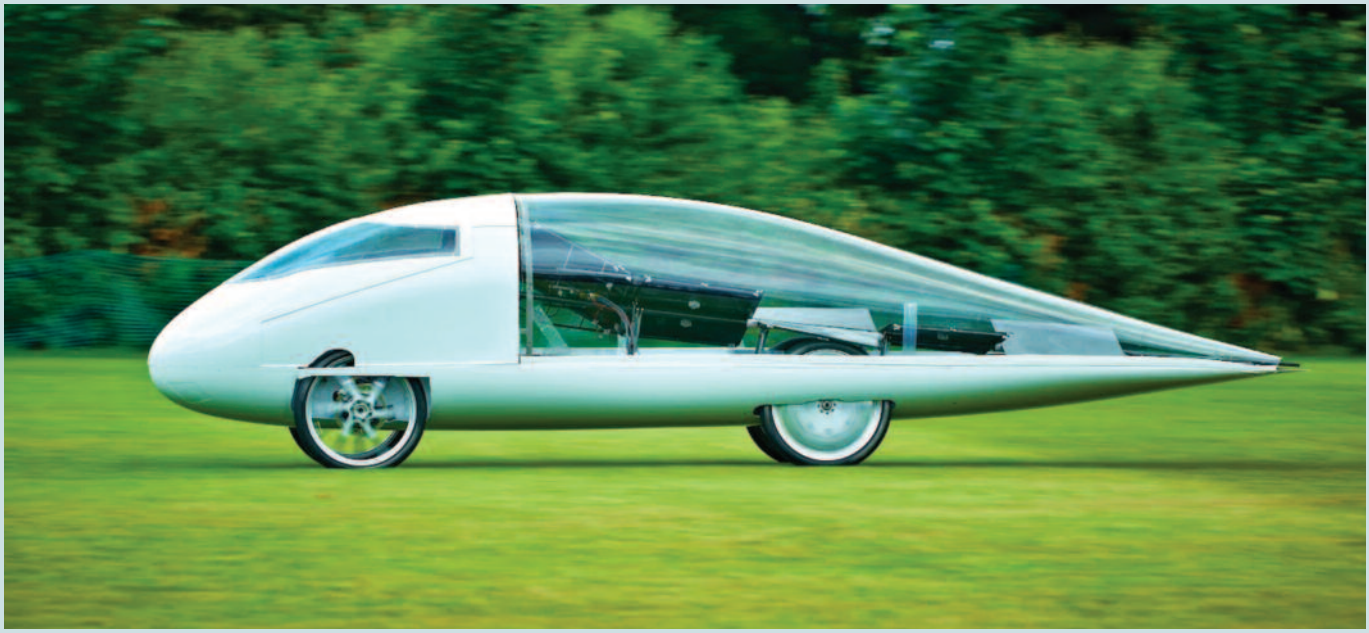
As well as finding applications for their new creation, the research team will now work on creating a version of the system which can be personalised by users themselves.

"Present day human-computer interaction still revolves around typing at a keyboard or moving and pointing with a mouse." Roberto added. "In the future, we will be able to open up computing to far more people if they can speak and gesture to machines in a more natural way. That is why we created Zoe – a more expressive, emotionally responsive face that human beings can actually have a conversation with."

www.toshiba.eu/eu/Cambridge-Research-Laboratory/

Will innovative design win the race?

A group of Cambridge students are hoping that their game-changing design of solar car will make them the first British winners of the World Solar Challenge.



A new solar car which, according to its creators, "rewrites the rulebook" for green vehicles, has been designed by students aiming to become the first British team to win the World Solar Challenge.

The prototype, which has been named Resolution, was built by engineers at the University of Cambridge. It received its public launch in a road-test at the Millbrook Race Track, near Bedford.

The team will be taking the car to Australia in October, where they will compete against rivals from all over the world in a 3,000km race from Darwin to Adelaide, in which the vehicles must be powered by the sun alone.

Their hope is that Resolution's radically different design, in particular a set of moving solar panels which maximise power by tracking the path of the sun across the sky, will enable them to take first place where others have failed. No British team has ever won the competition in its 26-year history.

Keno Mario-Ghae, team manager for Cambridge University Eco-Racing (CUER), based at the Department of Engineering, said: "Resolution is different because she overcomes one of the main limitations that affect most solar cars.

"Traditionally, the entire structure of a solar car has been based on a trade-off between aerodynamic performance and solar performance. That's how they've been designed for the past 10 years, and that's why they all tend to look the same."

"We turned the concept on its head. Our reasoning is that solar performance needs to adapt to the movement of the sun, but the car needs a fixed shape to be at its most aerodynamic. To make the car as fast and powerful as possible, we needed to find a way to separate the two ideas out, rather than find a compromise between them."

The solution the team eventually hit upon involved embedding the solar panels within an aft-facing tracking plate. This plate follows the sun's trajectory, and moves the panels themselves, so that they are optimally positioned at all times. The team estimate that this will give the car 20 per cent more power than it would have otherwise had.

> ***"The cumulative effect is a radical, race-winning design that also incorporates elements that could be used more widely in a low-carbon future."***
> **Keno Mario-Ghae, team manager**

This structure is placed under a canopy which forms part of the teardrop shape of the vehicle as a whole. The design is a departure from the "tabletop" look of most other solar cars, but is more aerodynamic. Because it encases the solar panels, rather than making them part of the shape, the question of power generation does not compromise the car's aerodynamics.

Resolution measures less than 5m in length, is 0.8m wide and about 1.1m in height. Driving her across the Australian desert is likely to be a claustrophobic experience – in fact, the driver must be a maximum of 5' 3" tall! These, however, are deliberate concessions made by the team for the sake of making the vehicle as fast and efficient as possible in the hope of winning the race. In the future, more conventional solar vehicles may well adopt similar ideas, but opt for comfort, rather than speed.

The car weights 120kg, and can reach a top speed of almost 140 kilometres per hour (almost 87 miles per hour), but only needs about the same amount of power as a hairdryer. It achieves this by maximising efficiency at every level - for example, the motor is located in the hub of the wheel, eliminating the need for gears, chains or differentials which would lower its efficiency overall.

For those small enough to squeeze inside the cockpit, the vehicle has also been fitted with on-board telemetry, an "intelligent cruise control" which takes into account traffic, weather and driving style, and will advise the team on how to optimise the vehicle's efficiency during the race itself.

The final product is the result of a huge, collaborative effort involving 60 students. "Efficiency is where our real strength lies and this is how we will be hoping to compete with the bigger teams entering the Challenge this time around," Keno added. "A huge amount of careful planning has gone into this project. It has involved research not just in terms of engineering and aerodynamics, but into the materials we use, the modelling behind the design, and the optimisation of the solar cells that power the car.

"The cumulative effect is, we think, a radical, race-winning design that also incorporates elements that could be used more widely in a low-carbon future. No British team has won this race before, but there is no reason why we can't be the first to do it."

www.cuer.co.uk

David MacKay appointed Regius Professor of Engineering

Professor David MacKay, acclaimed author of "Sustainable Energy Without The Hot Air", has been appointed as the first Regius Professor of Engineering at the University of Cambridge.

David MacKay in the University of Cambridge film, "How Many Lightbulbs", which looks at his research on sustainable energy.

An eminent researcher in machine learning and information theory, and a Fellow of the Royal Society, Professor MacKay is perhaps better known to the public for his ground-breaking work on sustainable energy and, in particular, as the author of the critically acclaimed book, *Sustainable Energy Without The Hot Air*. He is also Chief Scientific Adviser to the UK Government's Department of Energy and Climate Change.

Regius Professorships are Royal academic titles, created by the monarch. The Engineering role is a new Regius Professorship, announced in 2011 to celebrate the Duke of Edinburgh's 34 years as Chancellor of the University. The new post is designed to give an outstanding academic the opportunity to build on the Department of Engineering's world-leading research in fields that address major, global challenges. These include: creating lasting energy solutions, building cities in the future, managing risks and driving innovation.

Professor MacKay's work with the Department of Engineering will focus, in part, on the study of how we can model and communicate the full economic and societal impact of a shift to sustainable energy sources – a continuation of his recent work with the Government. He will also collaborate with academics, both within Engineering and elsewhere at Cambridge, to explore new opportunities in energy efficiency, renewable energy, and energy storage.

"I am hugely excited about this opportunity," Professor MacKay said. "Everything I have done over the past two decades has had an engineering element to it, and since developing an interest in sustainable energy that has only increased.

"The wonderful thing about this role is that I will have the chance to work alongside some truly fantastic engineers. My hope is that I will be able to bring new ideas about energy research to a Department which is already full of talent that can develop prototypes and bring those concepts to life."

Professor MacKay's recent reputation has been as a leading scientist and thinker on sustainability and responses to climate change. Before that, however, his career was focused on other areas, and included developing communication systems for the disabled.

He first came to Cambridge as an undergraduate in 1985, studying Natural Sciences at Trinity College. He then studied for his PhD in Computation and Neural Systems at the California Institute of Technology, where he also developed an interest in green politics and environmental science. In 1992, he returned to Cambridge as a postdoctoral researcher and Fellow of Darwin College, then became a lecturer in the Department of Physics. He was promoted to Professor in 2003.

As a specialist in machine learning and information theory, he has developed more efficient types of error-correcting code that are now used in satellite communications, digital broadcasting, and disk drives. He also used Bayesian methods to improve the performance of artificial neural networks, which are now widely used in applications such as the design of new types of steel for power stations.

His work on communications systems included the invention of "Dasher", an open-source software interface that enables people with disabilities to write efficiently in any language with any muscle.

More recently, Professor MacKay has devoted much of his time to the topic of sustainable energy. His widely-acclaimed book on the subject – *Sustainable Energy Without The Hot Air* – was conceived as a straight-talking assessment of the challenge of curbing human dependence on fossil fuels, and shifting to more sustainable forms of energy consumption and production. MacKay self-funded the publication, and the initial print run of 5,000 copies sold out in a matter of days. The subject of widespread critical praise, the book was described by Bill Gates as "one of the best books on energy that has been written", and it has been translated into several other languages. A digital edition remains free to download at www.withouthotair.com

In 2009, MacKay was elected a Fellow of the Royal Society. In the same year, he was appointed Chief Scientific Adviser to the Department of Energy and Climate Change. His duties include ensuring that policy and planning within the Government department is based on the best scientific evidence; providing advice on climate science; ensuring accurate reporting of national greenhouse gas emissions; and recruiting new engineering and science specialists.

