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DEPARTMENT OF ENGINEERING

NEWS

UNIVERSITY OF CAMBRIDGE

In this issue

Cover image: Dr Jenni Sidey, one of the Canadian Space Agency's new astronauts. Credit: Canadian Space Agency.

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Welcome

I'm delighted to share with you the news that the Department has been awarded Silver in the prestigious Athena SWAN scheme.

This is in recognition of the positive steps which we are taking to promote and support diversity in engineering. You can read all about it on p11.

Poor awareness about the nature, creativity and societal relevance of engineering is one of the main challenges to diversity, which means that many promising students, especially women, are not encouraged to consider engineering. This is why improving the UK public perception of engineering is one of the central objectives of the Department's Engineering Diversity initiative.

Call for alumni profiles

To support this initiative, we are publishing profiles of our alumni on the Department's Engineering Diversity website, to help inspire potential applicants and demonstrate the exciting range of careers available to those who choose to study engineering. These profiles will complement our collection of staff and student profiles which we are continuing to build upon.

We are particularly keen to hear from women and members of groups which are currently under-represented in engineering. If you would like to be a part of our profile series, please answer the following questions as a starting point:

- Background – how did you get into engineering?
- What are you doing now and what are your plans for the future?
- What motivates/interests you?
- What has helped your career?
- How have you overcome challenges/knockbacks in your career?
- How have you managed to balance family life/other interests with your career?
- Do you have any advice for those who are considering studying/pursuing a career in engineering?

Please email your profiles, together with photos which you would be happy for us to use, to engineering-diversity@eng.cam.ac.uk.

Student voices

During 2017-8, we will also launch a student ambassador programme to promote engineering directly to school children and their advisors. We will publish video clips of our students talking about their experiences and backgrounds on the Department's social media and website.

For more information, you can read the Department's full submission and action plan for the Athena SWAN Silver Award by visiting www-engineeringdiversity.eng.cam.ac.uk

Professor David Cardwell FREng

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Cambridge appoints new Professor of Innovation

Dr Tim Minshall has been appointed as the inaugural Dr John C Taylor Professor of Innovation at the University of Cambridge, a new post that will build on the University's strengths in science, engineering and entrepreneurship.

Prior to joining Cambridge's Institute for Manufacturing (IfM) in 2002, Dr Minshall worked as a manager and then a director of the St John's Innovation Centre – one of Europe's most successful incubators for technology-based start-ups. Since joining the University, he has played a very active role in the development of innovation and technology management activities throughout the University. He also works closely with companies in the Cambridge cluster, the largest and most successful technology cluster in Europe. He has been involved in a broad range of regional and national policy activities to support innovation.

"This professorship presents an extraordinary opportunity to address how we define and develop the innovation skills and capabilities of engineers so they can address economic and social needs: a challenge that has become critical for the UK given the current global economic and political context," said Dr Minshall.

In addition to his research in technology and innovation management, Dr Minshall is also a committed teacher and supporter of engineering outreach to the public. He teaches undergraduate and postgraduate students at the University, runs outreach programmes with local schools, and mentors students and researchers to develop their public engagement skills. "The development of future engineers is at the heart of my work," he said.

In his new role, Dr Minshall will continue to build on his strengths in innovation and technology management, both in the University and in the UK more broadly.

"The UK has long been superb at invention – the creation of new ideas – but we need to develop a generation of engineers able to create and capture value from these new ideas, and provide these innovators with the capabilities to respond to future challenges and opportunities throughout their careers," he said. "This requires us to take a much more joined-up, long term view of technology, management and policy issues."

"We're working very hard to make sure that we end up with technologies that change the way the world works," said Professor Andy Neely, Pro-Vice-Chancellor for Enterprise and Business Relations.

The new professorship has been made possible thanks to a generous donation of £2.5million from Dr John C Taylor OBE, one of the most successful British inventors of the last 50 years.

"You've got to have people who move the world forward: innovation is essential to trade, industry and the economy," said Dr Taylor. "I trust that the new professor of innovation will help people actually create and do things that will improve the world. The British are renowned for their creativity but all too often their invention is commercialised by other countries."

Having continued to innovate throughout his life, Dr Taylor now has over 400 patents to his name. In 2008, he created and donated to his former college the popular Corpus Chronophage Clock, positioned outside the Taylor Library at Corpus Christi College, Cambridge, which has now become one of the city's most popular tourist attractions.

Credit: www.johnctaylor.com

↑ (L-R): Dr John C Taylor, Dr Tim Minshall, Professor Andy Neely.

The new professorship, which has been endowed in perpetuity, will combine teaching and research to ensure young engineers combine innovation with practicality when approaching design.

Professor David Cardwell, Head of the Department of Engineering, said: "We are extremely grateful for this generous benefaction from Dr John C Taylor and honoured that this professorship will not only bear the name of such a distinguished inventor and engineer, but will help future generations to follow in his footsteps."

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

Postgraduate makes the Telegraph's 'Top 50 Women in Engineering' list

Nikita Hari, who is pursuing a PhD in Electrical Engineering, becomes the first University of Cambridge student and Indian citizen to make the Telegraph's 'Top 50 Women in Engineering' list.

Compiled by the Telegraph in collaboration with the Women's Engineering Society (WES), the list features the UK's top rising female stars of engineering. This year's list focused on women aged 35 and under — to highlight and encourage them to become future leaders in the industry.

Nikita, who is undertaking her PhD at Churchill College, focuses on making systems called 'Power Electronic Converters' with novel devices called 'GaN', which can efficiently convert and conserve power. 'Gallium Nitride' devices (2014 Nobel prize) have the potential to jump-start the next generation of smaller, faster, lighter, cheaper and more efficient power converters — helping to create a more sustainable energy future by meeting the world's ever increasing energy demands along with energy savings.

Nikita was also shortlisted as a 'Forbes 30 under 30 UK Finalist' and 'Hult Prize Finalist' earlier in the year.

Nikita said: "I'm incredibly honoured and humbled to be featured in the Telegraph's 'Top 50 Women in Engineering' list in the amazing company of top women engineers in the UK.

"It's a matter of pride for me personally to be on this list. Coming from a conventional background and a developing country like India, I've had to break glass ceilings and shatter many stereotypes to get to where I am now.

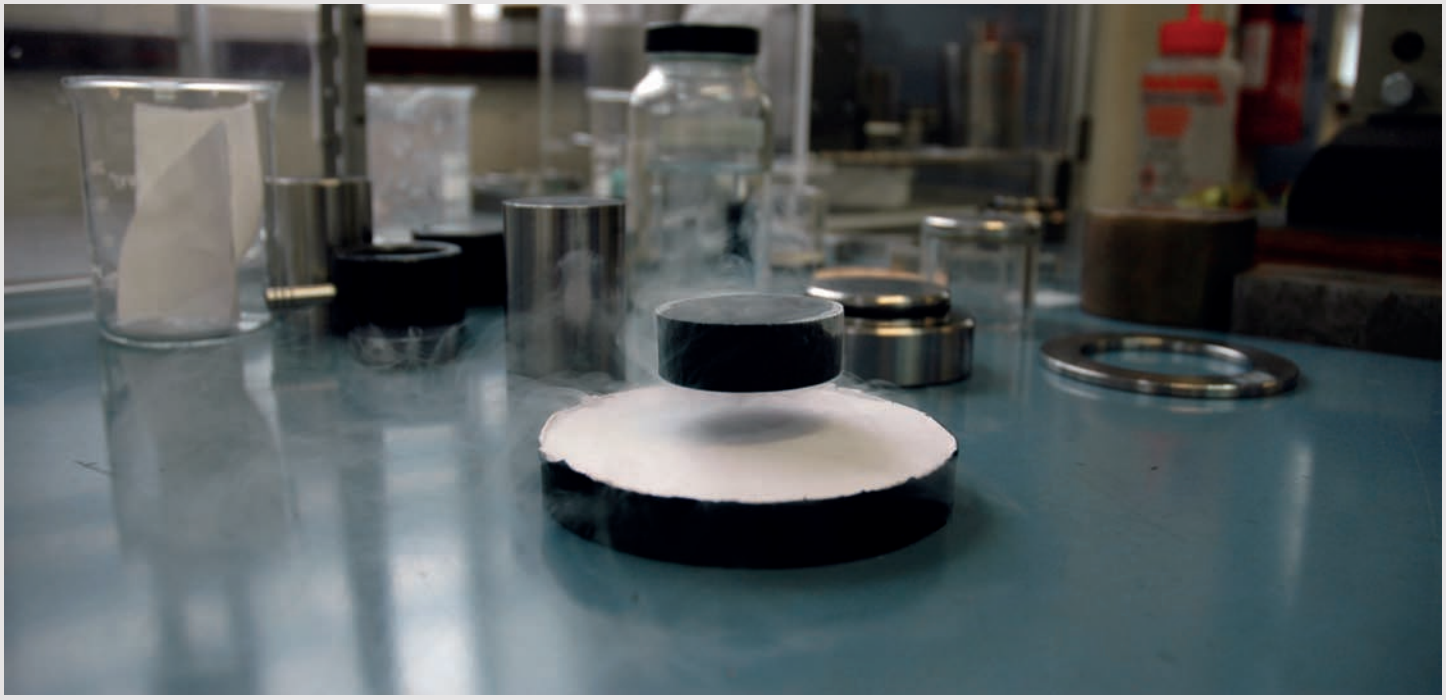
"I firmly believe that whatever your gender or socio-economic political background, you should find your way, and that self-motivation through my experience and my circumstances have brought me to where I am today."