As Regius Professor of Engineering, MacKay will continue work he has already begun with the Government on "whole energy system modelling" – examining the full implications of a shift away from fossil fuels towards secure, low-carbon energy supplies. His current work, notable with the open-source "2050 Calculator", describes how behavioural or technological changes in fields such as transport, lighting, heating, energy storage, and land and livestock management will impact on the scale of energy demand, energy supply, and greenhouse gas emissions.

"The more explicit and transparent we can be about the trade-offs involved in a shift away from fossil fuels, the better our final decisions will be."
Professor David MacKay

"Modelling tools like this have a huge impact on the public understanding of energy options, as well as policy-making itself," he said. "The more explicit and transparent we can be about the trade-offs involved in a shift away from fossil fuels, the better our final decisions will be. It helps to engage the public with the options, and replaces a culture of negativity by allowing people to understand what a low-carbon future will entail in a more complete and positive way."

MacKay's work at Engineering will also allow him to explore other, "blue skies" ideas on similar themes. In particular, he is interested in developing a cross-Cambridge collaboration, involving several departments around the University, which will look at developing biosystems that can efficiently turn sunlight into electricity and useful chemicals. Other possible projects may examine "osmotic power" (the extraction of energy from river mouths, where fresh water meets sea water), "kite power" (a possible solution to providing wind power without turbines), and new energy storage solutions. Professor MacKay will continue in his role as Chief Scientific Adviser to the UK Government's Department of Energy and Climate Change, which is due to run until the autumn of 2014.

Welcoming the appointment, Professor Dame Ann Dowling, Head of the Department of Engineering, said: "David has a track record of excellent achievements in machine learning and information, while his work on energy has laid out a quantitative framework for identifying technologies that can make a real difference to the world's growing energy needs in sustainable ways. The Department has highlighted energy, transport and urban infrastructure as a major strategic research theme and I look forward to David playing a significant role in that."

www.withouthotair.com

Construction Engineering Masters Programme success stories

Congratulations go to Richard Key (left) and Chris McKinstray (right), students from the Construction Engineering Master's Programme on their recent awards. This Course was established as the result of a generous donation by Laing O'Rourke plc in 2010.

Richard Key was awarded the Young Professional of the Year Award 2012 for Yorkshire and Humberside Chartered Institution of Highways and Transportation

The award is made to a young person under 35 who made a significant, active contribution to an interesting or notable project. The aim of the Award is to celebrate individual excellence in Transport Planning and/or Civil Engineering within the highways and transportation field.

Richard graduated in 2007 and became a Chartered Engineer and Member of the Institution of Civil Engineers in spring 2012. Since September 2011 he has also been studying a second Masters Degree (Mst) in Construction Engineering at the Department of Engineering.

Since July 2010 Richard has been working on the Highways Agency's M1 Junction 39 to 42 Managed Motorway project. This £185m scheme uses the latest Managed Motorway techniques to make journeys more reliable by controlling traffic flows more effectively through the use of overhead gantries, lane specific signals, and driver information signs. The hard shoulder is used as an additional live traffic lane to increase capacity. Richard's current role as Deputy Project Manager at Halcrow is very much client-facing. His work involves close liaison with the Highways Agency's Project Manager and her team. When Halcrow senior managers met with the Highways Agency team to get feedback on project performance, Richard was named a key player in the success of the project to date.

First European Supergrid Winner Chris McKinstray

Chris (Senior Engineer based at Arup's Edinburgh office) was nominated as the first winner of the The Friends of the Supergrid (FOSG) Award for the best Supergrid-related project of 2012.

Chris's work focused on research into technical, commercial & financial risks, as well as mitigation strategies to ensure the successful development of the Supergrid. The outcome was a risk map, designed to stimulate a wider and progressive discussion toward the successful development and implementation of this ambitious project.

The Supergrid aims to create a pan-European transmission network, powered by the renewable energy assets of participating Member States. It seeks to integrate and balance the transportation of electricity, with the aim of unifying and harmonising the European electricity market.

Together with his supervisor Dr Azad Camyab, Chris presented a paper titled "The European Supergrid – Messiah or Pariah?" at the 2nd Annual European Renewable Energy Project Finance Conference in London. The paper was also presented at the prestigious Powergen Europe energy conference in Vienna.

www.construction.cam.ac.uk

Keep on trucking

Whether it's a bag of oranges or a tank full of petrol, the commodities we rely on will have come down the motorway in a fleet of lorries crisscrossing the country to keep supermarket shelves full and fuel reservoirs topped up. Now a new Centre will look at how road freight can be made more sustainable.

Ceaseless traffic

Almost everything we consume arrives on a truck, even if its road trip represents just part of its overall journey. Lorries bring us the things that we need – but, as substantial users of diesel, they do so at significant cost. That cost is not just financial; it's also social and environmental.

A new initiative – the Centre for Sustainable Road Freight – was launched in December 2012 to look at the 'big picture' of the movement of freight by road in the UK and to explore ways of making the sector more economically, socially and environmentally sustainable. The reduction of carbon dioxide and other greenhouse gas emissions, which contribute to global warming, is a key objective of the programme, in tune with the government's targets of 34% reduction (compared with 1990 levels) by the year 2020, and 80% reduction by 2050.

The Centre, which has £5.8 million funding for the first five years, is a partnership between the Department of Engineering and Heriot-Watt University's Logistics Research Centre. It is headed by Cambridge's Professor David Cebon, an engineer with expertise in the dynamics of heavy vehicles, who leads a team of ten academics from the two institutions: "The Centre draws on the strengths of both institutions – Cambridge's skill set in engineering and Heriot-Watt's capabilities in logistics. It brings together experts from a wide range of fields, from the aerodynamics of vehicles through to logistical operations and driver behaviour."

A vital feature of the Centre is its close links with the freight industry. Of the initial funding, £4.4 million will come from the Engineering and Physical Sciences Research Council and £1.4 million from a new industrial consortium. The consortium will comprise freight operators such as DHL, John Lewis Partnership, Tesco and Wincanton, as well as vehicle industry partners including Firestone, Goodyear, Haldex and Volvo. These companies will help to set the research agenda and set the pace in the adoption of results. With fuel representing, on average, 45% of operating costs, and with aggressive emission-reduction targets set by government, the road freight industry has substantial incentives to minimise its use of diesel.

> ***"Our aim is to focus on the big-picture issues and make sure that the most important factors get the right amount of industrial and political attention, at the right time"***
> **David Cebon**

The programme will look at the most influential factors that govern fuel usage by the road freight industry to develop a road map for the industry and help it meet emissions reduction targets. The key is to have a sequence of practical interventions, both logistical and engineering, which are socially acceptable and economically attractive, and which drive down emissions. "It is no use having an ambitious end point if there is no practical way to get there," said Professor Cebon. "Our aim is to focus on the big-picture issues and make sure that the most important factors get the right amount of industrial and political attention, at the right time."

To illustrate this point, Professor Cebon explained how an improvement in vehicle aerodynamics would reduce fuel consumption for motorway operations – but that advance in performance may be small when matched against other factors such as traffic congestion, which is heavy on fuel consumption. He said: "A viable reduction in fuel consumption due to improved vehicle aerodynamics is 5%. If you set this against the extra fuel used in one unscheduled vehicle stop, it would take about 45 km of continuous driving by the improved vehicle to break even. Although improved aerodynamics does make a difference, traffic flow is hugely influential, meaning that improved road systems, better route planning and delivery time scheduling can make a big contribution to reducing fuel consumption."

The Centre is guided by the 'triple bottom line' approach to sustainability: planet, people and profit. In devising workable solutions, the second and third of these are as important as the first. The public might complain about emissions and noise, and lobby to keep trucks out of residential areas, but lorries are the lifeblood of the country's economy. Without freight transportation by road, the economy would grind to a halt within four or five days. All along the supply chain, companies rely on just-in-time delivery systems working 24 hours a day, seven days a week, on narrow profit margins. According to the latest figures, some 400,000 lorries and 290,000 drivers deliver around 3.9 million tonnes of freight on a daily basis.

One of the aspects of freight transport that offers most potential for reducing fuel costs, and thereby emissions, is to maximise loads. When a vehicle delivers its freight and returns empty, the energy used for the return trip serves no useful freight purpose and the fuel consumption per freight task is increased by 70%. The solution to this problem lies in improved logistics management and collaboration between different operators. Similarly, when freight is taken off a large

articulated truck and put on two smaller trucks, 40% more fuel is used. In this case, there is an opportunity for the development of large vehicles that are more manoeuvrable in narrow streets and safer for vulnerable road users such as pedestrians and cyclists.

Modern trucks are designed to be aerodynamic with smooth shapes that offer least wind resistance and skirts to streamline air flow. An area of aerodynamics that has thus far been largely neglected is the underside of trucks. This aspect of truck design is being investigated by a team led by Cambridge's Professor Holger Babinsky, who has worked extensively on the aerodynamics of Formula 1 cars.

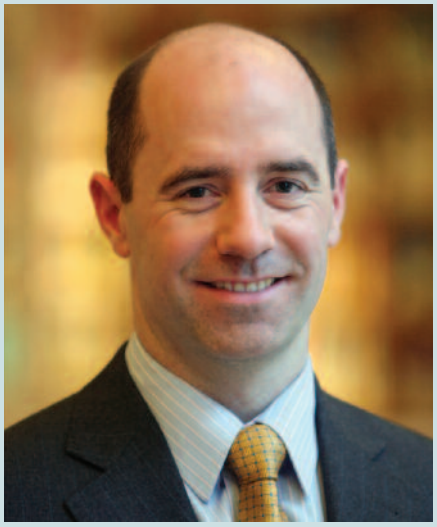
Measuring the flow between the underside of a truck and the ground it is passing over presents a particular challenge because of the difficulties in running realistic wind-tunnel tests. Using a model truck, researchers have developed a method of scaling up some of the parameters by towing the model through water in a glass tank. "We think that the underside of a truck contributes as much as 30% of total drag and that by redesigning the underside we can reduce that figure by 10 to 20%," said Professor Babinsky.

"What's exciting about the Centre is the fact that it brings together so many leaders in their fields," added Professor Cebon. "By working together and focusing on both the logistical issues and vehicle engineering we can devise solutions that will make a major contribution to sustainability in the road freight industry."

www.csrf.ac.uk

EPSRC Fellowship for Engineering Design lecturer

Dr Nathan Crilly, a lecturer in Engineering Design in the Department of Engineering, has been awarded a £1.2M fellowship from the Engineering and Physical Sciences Research Council (EPSRC).



The five-year EPSRC Early Career Fellowship will allow Nathan to create design guidance that will assist in developing products from emerging technologies.