Nikita is now committed to encouraging others, especially young women and girls to pursue their dreams. Her vision to uplift society through education and technology has seen her become Co-founder of two social tech start-ups: Wudi and Favalley.

> "It's a matter of pride for me personally to be on this list. Coming from a conventional background and a developing country like India, I've had to break glass ceilings and shatter many stereotypes to get to where I am now.
>
> Nikita Hari, PhD Electrical Engineering

www.eng.cam.ac.uk/profiles/nh416

Watch Nikita's reaction to making the list: youtu.be/ufbOyg1hlGA



↑ A bulk superconductor levitated by a permanent magnet

Novel superconductor acts as portable permanent magnet

A team led by Dr John Durrell, University Lecturer in the Bulk Superconductivity Group, has demonstrated a portable superconducting magnetic system that can act as a high-performance substitute for a conventional permanent magnet and can attain a 3-tesla level for the magnetic field.

Durrell said his team's work in large part evolved from the innovative findings of University of Houston physicist Roy Weinstein, who has shown how conventional electromagnets and pulsed field magnetisation can be used to activate superconducting magnetic fields which are 'captured' and sustained as part of a superconductive arrangement. This avoids the requirement for large expensive superconducting magnets to 'activate' such portable systems. Also key, Durrell pointed out, is that his team capitalised on other new and cheaper technologies, especially for cooling.

"The leap with advances in cryogenics, allows you to do interesting things in other areas, too," Durrell explained. "There is a lot coming together to make this possible." While large industrial-size superconducting systems do generate a 20-tesla magnetic field, Durrell's 3-tesla magnetic field is new for a portable system.

Durrell and his team were curious about what they could do as they looked at Weinstein's work just a few years earlier. Weinstein demonstrated that with conventional external electromagnetic pulsing of a medium, it was possible to 'capture' a magnetic field in a superconductor using a much smaller external magnetic field than previously thought possible. The Weinstein investigation used yttrium barium copper oxide (YBCO) doped with uranium and subject to an irradiation treatment. Durrell's team looked for a less expensive material and chose gadolinium barium cuprate, without uranium doping.

Difan Zhou, team investigator and lead author of the paper, came up with the idea of extending Weinstein's findings and the research, which took just short of two years to do, has paid off.