Emerging technologies are science-based innovations with the potential to create, transform or obsolete entire industries. Examples range from 'small-tech' materials constructed at the atomic level through to 'large-tech' infrastructures enabled by the internet and other complex systems. Irrespective of their physical scale, emerging technologies have the potential to drive and support sustained economic growth. However, realising these opportunities critically depends on the capacity to translate scientific advances and technological developments into product ideas that are suitable for manufacture, distribution and use.

The fellowship project involves developing fundamental design knowledge that is relevant to a broad range of different types of system. Multiple system types will be investigated, along with the attributes of those systems and the system behaviours that those attributes promote. A comparative analysis of industrial case studies will be used to develop flexibly applicable design guidance. In doing so, the project will provide scientists, technologists and engineers with the cross-domain knowledge of systems that they require to design for newly emerging technologies and for technologies that have not yet been imagined.

Nathan's research interests are in the areas of design, creativity and communication. He employs an interdisciplinary approach to studying designed products and systems. In particular, he studies how these artefacts are developed, the properties they exhibit and the ways in which users respond to them. Nathan works with the Cambridge Engineering Design Centre, where he leads the Design Practice theme. He is a member of the Design Research Society and serves on the International Editorial Board of Design Studies.

www-edc.eng.cam.ac.uk/research/designpractice

Royal Society Research honour for Professor Daniel Wolpert

Professor Daniel Wolpert has been awarded a Royal Society Research Professorship to fund long-term UK research.

This prestigious award provides long-term support enabling leading scientists to focus on their research. Appointments are usually made for approximately 10 years.

Professor Wolpert is a world leader in the study of how the brain controls movement and is head of the Sensorimotor Learning Group at the Department of Engineering. His group uses virtual reality systems and robotics to test their theories.

"Movement is fundamental to human existence, being the only way we have to affect the world around us," explained Professor Wolpert.

"Despite the recent dramatic advances in the field, understanding the control of movement remains an extremely challenging problem. This is evident when we try to build machines to do what our brains do so effortlessly. We can now build machines that outperform grandmasters at chess, yet there is no robot that can manipulate a chess piece with the dexterity of a five year old child. I am delighted to be appointed to the Royal Society Noreen Murray Research Professorship in Neurobiology which will allow me to focus my efforts on understanding the computational principles by which the brain controls movement."

These prestigious posts provide support for internationally-recognised scientists of outstanding achievement and promise. Previous holders of Royal Society Research Professorships include six Nobel Laureates and five Presidents of the Royal Society.

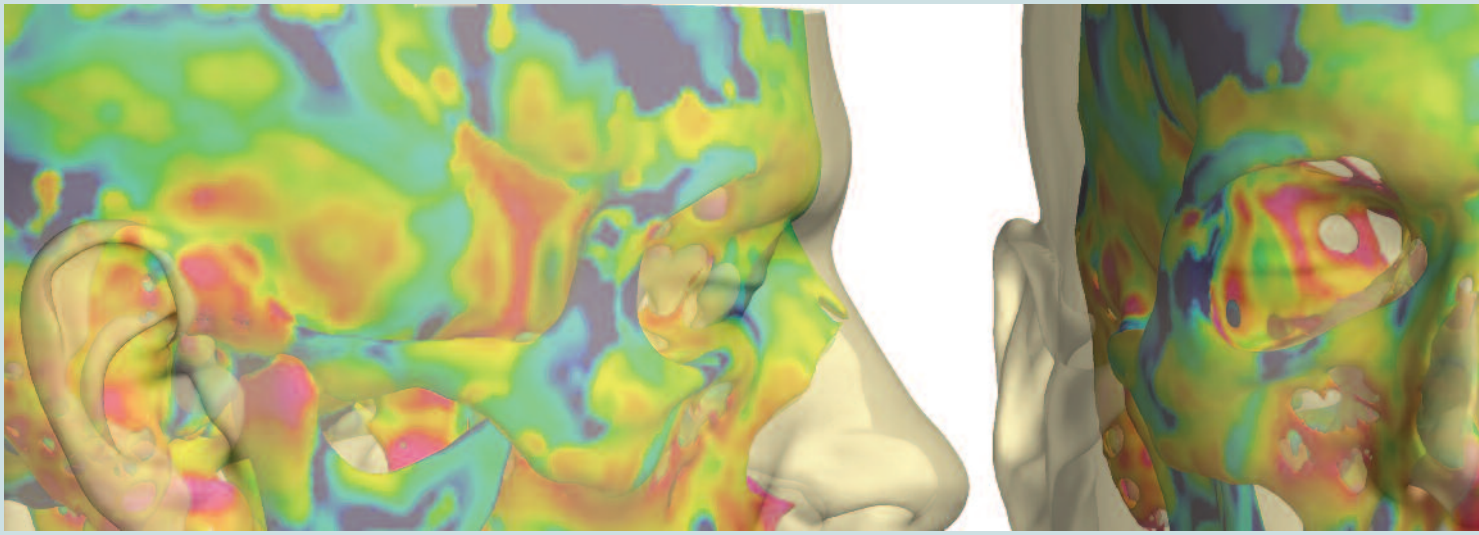
cbl.eng.cam.ac.uk/Public/Wolpert

Caught on camera: engineering in action

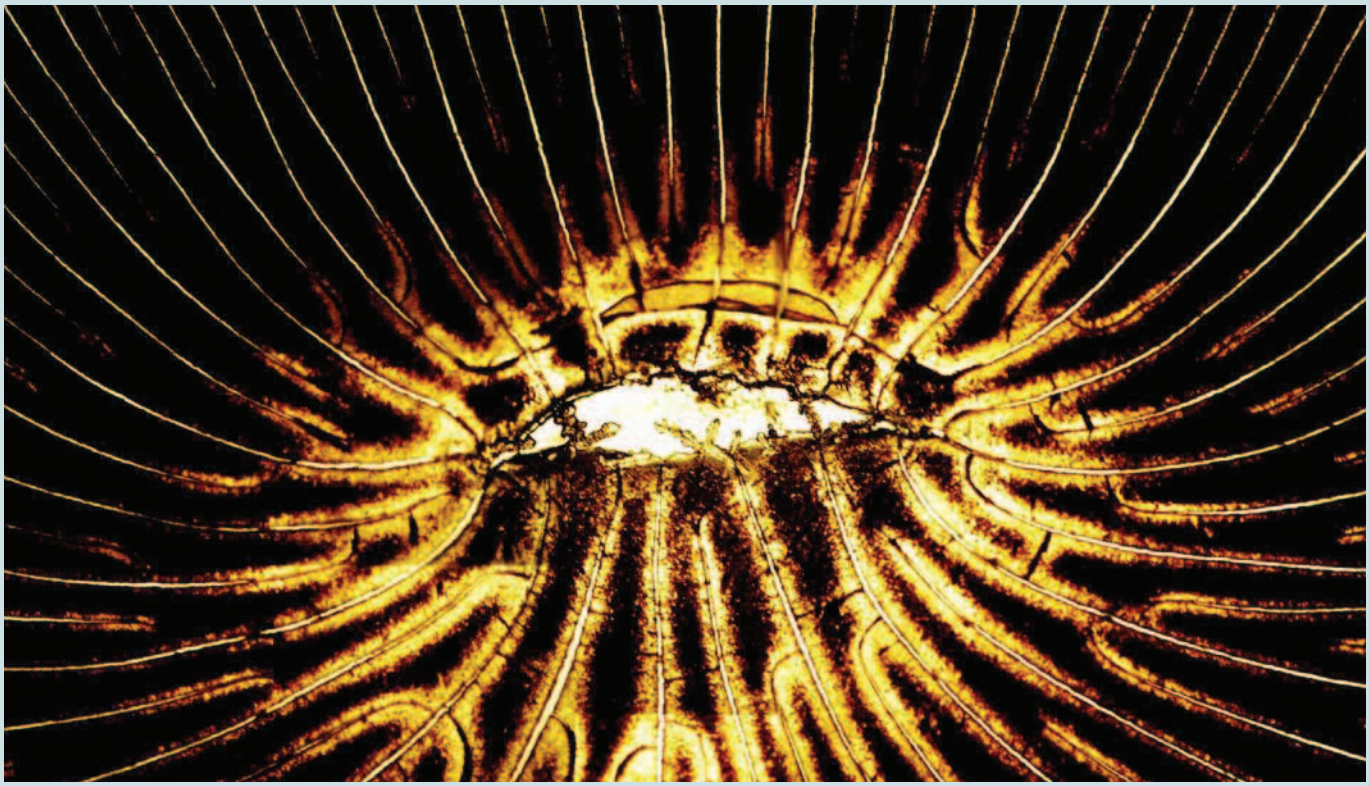
The winning entries of the Photography Competition at the Department of Engineering, sponsored by Carl Zeiss, provide a stunning visual insight into the ways in which engineering makes a vital contribution to our lives.

Engineering is about much more than dams and bridges. A glance at the hundreds of stunning images submitted for the 2012 Photography Competition at the Department of Engineering, sponsored by leading optical systems manufacturer Carl Zeiss, offers a window into a world of ground-breaking research in a staggering array of fields, encompassing applications that range from new adhesives and inkjet printing techniques through to the development of replacement human tissues.

Each year four prizes are awarded with the top photographers winning items of up-to-the-minute equipment that will enable them to take their photography skills to new levels. Hundreds of images were submitted for the competition which asked for pictures that both related to research or teaching undertaken in the Department of Engineering, or out in the field, and were also interesting or beautiful as works of art in their own right. The engineering subjects captured in the photographs



▲ **Graham Treece** won **second prize** with his computer-generated image taken from a CT scan of the head. The image (A New Way of Looking) represents more than ten years of research into new techniques for measuring variations in the thickness of the cortex (the surface of the skull) and offers a valuable new tool for clinicians looking at injuries such as fractures.



▲ **First prize** for 2012 was awarded jointly to **Dr Ronan Daly** and **Dr Alfonso Castrejon-Pita**, of the Inkjet Research Centre, whose winning entry (Drying Patterns of AKD on Glass) shows the drying and cracking of a film formed when an alkyl ketene dimer (AKD) dispersion is deposited and dried on a glass microscope slide. The work of these researchers explores the new generation of inkjet printing techniques which have potential applications in diagnostic and lab-on-chip technologies that could speed up the process of identifying and treating life-threatening diseases.

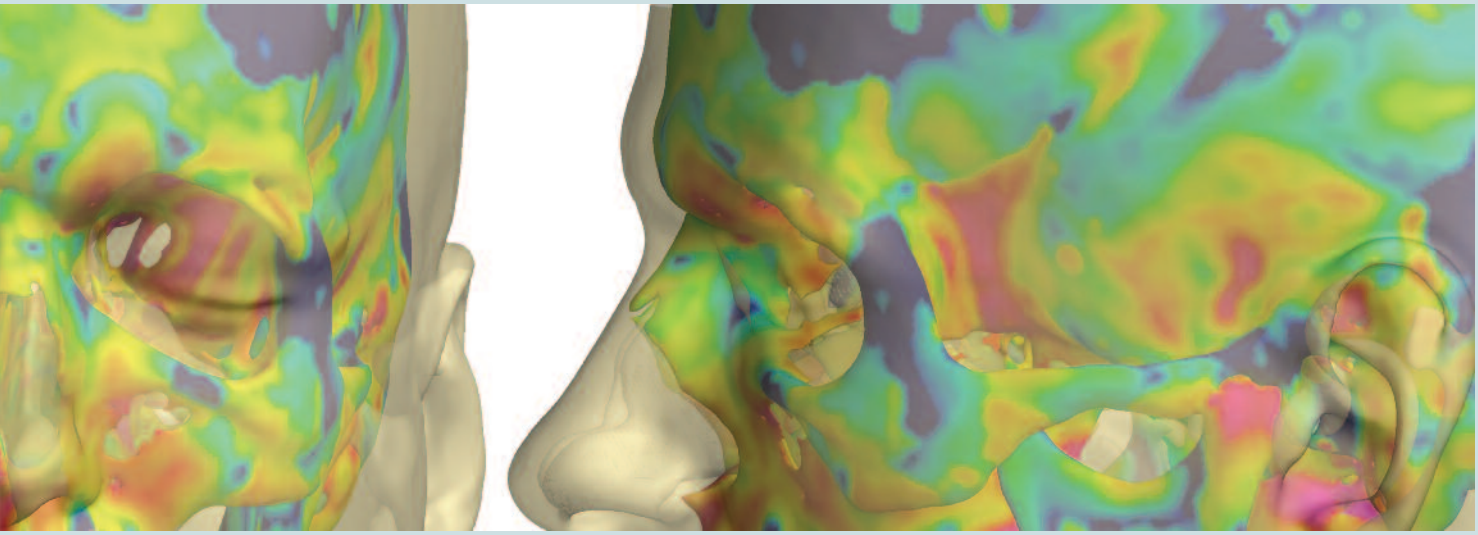
entered range in size from the tiniest atom-scale through to some of the world's largest structures.

This year's judges included Professor Roberto Cipolla, Dr Allan McRobie, Professor Dame Ann Dowling and Philip Guildford – all from the Department of Engineering. Also on the judging panel was Ken Robinson, Senior Applications Specialist at Carl Zeiss.

Philip Guildford, Director of Research at the Department of Engineering, explained that, given the high standard of entries, the selection process was ambitious with the panel looking for images that would hold their own in a gallery such as Tate Modern or Tate Britain. He also remarked that, while the competition had begun nine years ago as "a bit of fun", it now played an extremely powerful role in communicating visually the sheer span of engineering and the excitement of working in a rapidly-developing discipline. "Behind each image is a fascinating story of dedicated research," he said.

"Behind each image is a fascinating story of dedicated research"
Philip Guildford, Director of Research at the Department of Engineering

All entries can be viewed at: www.flickr.com/photos/cambridgeuniversity-engineering/



▲ **Third prize** was won by **Pola Goldberg Oppenheimer** for her image (Nanoscale Fractal Branching Patterns) of adhesive structures that mimic the ability of the gecko's feet to stick to surfaces repeatedly without losing their stickiness.

▲ A separate **monograph prize** – for images captured using an electron microscope – is awarded jointly to **Ching Theng Koh** and **Daniel Strange** who are developing electro-spinning techniques that will produce networks of fibres with diameters one millionth of a metre or less. Their image (Electrospun Scaffold – A Fibrous Material with Nanoscale Fibres) shows the fibrous networks that mimic those found in many natural materials and have potential applications as human tissue replacements.

Excellence in Teaching Award for Tim Minshall

Dr Tim Minshall, Senior Lecturer in Technology Management, has won a Royal Academy of Engineering ExxonMobil Excellence in Teaching Award.

These awards are for Centres of Excellence in Engineering Teaching in the UK and the Republic of Ireland and are given to people who have "distinguished themselves within their peer group by showing a strong and continuing commitment to teaching, professional activities, promoting engineering as a rewarding and creative career, establishing industrial-academic links and other activities which ultimately ensure the output of top-quality graduate engineers."

Tim is planning to use the £5k award to help develop resources to support the Department of Engineering's outreach activities with schools. In particular, he would like to develop a community of practice to support engineering PhD students develop their teaching skills; supplement outreach activities by supporting students in Cambridge and elsewhere who want to share the excitement of the more innovative and creative aspects of engineering with schools; and produce a collection of short videos and animations (such as those from ASAPScience), developed in collaboration with undergraduate students and industrial partners, to highlight the diverse activities of engineers. Tim is seeking additional funding to be able to develop these projects.

He said: "I am absolutely delighted to receive this award, and that the Department has been recognised by RAEng/ExxonMobil as a Centre of Excellence in Engineering Teaching. This is a reflection of the very supportive environment provided by the Department of Engineering for the development and delivery of new teaching and outreach programmes. I am particularly excited to be able to use the funding to support the on-going development of our innovation-related resources for schools, and the provision of support for PhD students to develop their teaching and outreach skills."

www.ifm.eng.cam.ac.uk/people/thwm100

Professor Dame Ann Dowling makes BBC Radio 4's *Woman's Hour*, Power List 2013

Congratulations to our Head of Department, Professor Dame Ann Dowling FREng for making the BBC *Woman's Hour* Power List 2013.

Professor Dowling made headlines in 1993 when she was appointed the first female Professor in the Department of Engineering. In 2002 she was recognised in the Queen's Birthday honours, receiving the Commander of the British Empire medal (CBE) for services to Mechanical Engineering, and again in the 2007 in the New Year's Honours List when she received a DBE (Dame of the British Empire) for services to science. More recently in 2011 she was awarded a UKRC award for her 'Inspiration and Leadership in Academic and Research'.

The BBC Radio 4's list consisted of the top 100 most powerful women in the UK today. Listeners of the show and members of the public were allowed to suggest women who they believed were most powerful in the UK today. For example top female politicians, business women and leaders in a range of fields. The top 100 list was then chosen and ranked from a panel of judges: Eve Pollard, Jill Burridge, Oona King, Val McDermid, Dawn O'Porter and Priti Patel.

Professor Dowling has also been honoured by Imperial College, London. Described as a 'pioneering engineer' by Imperial's President and Rector Sir Keith O'Nions, Professor Dowling received an honourary doctorate at a postgraduate graduation ceremony in the Royal Albert Hall alongside industrialist and President of the Royal Academy of Engineering, Sir John Parker.

www.bbc.co.uk/programmes/b007qlvb/features/power-list-100

Pilkington Prize honour for academics

Dr Dick Fenner and Dr Andrew Flewitt from the Department of Engineering have been honoured at this year's Pilkington Prize ceremony.

This is the 20th year of the Pilkington Prizes which honour excellence in teaching across the University of Cambridge.

Thirteen inspirational academics were honoured for the outstanding quality and approach to their teaching. This year's recipients received their awards at a ceremony at Murray Edwards College attended by Vice-Chancellor Professor Sir Leszek Borysiewicz and Lord Watson of Richmond CBE, the University's High Steward.

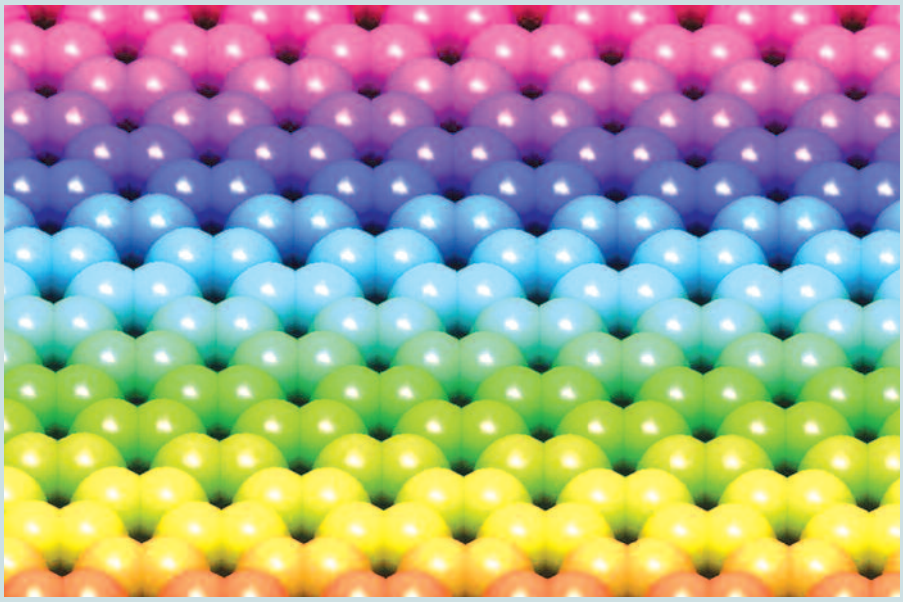
Senior Lecturer Dr Dick Fenner received his award in recognition of his work on the MPhil course in Engineering for Sustainable Development. His citation read: "Dick Fenner has been the Course Director of the highly successful MPhil in Engineering for Sustainable Development since its establishment in 2002. With students from over 60 countries ranging in age from 20-65, some with considerable professional experience and some with very little, he has had to devise many innovative approaches to teaching. He has constantly evolved the course to reflect the changing needs of the students, and his transformative educational experience has included role plays, games, debates, site visits and mock inquiries, and field trips."

Dr Andrew Flewitt is a Reader in Electronic Engineering. His citation stated: "Andrew Flewitt has consistently delivered excellent and innovative electrical engineering teaching in the Engineering Tripos for over ten years. He set up a new fourth year course in Micro-Electrical-Mechanical Systems, which has attracted students specialising in many different areas of engineering. His introduction of an innovative coursework element to this gives students the much-valued opportunity to get into a clean room to fabricate simple devices. He has also devised a new third year course in Semiconductor Engineering, and has reinvigorated laboratories for the general Part I."

The Pilkington Prizes were initiated by Sir Alastair Pilkington, the first Chairman of the Cambridge Foundation, who believed passionately that the quality of teaching was crucial to Cambridge's success.

Graphene: Taking the wonder-stuff from dream to reality

A centre for research on graphene, a material which has the potential to revolutionise numerous industries, ranging from healthcare to electronics, has been created at the University of Cambridge. The University has been a hub for graphene engineering from the very start and now aims to make this "wonder material" work in real-life applications.