"It was a surprise to us that we managed to see in a not-quite-so-cutting-edge-material the same giant flux leap effect as Roy Weinstein demonstrated," Durrell said. "The key thing that made this possible is that we have looked at what Roy has done to get it to work but for this kind of portable system. Before we were using conventional superconducting magnets to charge our bulks. This will make access to these high fields cheaper and more practical."

Advances in cheaper, more efficient cooling – the cryogenic system – were also key for Durrell and the team's research. For both the magnetic field charging and sustaining phases, it is necessary to keep the superconducting sample cool or else the superconductivity gives out. Recently, the private sector has come up with cryogenic systems that are cheap and light, and Durrell used a cooling system from US firm Sunpower. According to Durrell, this lightness and relative low cost could make portable superconductivity in various products a real possibility.

Durrell and his team are planning for more testing for more magnetic power and overall efficiency. They have received significant support from Boeing for this investigation, and Durrell feels it is a strong example of what a company and an academic lab can do when they team up for basic research.

www.eng.cam.ac.uk/profiles/jhd25
bulk-sucon.eng.cam.ac.uk

How Cambridge research helped revolutionise suspension systems in motorsport

Academics from around the world descended upon the University of Cambridge for a special workshop held in honour of Professor Malcolm Smith's contribution to control systems.

Hosted by Gonville & Caius College in celebration of Professor Smith's 60th birthday, the Workshop on Networks and Control was organised by the Department of Engineering and sponsored by McLaren. It included presentations from Cambridge academics, former students, as well as experts from universities in Japan, the United States and Germany.

Malcolm Smith, Professor in Control Engineering and a Fellow of Caius, is well known for his invention of a vehicle suspension device called an inerter, which is now a standard component in Formula 1 suspensions and widely used in motorsport.

Revealed at the workshop was Professor Smith's contributions to a technology which has been utilised in the latest McLaren supercar – the 720S. The suspension system is termed 'semi-active' since it makes use of continuously adjustable dampers which are controlled by a computer in real time. The system employs a new algorithm, which Professor Smith developed with his former PhD student Dr Panos Brezas. In honour of his birthday, the McLaren 720S was displayed at the College during the workshop.

Although semi-active systems are not new in themselves, the algorithm developed by the pair has achieved a big step forward in performance by simultaneously optimising the car's ride and handling response. The ride behaviour is the car's response to undulations in the road, whereas the handling behaviour is the response to driver inputs such as steering, accelerating and braking.

Professor Smith said:"When Panos began his PhD under my supervision back in 2008, we looked carefully, in collaboration with our sponsor McLaren, at the problem of controlling the car under arbitrary and simultaneous excitation from both types of exogenous inputs: road undulations and driver inputs. The inputs have different character, and affect the vehicle in different ways. We modelled the road inputs stochastically and the driver inputs deterministically.

The challenge

"The most difficult part of the control problem is that the control input (the adjustable damper rate) enters the problem non-linearly. Nevertheless, we did succeed in deriving a control law for a suitable performance criterion that incorporated all the important attributes: body accelerations, tyre forces etc.

"The next challenge arose because our algorithm relied on 'state feedback', but not all components of the car's state are directly measurable. An observer of special type had to be developed to take account of the two types of disturbance on the vehicle.

"We were very fortunate to work with a former Cambridge PhD student Dr Will Hoult (who was supervised by Dr David Cole) who took charge of the algorithm development at McLaren.

The solution

"It took a number of years of effort working on prototype vehicles and subsequent road testing in order to get to the stage when the algorithm was finally ready for a production vehicle. British auto racing driver Chris Goodwin, who is currently Chief Test Driver for McLaren Automotive, was the one who got to test the car and the simulation results from the beginning were very positive – we knew we were on to a winner!