Graphene is a one-atom thick layer of carbon atoms. Producing high-quality single layers in a manner compatible with industrial processes is just one of the challenges that researchers will be trying to surmount. The image shows a printed graphene device

The Cambridge Graphene Centre started its activities in February this year, with a dedicated facility due to open at the end of 2013. Its objective is to take graphene to the next level, bridging the gap between academia and industry. It will also be a shared research facility with state-of-the-art equipment, which any scientist researching graphene will have the opportunity to use.

The Centre's activities will be funded by a Government grant worth more than £12 million, which was allocated to the University in December by the Engineering and Physical Sciences Research Council (EPSRC). The rest of this money will support projects focusing both on how to manufacture high-quality graphene on an industrial scale, and on developing some of its potential applications.

Graphene is a one-atom thick layer of graphite with remarkable properties. It is exceptionally strong, yet also lightweight and flexible, enables electrons to flow faster than silicon and functions as a transparent conductor. Researchers in industry and academia are keen to harness its potential to make significant technological advances. This work might lead to numerous new devices and applications which could then be commercialised by industry and help to boost economic growth.

There is still much to be done before that early promise becomes reality. The first job for those working in the Cambridge Graphene Centre will be to find ways of manufacturing and optimising graphene films, dispersions and inks so that it can be used to good effect.

Professor Andrea Ferrari, who will be the Centre's Director, said: "We are now in the second phase of graphene research, following the award of the Nobel Prize to Geim and Novoselov. That means we are targeting applications and manufacturing processes, and broadening research to other two-dimensional materials and hybrid systems. The integration of these new materials could bring a new dimension to future technologies, creating faster, thinner, stronger, more flexible broadband devices."

Professor Sir Leszek Borysiewicz, Vice-Chancellor of the University of Cambridge, said: "Graphene's potential is beyond doubt, but much more research is needed if we are to develop it to a point where it proves of benefit to society as a whole. The pioneering work of Cambridge engineers and scientists in fields such as carbon nanotechnology and flexible electronics, coupled with our record of working with industry and launching spin-out firms based on our research, means that we are in a unique position to take graphene to that next level."

Professor Bill Milne, who will be part of the Centre's management group, said: "Graphene has amazing fundamental properties but at the moment we cannot produce it in a perfect form over large areas. Our first aim is to look at ways of making graphene that ensure it is still useful at the end of the process. We have to find modes of production that are consistently effective – and there is still a lot of work to be done in this respect."

One such project, led by Dr Stephan Hofmann, a Reader and specialist in nanotechnology, will look specifically at the manufacturability of graphene and other, layered, 2D materials. At the moment, sheets of graphene that are just one atom thick are difficult to grow in a controllable manner, manipulate, or connect with other materials.

Dr Hofmann's research team will focus on a growth method called chemical vapour deposition (CVD), which has already opened up other materials, such as diamond, carbon nanotubes and gallium nitride, to industrial scale production.

"We are in a unique position to take graphene to the next level."
Sir Leszek Borysiewicz

"The process technology will open up new horizons for nanomaterials, built layer by layer, which means that it could lead to an amazing range of future devices and applications," Dr Hofmann said.

The Government funding for the Centre is complemented by strong industrial support, worth an additional £13 million, from over 20 partners, including Nokia, Dyson, Plastic Logic, Philips and BaE systems. A further £11M of European Research Council funding will support activities with the Graphene Institute in Manchester, and Lancaster University.

Its work will focus on taking graphene from a state of raw potential to a point where it can revolutionise flexible, wearable and transparent electronics. The Centre will target the manufacture of graphene on an industrial scale, and applications in the areas of flexible electronics, energy, connectivity and optoelectronics.

Professor Yang Hao, of Queen Mary, University of London, will lead Centre activities targeting connectivity, so that graphene can be integrated into networked devices, with the ultimate vision of creating an "internet of things".

Professor Clare Grey, from Cambridge's Department of Chemistry, will lead the activities targeting the use of graphene in super-capacitors and batteries for energy storage. The research could, ultimately, provide a more effective energy storage for electric vehicles, storage on the grid, as well as boosting the energy storage possibilities of personal devices such as MP3 players and mobile phones.

www.graphene.cam.ac.uk

EURASIP Technical Achievement Award for Professor Steve Young

Professor Steve Young (right) has been honoured by the European Association for Signal Processing (EURASIP) for his work in spoken language systems.

He was presented with the EURASIP Technical Achievement Award at the European Signal Processing Conference in Marrakech, Morocco, earlier this year.

The award honours a person who, over a period of years, has made outstanding technical contributions to theory or practice in technical areas within the scope of the Society, as demonstrated by publications, patents, or recognized impact in this field. In announcing the award, Patrick A. Naylor, EURASIP Awards Chairman, said that Professor Young was being honoured for his "Contributions to the development of spoken language systems including speech recognition, speech synthesis and dialogue management".

Steve Young is Professor of Information Engineering in the Department's Information Engineering Division. He has served as Chair of the School of Technology, was a member of the University General Board and has served as an elected member of the University Council. He is currently Senior Pro-Vice Chancellor responsible for Planning and Resources. His main research interests lie in the area of spoken language systems including speech recognition, speech synthesis and dialogue management.

Commenting on his EURASIP award, Professor Young said: "Speech technology is an interdisciplinary subject spanning engineering, computer science, mathematics and linguistics and as such it is often overlooked by mainstream engineering disciplines such as signal processing. This recognition by EURASIP is therefore not only a great personal honour, it is also an acknowledgement of the growing importance of speech technology in today's world.

"Previous winners of this award include some of the major figures in signal processing such as Djuric, Vetterli, and Mitra, and to be ranked amongst them is a great honour."

Professor Young is a Fellow of the Royal Academy of Engineering, the Institution of Engineering and Technology (IET), the Institute of Electrical and Electronics Engineers (IEEE) and the Royal Society for the encouragement of Arts, Manufactures and Commerce (RSA). In 2004, he was a recipient of an IEEE Signal Processing Society Technical Achievement Award; in 2008 he was elected Fellow of the International Speech Communication Association (ISCA) ; and in 2010, he received the ISCA Medal for Scientific Achievement.

"This recognition by EURASIP is not only a great personal honour, it is also an acknowledgement of the growing importance of speech technology in today's world."
Professor Steve Young

www.neuroscience.cam.ac.uk/directory/profile.php?sjyoung

Dambusters expert Hugh Hunt featured on BBC radio and television

As the country commemorated the 70th anniversary of the daring Dambusters raid of World War II, Dr Hugh Hunt found himself interviewed on both radio and television.

Dr Hugh Hunt with Chris Evans

A senior lecturer in the Department of Engineering, Hugh's expertise and knowledge of the engineering complexity of the remarkable raid, which took place on the night of 16/17 May 1943, made him an ideal guest on a number of radio and television shows - most notably the Chris Evans Radio 2 *Breakfast Show* and the BBC 1 *The One Show*. As a guest on Radio 2, Hugh had to travel to RAF Scampton in Lincolnshire where Chris Evans was broadcasting his show.

Hugh said: "I met Chris Evans about 30 seconds before going on air. The music stopped and he started talking about our documentary and then he asked me a question. He stands very close! He pushed the microphone up to my face and I had to lean back – so the microphone came even closer. It was very intimate.

"The interview itself was so easy because Chris was well prepared and had really good questions to ask. It was like talking with a friend. It was all great fun.

"Later the same day, after coming back to Cambridge, I travelled down to the BBC studios in White City for *The One Show*. Alex Jones introduced herself and then said "you know Chris" as if we were old friends. We rehearsed for about 2 minutes and then at 7pm the show began!"

Hugh led the Cambridge team which recreated the famous bouncing bomb for the award-winning 2011 Channel 4 documentary, *Dambusters: Building The Bouncing Bomb*.

Later immortalised in the 1955 film, *The Dam Busters*, the raid sent Lancaster bombers to fly dangerously low over reservoirs in the strategically important Ruhr Valley. Under intense anti-aircraft fire, the crews dropped "bouncing" bombs, specially designed by the British engineer, Sir Barnes Neville Wallis. While the mission itself has gone down as one of the most iconic episodes in Britain's wartime story, of the 133 hand-picked air-crew in 1943, 53 lost their lives in the original Dambusters raid.

"Our pilots had no-one shooting at them, the engineers could use things like bowling machines to test their theories, and the whole thing was only at one third scale – and even then it was hard enough," commented Hugh. "You compare that with the original challenge – for Barnes Wallis and for the pilots – and you realise what an amazing achievement it was."

www.bbc.co.uk/programmes/p01952pm

Graduate Eva MacNamara wins IStructE Young Structural Engineer of the Year Award

Department graduate Eva MacNamara of Expedition Engineering has won the Young Structural Engineer of the Year Award for "The Dune Grass", her project which was a part of the recent regeneration of the Blackpool Promenade. James Engwall, also a Department graduate now of Price & Myers, was selected as a close runner up for his involvement in the Brockholes Visitor Centre project.

Eva graduated from Cambridge University in 2007 with a Master's Distinction in Civil, Structural and Environmental Engineering. She has since been working as a structural engineer; first with Atelier One for four years and then with Expedition Engineering since October 2011.

Eva's submission details the concept and application of the Dune Grass structures, whilst at Atelier One, which are 35m-high swaying "dune grass" blades, part of the overall 'People's Playground' concept, inspired by the notion of escapism. One of the main challenges Eva faced was designing the structures so that they moved about at low wind speeds while remaining stable at high wind speeds, something that a majority of similarly moving installations were not able to achieve.

The judges expressed particular commendation for Eva's submission in the following areas:

- How she had tackled a very unusual engineering task from first principles.
- Her understanding of wind engineering.
- Her use of models, tests and a prototype to develop the engineering of the sculptures.
- Her work was very well illustrated in her submission.
- How she promotes engineering as a career to schools and as a profession to a wide audience.

The Dune Grass masts (right) were successfully installed on Blackpool promenade in October 2011 creating an electrifying spectacle for promenade visitors and baffled engineers.

James Engwall graduated from the University of Cambridge in 2006 with an MEng (hons) in Engineering. After graduating, he was selected to work as a Structural Engineer at Price & Myers.

His submission was based on his role in developing a design and construction method for the Brockholes Visitor Centre, Preston.

His role in the project initially saw him researching how the Centre's proposed barn-shaped roof designs could be realised into full-sized ten-metre tall buildings. As the project developed, he took on the role of project engineer. The judges were particularly impressed by:

- The approach he adopted to the buildability of the floating pontoon including practical considerations of loading and floating.
- The elegant timber roof structure of the retail and exhibition buildings.

Winner: Eva MacNamara

What does receiving the award mean to you?
My entry for the award detailed my work on a rather unconventional large moving sculpture. I was delighted that the Institution honoured this kind of project for the fascinating, experimental piece of engineering it was. Winning the award validates my strong interest and development in designing structures which really communicate with people. Receiving the award has encouraged me to keep pushing and pursuing engineering solutions that are not always obvious; they sometimes require some kind of prototyping and often lead to something both unexpected and fantastic.

Why do you think it's important to recognise the work of young structural engineers?
It's incredibly important to recognise the work of young structural engineers. There are so many young engineers with a huge passion for what they do, but it often goes unrecognised as a smaller part of something much bigger. Having awards like this and running design competitions gives young engineers the confidence and encouragement to continue on through their careers until they reach their peaks much later on; it can be a long wait otherwise! Showcasing winning entries can be an inspiration to others as they realise that the work they do themselves could also be award winning. For those who have not set out on their career yet, seeing the work of young engineers recognised gives them something tangible to work towards that they can relate to more easily.

What attracted you to structural engineering as a profession?
I have always been interested in a career in structural engineering but my interests within it have evolved significantly over time. At a young age it was probably because I liked making things, particularly sandcastle

bridges with just the right sand wetness to keep them up and, as I got older, because I appreciated the satisfaction of designing something people use, look at and respond to. The reward of people enjoying something you've had a part in is priceless. As a person who constantly wants to learn new things, engineering couldn't be a better career. We are always developing through the incredible collaborators we work with, for example architects who share the vision and desire to do something better and different. I love the sense of tranquillity that comes with finding the right structural solution; if it looks beautiful, it is probably working the way it should.

Can you tell us about your career to date?
Since graduating in 2007 from Cambridge, I have been working as a structural engineer; first with Atelier One for four years and with Expedition Engineering since October 2011. I became chartered with the IStructE in 2012 and am currently on secondment to Costain to work on the London Bridge Station Redevelopment. My experience at Atelier One was extremely varied and challenged me to work on a number of projects where there was no previous precedent. This has meant that I have developed into an engineer who can design in many different materials, from my experience as the engineer on James May's Lego House with Lego, to a steel 120m gridshell arena roof in Slovenia with Sadar Vuga Architects through to a composite cross

laminated timber roof with FCB Studios saving 250 tonnes of steel. I have been able to put these skills to good use at Expedition Engineering and am now working on a three span tied arch footbridge which is technically complex due to its curvature on plan. We are the lead consultant on the bridge which means I have been able further to develop my skills in aesthetic engineering. I am also part of the team working on the concept and prototyping for a suspended monorail cycling transit system. My cross disciplinary expertise and familiarity with working with moving structures has been put to good use. As well as my project work I am dedicated to promoting the engineering profession to those selecting a career. I have presented in industry webinars, carry out talks at schools to encourage young people into engineering and tutor Bartlett students for their 5th year technical thesis. In March 2012 I was selected to be part of a panel giving oral evidence on higher education in STEM subjects to a subcommittee at the House of Lords.

Runner up: James Engwall

Why do you think it's important to recognise the work of young structural engineers?

The YSEOY Award showcases the potential of young structural engineers and also encourages others in the industry to reflect on the contribution they can make to their own projects. By drawing attention to the work of young engineers the Award also recognises the quality of the training and guidance they receive from their colleagues, mentors and the wider industry, promoting opportunities for personal success and achievement at any age.

What attracted you to structural engineering as a profession?

I've always enjoyed problem solving and building things and so for me, structural engineering is the perfect combination of both. It is an inventive and internationally recognised profession where you are regularly presented with complex challenges that require you to think beyond the boundaries of pure engineering, considering issues of sustainability, aesthetics and value. In addition, the skills you develop can be applied to a wide variety of situations. For example one day I can be in the office designing a reinforced concrete frame for a commercial development, the next day I can be investigating renovations on a listed building and on other days I can be working on community projects with an international development focus.

www.istructe.org

Smarter infrastructure

A team from the Centre for Smart Infrastructure and Construction have developed a mechanical amplifier to convert ambient vibrations into electricity more effectively, which could be used to power wireless sensors for monitoring the structural health of roads, bridges and tunnels.

STOPTHEGEARS, VIA FLICKR CREATIVE COMMONS

Undetected structural problems in ageing infrastructure can be disastrous, such as the recent incident in the busy Sasago tunnel west of Tokyo. Nine people were killed when huge chunks of concrete began to fall from the roof of the tunnel, starting a fire and trapping people in their vehicles. Thankfully, such incidents are rare, but the ability to determine when structural problems may become a threat to public safety is a major priority for government and industry.

The Centre for Smart Infrastructure and Construction (CSIC) was established in 2011 to develop and commercialise new technologies designed to make smart infrastructure possible, primarily through the development of new sensor and data management technologies, which will enable continuous monitoring of our roads, tunnels and bridges.

A new device designed by researchers in the CSIC could allow this type of observations by converting the vibration experienced by structures into electricity, in order to power small remote monitoring devices in locations where access is limited, such as inside a tunnel or underneath a bridge.

"Wireless sensors are one way to look after infrastructure better, and it's something that industry is interested in doing, but batteries are always the sticking point," 'says Professor Kenichi Soga, who designed the device with Dr Ashwin Seshia, Yu Jia (PhD student) and Dr Jize Yan. "It's not the cost of the batteries that is the issue; it's the cost of human power to replace the batteries."

Since the devices are self-powered, there is no need to have individuals change the batteries on a regular basis, thereby decreasing cost to industry while enabling continuous remote monitoring in order to detect problems at an early stage.

Self-powered battery-less devices are not an entirely new concept: other energy harvesting principles are used to power digital wristwatches and handheld torches. Existing devices based on vibrational energy harvesting suffer from two key technical limitations, however: low output power density, and the mismatch between the narrow operational frequency bandwidth of conventional energy harvesters and the wideband nature of vibrations experienced by bridges, tunnels and roads.

The device developed by the CSIC team addresses these issues by basing their harvester on a phenomenon known as parametric resonance. The energy harvesting device can be realised as a micro-electromechanical system (MEMS) device, consisting of a micro-cantilever structure and a transducer. When force is applied to the cantilever perpendicular to the length instead of transversely, parametric resonance can be achieved, generating more energy from the same amount of vibration.

The MEMS device provides the added advantage of using batch manufacturing principles common to the semiconductor industry, potentially enabling low-cost battery replacement, large-scale volume production and co-integration with sensors and interface electronics to realise truly autonomous smart sensor nodes: a challenge that the CSIC team are seeking to address in the context of developing innovative monitoring technologies for large-scale built infrastructure.

Prototype versions of MEMS and macro-scale devices based on these principles have demonstrated a significantly improved power output and a wider operational bandwidth relative to current state-of-the-art devices. Preliminary results on a MEMS prototype were presented at the PowerMEMS conference in Atlanta in December. The device is being commercialised by Cambridge Enterprise, the University's technology transfer office.

In addition to applications in the construction industry, the device also has potential applications such as powering wearable medical devices or extending the life of batteries in mobile phones.

CSIC brings together researchers from the Department of Engineering, along with colleagues from the Department of Architecture, the Computer Laboratory, the Judge Business School and Cambridge Enterprise.

www.centreforsmartinfrastructure.com

Former student wins New Civil Engineer's Graduate of the Year Award

Jamie Radford was named as the overall winner in the 2012 New Civil Engineer (NCE) Graduate Awards and is also the runner up of the Institution of Civil Engineers (ICE) Graduate and Student paper competition.

Jamie Radford, who graduated from the Department of Engineering in 2011 and is now working at Mott MacDonald, was named as the overall winner in the New Civil Engineer Graduate Awards. At the presentation lunch Jamie was handed a cheque for £1,500 and a trophy by BBC sports journalist Chris Hollins.

In addition to being the National Graduate of the Year, Jamie is also the runner up of the 2012 ICE Graduate and Student paper competition. His paper titled 'The characteristics of pit latrine sludge' was based on work he carried out for his final year project, working with the Department's Dr Dick Fenner to develop improved means of emptying pit latrines in dense urban areas in developing countries.

The paper is only part of the reason Jamie beat off 115 worldwide entrants to take the award. He was one of six finalists grilled by a panel of 17 senior directors from sponsoring companies. They were impressed with his experience and knowledge. This includes his term as president of the university's engineering society where he chaired a committee of 14, allocated a £30K budget and voiced the opinions of 1,000 undergraduates to university management boards. He is also credited with organising the largest volunteer-run careers fair in any UK university.

It was as co-president of the Cambridge branch of the student-run charity Engineers Without Borders that Jamie gained his exposure to developing countries. A two month trip to El Salvador resulted in the design of a sustainable wood burning stove, which could be built by local inhabitants. He then founded a research initiative into sustainable housing, a project involving 150 undergraduates, a dozen full time research academics and $190K in grants. He is currently seeking charity status for the whole scheme.

A two month expedition to Ecuador saw him identify six previously unknown butterfly species including one now named after him. Towards the end of his time at the Department of Engineering Jamie had notched up three major academic prizes and scholarships. But it is his work on latrine sludge that fires him most.

"We know nothing about the physical strength of faecal sludge and how it behaves while being pumped from village latrine pits," said Jamie. "Thousands of inefficient pumps result in filled-up toilets simply being abandoned leading to serious health hazards and shortages of valuable land for house building."

NCE MAGAZINE

Water Engineer Jamie Radford 24 (centre) has won top spot in the annual Graduate Awards run by New Civil Engineer (NCE) magazine.

Since graduating Jamie has continued to develop this work for Water for People by using a new approach to characterising sludge in pit latrines in Kampala, Uganda, to determine the ease with which individual pits can be emptied using various vacuum devices. He has been central to developing a Mott MacDonald proposal project which aims to develop devices capable of removing and processing faecal waste in a manner compatible with environmentally and socially acceptable standards. With Mott Macdonald's support Jamie has forged a reputation as a world authority on the subject and hopes it will lead to sustainable solutions that will positively benefit communities in the developing world.

www.waterforpeople.org

Academics honoured

Professors John Robertson, Phil Woodland and Nick Kingsbury from the Department of Engineering have been awarded fellowshipsof the Institute of Electrical and Electronics Engineers (IEEE).

IEEE is the world's largest professional association dedicated to advancing technological innovation and excellence for the benefit of humanity. Fellowships are awarded internationally to no more than 0.1% of the active IEEE membership each year.

The IEEE commended them as follows:

Professor John Robertson, of the Solid State Electronics and Nanoscale Science Group, for "contributions to the understanding of high-k gate dielectrics and metal gate electrodes for CMOS technology".

Professor Phil Woodland, of the Machine Intelligence Laboratory, for "contributions to large vocabulary speech recognition".

Professor Nick Kingsbury, of the Signal Processing and Communications Group, for "contributions to wavelet transform theory and filterbank design".

IEEE Fellow is a distinction reserved for select IEEE members whose extraordinary accomplishments in any of the IEEE fields of interest are deemed fitting of this prestigious grade elevation. The award is conferred by the Board of Directors upon a person with an extraordinary record of accomplishments in any of the IEEE fields of interest.

www-g.eng.cam.ac.uk/SSENS/links/ssens.php
mi.eng.cam.ac.uk/mi
www-sigproc.eng.cam.ac.uk

The future of flying

Aircraft that work together to solve complicated mathematical problems and airports with more flexibly used runways could be the future of flying, according to studies by the Department of Engineering and its industrial and academic partners.

Heathrow Airport

JOHN WOOD ON FLICKR

Air traffic across Europe is likely to almost double over the next 20 years. This estimated increase represents a remarkable number of flights when you consider that last year in the UK alone almost 2.2 million flights carrying 200 million passengers were handled by the National Air Traffic Services.

It also represents a massive challenge for UK aviation policy, which is faced with airports operating at near full capacity such as Heathrow - the busiest in the UK and one of the busiest in the world. Increased air traffic, rising fuel prices and tight security all combine to increase the vulnerability to system-wide breakdowns, delayed flights, long queues and rising costs.

Efforts to reduce pressure on overstretched airport facilities are being aided by research projects involving University of Cambridge engineers working with industrial and academic partners. Each project is aimed at tackling some of the uncertainties associated with air traffic, and the risks these pose to heavily loaded airports, when even a short delay finding a wheelchair for a passenger with reduced mobility can affect the tight workings of the airport.

One limiting factor in dealing with a vastly increased air traffic density is the workload falling on air traffic management (ATM). "Some of the technologies assisting ATM date from the 1950s," explained Professor Jan Maciejowski, who led the Department of Engineering component of a pan-European study, iFly. "We've been looking at how we can modernise and automate ATM to improve safety at the same time as reducing workload, costs and environmental impact."

The project, funded by the European Commission and coordinated by the National Aerospace Laboratory in the Netherlands, brought together 17 partners from academia and aerospace industries across Europe. Their mission was to develop an advanced airborne flight information system so that processes normally carried out on the ground by air traffic controllers can be carried out mid-flight by multiple aircraft requiring the same airspace.

"Essentially the idea is for the aircraft to use onboard computers to predict future positions of other aircraft and to dynamically share information," explained Professor Maciejowski, who worked on the project with PhD student Ellie Siva and colleagues at the Swiss Federal Institute of Technology Zürich and the National Technical University of Athens. "The computers communicate with each other, negotiating how best to use the airspace with least cost in terms of fuel and time."

The automated system enables different aircraft to solve complex mathematical optimisation problems between them – each one solving the problem for itself and then passing on its current solution and intentions to the next aircraft, which then responds, and so on. In a simulation of about 1,000 flights, the researchers found that this cooperative activity resulted in only a very small extra distance being flown (less than 1%) per aircraft. Ultimately, the hope is that if such a system came into operation, it would accommodate a three-to-six fold increase in current en-route traffic levels and be part of a System Wide Information Management 'database in the sky' proposed across Europe.

At the heart of the project is the discipline of control engineering. A recent programme grant awarded to the University of Cambridge and Imperial College London by the Engineering and Physical Sciences Research Council has assembled a team to push the boundaries of control engineering in relation to power systems and transportation. As part of this programme, Professor Maciejowski is looking at another aspect of air traffic control – the terminal manoeuvring area between the airport and 10,000 feet up.

Here, a very different scenario is in operation: many aircraft in a small space require coordination to land using the least amount of fuel, a situation too complicated to solve by aircraft communicating with each other. Professor Maciejowski and colleague Dr Alison Eele are creating a new mathematical system to optimise the landing trajectories of each plane. Their formulae use thousands of processors, now economically available as graphical processor units, to combine location measurements by radar, work out the flight plan for landing, give instructions and then recalculate every few seconds.

Meanwhile, the focus of Professor Duncan McFarlane's research is what happens on the ground. Working with Alan Thorne and other colleagues at the Department of Engineering's Institute for Manufacturing (IfM), the team is involved in trials conducted by BAA at Heathrow Airport on measures to increase punctuality, reduce delays and strengthen resilience at the UK's hub airport. The trials are centred on making the best use of the airport's two runways, which are in heavy demand.

In the first phase of the Operational Freedoms trial Heathrow explored how its runways and airspace can be better used to recover quickly following airport disruption, such as that caused by bad weather. One strategy was to use both runways for either arrivals or for departures, instead of one for each. Initial results indicated improvements in punctuality, reduced emissions and fewer planes having to taxi across runways. A second phase is now ongoing until March 2013 to carry out a more detailed analysis.

"The Civil Aviation Authority is overseeing the tests. Our role has been to independently audit the trial and ensure its objectives are met," explained Professor McFarlane. "We measure everything to do with the impact of

changes on the performance of the airport, from how long the aircraft are in overhead 'circulation stacks', to take-off delays, to emissions and noise, and then we generate what we think are appropriate recommendations."

A further study has also just started, this time examining the order of aircraft landing on runways. "A big aircraft creates a huge air turbulence behind it and small aircraft have to wait proportionally longer before landing," said McFarlane. "Flexible use of runways could mean landing larger aircraft on one and smaller on another, or ordering planes in overhead circulation stacks into optimal landing sequences. Using runways effectively could go a long way towards helping airport operations recover quickly and efficiently from unwanted variability."

The current studies build on a major aerospace programme at the IfM driven by the end users of the research – the aircraft manufacturers, airlines and airports. For instance, the researchers have previously examined how radio-frequency identification (RFID) technology and better data sharing in airports can reduce costs and achieve greater business efficiencies.

Many of the delays in airports occur as a result of bottlenecks in the sequence of activities that take place when an aircraft is at a gate between flights. Referred to as the turnaround process, the operation involves the coordination of activities such as baggage handling, refuelling, maintenance tasks and passenger transfer. Because the companies carrying out these tasks don't always share information, a breakdown somewhere along the line can cause a system-wide snarl-up.

Tiny electronic RFID tags can be used to provide visibility for different assets used in airport operations, such as bags, baggage containers and catering trolleys, which can then be fed back to computers used by the different service teams on the ground, allowing them to recognise and share problems quickly.

Working with airlines such as Easyjet and FlyBe, and Manchester, Luton and Heathrow Airports, the researchers looked at what causes delays and whether better information usage can improve aircraft turnaround time. "For example, one cause of aircraft delay can be the unavailability of a wheelchair to take a passenger to a flight. Something as simple as a strategy for locating and ensuring wheelchairs are in the right place at the right time can make a considerable difference to guarding against delays," commented Professor McFarlane. "What our aerospace programme is trying to do is quantify the risk and uncertainty associated with different disruptions, and then redesign and pilot robust practices that will eliminate unexpected delays or increased costs."

www.ifm.eng.cam.ac.uk
www-control.eng.cam.ac.uk

Meet the Schlumberger Foundation Faculty for the Future Fellows

Four talented female PhD students in the Department are some of the proud recipients of the Schlumberger Foundation Faculty for the Future fellowships for their PhD studies at Cambridge University. Three are in the Geotechnical and Geoenvironmental group and supervised by Dr Abir Al-Tabbaa. Maryam Masood is at the Department's Institute for Manufacturing and supervised by Dr Claire Barlow.

Rui Hao (left) Funmi Alayaki (centre) Tiffany Wang (right)

Maryam Masood

The Schlumberger Foundation Faculty for the Future fellowships are awarded to talented women in science and engineering from developing and emerging countries. They provide funding for their advanced graduate studies at top universities abroad. These awards are very competitive, include an interview process, and are awarded to women who have excelled academically and who are potential role models for other women in science and engineering.

Funmi Alayaki won scholarships to study Civil Engineering at the University of Lagos followed by a masters degree in Highway and Traffic Engineering. She worked as a road engineer for six years and then as an academic at the Federal University of Agriculture Abeokuta for another six years. She is a registered member of COREN, a corporate member of Nigeria Society of Engineers (NSE) and the Association of Professional Women Engineers of Nigeria (APWEN). Her PhD study, which started in October 2011 through the Faculty for the Future fellowship, is related to the development of ground improvement techniques for the difficult soils in the Niger Delta area of Nigeria. Her work involves both laboratory and field testing.

Tiffany Wang obtained a BEng in Environmental Engineering from the University of Yangzhou in China, with prizes, followed by a masters degree at Hong Kong University of Science and Technology. Her PhD project involves the assessment of the long-term performance of cement-treated contaminated soils from two field trials. One was at West Drayton near Heathrow airport, completed in 1996 and the other was in Castleford, Yorkshire, completed in 2011 as part of the TSB-funded project SMiRT.

Rui Hao obtained a BEng in Environmental Engineering from the University of Nottingham as part of their 2+2 course (first two years in their China Ningbo Campus) and was top of her class throughout. Her PhD project is on the use of reject brines to sequester CO^2 for the production of low carbon construction materials.

Maryam Masood obtained a BSc in Mechanical Engineering from the University of Engineering and Technology, Lahore, Pakistan. She then went on to obtain a masters degree in sustainable energy systems from Queen Mary College, University of London. She has also been involved in teaching at the University of Engineering and Technology, Pakistan for one year. Her PhD project is on the analysis of the current solid waste management systems in Pakistan with a focus on quantifying the role of informal networks in the solid waste management systems.

In collaboration with Cambridge University, Schlumberger hosted their Fellows Regional Forum this year at the Moller Centre on 20-22 May. The aim of these forums is to bring these women together in small groups to help strengthen their academic and scientific networks and further develop their leadership skills. The forum consisted of keynote lectures, workshops and poster sessions. Dr Al-Tabbaa was invited to speak to the delegates on the "Contrast between Engineering Academia and Engineering Practice."

The program's long-term goal is to generate conditions that result in more women pursuing academic careers in scientific disciplines. Grant recipients are expected to return to their home countries to continue their academic careers and inspire other young women to choose careers in science and engineering. Since its launch in 2004, 323 women from 63 emerging countries have received such fellowships.

www.facultyforthefuture.net

Alumnus Eben Upton, Co-Founder of Raspberry Pi, has been awarded a Silver Medal from the Royal Academy of Engineering

Alumnus Eben Upton is co-founder of The Raspberry Pi Foundation (below), a charity founded in 2009 to promote the study of basic computer science in schools, and is responsible for developing a single-board computer called the Raspberry Pi.

Eben is one of four entrepreneurs who have been awarded a Silver Medal from the Royal Academy of Engineering. He has sold more than a million units of his cheap, credit card-sized computer. The medal marks "significant commercial success" achieved by those who have also "advanced the cause" of British engineering.

Eben developed the Raspberry Pi computer to help children learn about computer programming and inspire a new generation of engineering talent. He was inspired by Acorn's BBC Micro computer, which helped students and hobbyists learn about computers in the 1980s.

Proceeds from sales of the Cambridge-developed Raspberry Pi computer – which retails for as little as $25 (£16.26) – go to the Raspberry Pi Foundation. The introduction of the computer in February last year was met with such strong demand that the organisation's website crashed.

The Raspberry Pi has won fans far beyond the classroom, with uses including a controller for a robotic boat which is steering itself across the Atlantic Ocean, and powering cameras designed to help park rangers to prevent illegal poaching in Kenya.

The Raspberry Pi computer is on a tiny circuit board and has one or two USB ports on one end to plug into a keyboard and mouse and a connection for a TV on the other end. The result is a working computer running a Linux operating system at very little cost, and a device that that has been designed to encourage users to tinker around with the components.

Eben started his undergraduate life at Cambridge as a Physicist then moved across to the Department of Engineering in his third year to join the Electrical and Information Sciences Tripos, with his focus very much on computing. Part way through his third year in 1998 he started a computer graphics company, Ideaworks, and as the company quickly became a success Eben deferred his studies for a year. He returned to Cambridge to do a post graduate Diploma of Computer Science. From the Diploma he went straight onto a PhD at Cambridge's Computer Lab, carrying out research into optimizing compilers for the C programming language.

"The Royal Academy of Engineering celebrates the strength and diversity of UK engineering with the presentation of its coveted Silver Medal - winners must have achieved significant commercial success in their fields and be recognised for advancing the cause of engineering in this country"
Royal Academy of Engineering citation

After his PhD Eben worked briefly for a small company in Newmarket that made low voltage motor controllers for golf buggies etc. This is where he really discovered electronics. He went on to join Broadcom Corporation, a global leader in semiconductor solutions for wired and wireless communications. During the last year of his PhD and his first year at Broadcom Eben took on the post of Director of Studies for St John's College. It was whilst interviewing potential undergraduates that he realised there was a huge skills shortage in those applying for Computer Science. He noticed that past applicants who had started programming on their Commodore 64s, Amigas and BBC Micro Computers of years gone by were much better versed in computer science than the Windows generation who were taught basic computer literacy and not pushed to learn to code. Huge drops in the numbers of applicants supported his theory that schools were not doing enough to encourage programming. He recognised that children need a platform to learn to program; by 2010 he had created a chip suitable for this purpose, BCM2835, which is now used in the Raspberry Pi.

Today a Raspberry Pi can be purchased and delivered for under £20 and they can also be purchased bundled with educational software. Raspberry Pi computers can talk to each other and to electronic sensors, lights etc which is not something that a PC can typically do out of the box. As the Raspberry Pi market has grown it has become clear that the bulk of the community are adults, programmers and hobbyists. Approximately 20% to 30% are children which means that Raspberry Pi has potentially reached 200,000/300,000 children.

Computer Science application numbers at Cambridge were up by 30% last year and although Eben does not claim this is the result of Raspberry Pi he does believe that the Raspberry Pi Foundation has helped to create a lot of noise about computer science and has been an excellent awareness-raising tool.

Eben is very conscious that the majority of Raspberry Pi computers being used by children are the children of engineers in the prosperous western world. The foundation's remit is to broaden this audience to reach children from all backgrounds and geographical areas. In order to achieve this the Foundation is focusing on producing support materials that will enable children to be able to pick up a Raspberry Pi computer and, by self-directed learning, teach themselves programming and understand how computers work.

www.raspberrypi.org

Cambridge extends MIT exchange partnership

An extension to the University of Cambridge's exchange programme with the Massachusetts Institute of Technology has been announced, enabling more undergraduates to study at "both" Cambridges during their degree.

PHIL BALL/PANDIS

Andy Leonard, Vice President BP Cambridge, with some of the first BP supported Cambridge-MIT exchange students at the launch of the extension of the programme to non-Engineers from Cambridge University.

Originally set up in 2000, the Cambridge-MIT exchange programme has to date enabled more than 300 Cambridge students to benefit from a chance to study in the United States as part of their undergraduate course. In the last two academic years, generous funding from BP has allowed more than 30 students, most of them from the Department of Engineering, to take part.

"The students who have been on this exchange have all benefited greatly from the adventure, often returning to lead new University activities and going on to flourish in industry and research."
Peter Long

Now, BP has given further funding to the University which will enable more students to participate. The arrangements will mean that places are open to students from Chemical Engineering, Chemistry, Computer Sciences, Mathematics and Physics as well. In total a further 18 places on the programme will be funded over the course of the next three years.

Those who have been on the exchange have typically found it a life-changing experience. One graduate reported back: "My year at MIT was long, challenging and full of by far the most rewarding experiences of my life. From the range of fascinating and varied courses I took to the unbelievable friends I made, every aspect of the exchange scored a massive success. If I had to pick one standout feature, it would be that as a structural engineer I really appreciated the chance to interact intimately with other disciplines in cross-over classes at both MIT and Harvard."

Another wrote: "The experience taught me not only the joy of teamwork, but also gave me a chance to meet engineers from across the US, and beyond."

Dr Peter Long, from the University's Department of Engineering, said: "The students who have been on this exchange have all benefited greatly from the adventure, often returning to lead new University activities and going on to flourish in industry and research."

"The extension of the scope of the programme beyond the Engineering core will strengthen the exchange and further enable students to take advantage of the breadth of subjects in the two Universities. We hope that this is just a sign of things to come and that in the future it will be possible to extend the exchange programme again, taking it beyond the physical sciences."

www.eng.cam.ac.uk/DesignOffice/cme/2012/index.html

Legoline: An innovation in the teaching of systems engineering

With support from the Royal Academy of Engineering, the Cambridge Engineering Design Centre (EDC) has developed a new Graduate module in Systems Engineering, combining informal talks on a wide range of practical issues with hands-on sessions investigating the design of a pallet handling line.

Simple calculations, Discrete Event Simulation (DES) and a Lego Mindstorms model – "Legoline" – are all used to illustrate the challenges faced by engineers designing real-life systems.

The module is led by Tony Purnell, the former principal of the Jaguar and Red Bull Formula One teams and Academy Visiting Professor in Integrated System Design, Professor John Clarkson, Director of the EDC, and Drs David Delamore and Alexander Komashie. The Integrated Systems Design, was first delivered to 1st year graduate students in the Department during the Lent term of 2012.

Legoline was developed in 2010 by undergraduate Konrad Newton in his final year MEng project. It was subsequently upgraded by David and Alexander. Then, in the summer of 2012, it was radically improved by Tom Neat and Nikki Phoolchund, both final year students in the Department, as part of the national Undergraduate Research Opportunities Program.

Spin-off company Cambustion celebrate 25 years at the forefront of global engine emissions research

Staff at the Department of Engineering spin-off company Cambustion have celebrated 25 years at the forefront of global engine emissions research.

In the late 1980s the drive to improve air quality placed increasing scrutiny on vehicle emissions. A tea room conversation between the Department's Nick Collings and Rex Britter led to the timely development of an analyser capable of measuring hydrocarbon emissions from a running engine on a cycle-by-cycle basis, where previous measurements had been on a timescale of several seconds. This allowed Nick and his team – Nigel Baker, Steve Dinsdale, Tim Hands, Steve Montgomery and John Willey – to investigate the emissions performance of engines in unprecedented detail. Early collaboration and joint publications with the Ford Motor Company followed. Realising that the analyser had commercial prospects, the research group formed Cambustion to bring to market a fully developed system.

"Vehicle emissions are a global problem, and Cambustion's products have been sold in 26 countries around the world, where they are used for both fundamental combustion research in universities and to improve the emissions performance of engines by vehicle manufacturers. "

Seeking somewhere to set up the business, Cambustion became the first tenants of the St John's Innovation Centre, although a subsequent move closer to the Department saw the company occupy a house on Portugal Place in the very centre of Cambridge.

Running a manufacturing company from a terraced house with no vehicle access turned out not to be totally straightforward (although it did have its advantages), but a move to more conventional office space in the mid 1990s saw the company placed to expand. The rise of the Internet and email made it viable to support customers using Cambustion's unique products abroad. These days the fax machine is virtually redundant. Now one of the company's most effective marketing tools is an online list of the technical publications produced by researchers using Cambustion products and published in journals around the world.

CAMBUSTION

Cambustion's fast response particle analyser is used in the development of cleaner engines

Since then Cambustion has continued to develop new emissions analysers, including sensors for hydrocarbons, oxides of nitrogen, carbon monoxide/dioxide and particulates. Vehicle emissions legislation first introduced across Europe in 1992 limits the permissible levels of these emissions and subsequent legislation has seen permissible levels steadily reduce, bringing air quality benefits to all.

Having developed the tools, Cambustion were faced with the challenge of convincing others of the value of the data produced. The logical step was to undertake consulting work, initially renting engine dynamometer facilities at the Department of Engineering, and then building four high-tech engine test cells at their headquarters on Cherry Hinton Road in Cambridge. The consultancy business turned out to be much more than a marketing tool and continues to expand, with plans already well underway to build further test cells during 2012.

The strong links with the University have also provided Cambustion with a steady pool of talent: a large proportion of the employees studied at the University.

Vehicle emissions are a global problem, and Cambustion's products have been sold in 26 countries around the world, where they are used for both fundamental combustion research in universities and to improve the emissions performance of engines by vehicle manufacturers. The link between industry and university customers has proved particularly valuable to Cambustion, since students exposed to Cambustion's products during their research often go on to do similar work in industry, bringing with them their knowledge and experience of what Cambustion can offer. Together with repeat sales into traditional markets such as the USA, Europe and Japan, recent years have seen an expansion into China with a local office, and many sales to Chinese universities.

In 2012 Cambustion's latest product for measuring ultrafine aerosol particle mass was launched. The main application of this product lies outside traditional automotive R&D and is already generating great interest in the atmospheric aerosol community with sales to China, Europe, Japan and the US. Cambustion's large and ever expanding R&D team continue to develop new products for gas and particle measurement.

www.cambustion.com