"The 720S was also tested by McLaren in a wide range of motoring conditions, ranging from Death Valley and the snows of Colorado and the Alps to a bumpy roundabout near Woking. The roundabout offered a combination of demanding handling and an uneven road surface, permitting testing of the algorithm's ability to find a balance between comfort and control."

www.eng.cam.ac.uk/profiles/mcs1000
www-control.eng.cam.ac.uk/Main/Workshop9

Watch the McLaren 720S in action:
youtu.be/Z5haBAzgp7Y

ALUMNI UPDATE

Alumnus wins Royal Academy of Engineering's Silver Medal

Alumnus Billy Boyle, Founder and CEO of Owlstone Medical, a diagnostics company developing a breathalyser for disease, has been awarded the Royal Academy of Engineering's prestigious Silver Medal.

The award recognises engineer Billy's work in spearheading the development of the company's Breath Biopsy platform and driving a vision to save 100,000 lives and $1.5 billion in healthcare costs.

Established in 1994, the Royal Academy of Engineering's Silver Medal acknowledges outstanding and demonstrated personal contribution to British engineering which has resulted in successful market exploitation. Billy's pioneering work has been recognised when he received the Royal Academy of Engineering's prestigious Silver Medal on Thursday June 29 at the Academy Awards dinner in London.

Initially developed for military applications, the Owlstone technology is a miniature chemical sensor on a silicon chip, based on a technique called Field Asymmetric Ion Mobility Spectrometry (FAIMS). Spun out of Cambridge University in 2004, Owlstone Inc. grew into a profitable business, winning >$25 million in defense contracts, and providing FAIMS technology for a range of military and industrial applications globally.

The last year has been transformational for Owlstone Medical; having spun out from its parent company Owlstone Inc. in March 2016, the company has raised $23.5 million, including investment from Aviva Ventures, the venture capital arm of global insurance firm Aviva, validating the importance of the technology for the future development of healthcare. As CEO, Billy leads a team of 88 scientists and engineers based on the Cambridge Science Park.

Owlstone Medical is running breath based trials for early detection of lung and colorectal cancer, two of the most common cancer killers worldwide. Half the population will get cancer at some point in their lives but early detection can dramatically improve survival rates. If detected early over half of lung cancer patients and 93% of colon cancer patients can be cured with treatments that exist today.

Working with clinical and pharmaceutical partners, Billy has demonstrated the diagnostic power of FAIMS across a range of infectious and inflammatory diseases as well as different types of cancer. In 2015 he led a project that resulted in the LuCID trial, a 3,000 patient study looking to develop a cancer breathalyser for early stage lung cancer detection, supported by a £1.1 million NHS contract.

Owlstone Medical's Breath Biopsy platform is highly sensitive and selective, and has the potential to revolutionise early detection and precision medicine where treatment can be tailored to the individual patient. With the world's largest breath-based clinical trials, Billy and his team are pioneering the field of breath biomarkers, demonstrating how they can get the right treatment, to the right patient, at the right time, ultimately reducing treatment costs and saving lives.

Billy Boyle says: "Every time you breathe out there are thousands of chemicals on your breath; some are tell-tale markers of disease, which our Breath Biopsy platform is able to detect. Our vision is to change the way we currently diagnose and monitor serious disease; we aim to be become the global leader in the non-invasive early detection and precision medicine for cancer, infectious disease and inflammatory disease."

www.owlstonemedical.com
www.raeng.org.uk

Microfluidic-based cell culture: is it fit for purpose?

↑ Research students Ye Liu and Lizzie Gill can be seen imaging living human cells in a thumb-sized microfluidic chip under a light microscope

Bioscientist attitudes towards the future of microfluidics-based 3D culture technology and the search for their 'ideal' model have been revealed in a new research survey conducted by the Department of Engineering.

Organ-on-a-chip and vasculature-on-a-chip are examples of microfluidics-based 3D cell/tissue culture models which are created with microchip manufacturing methods that arrange living cells to simulate tissues and organs.

But a new research survey from the point of view of the end users – the biomedical community (including industrial scientists)[1] – has shown that a 'significant gap' exists between the desired systems and the existing 3D culture options.

The research, led by Dr Yan Yan Shery Huang, Lecturer in Bioengineering, revealed that those surveyed (42) had expressed concern that the reliability, functionality and validation of engineered tissues may prevent the uptake of new cell culture technologies, but that these obstacles should be overcome by future 3D models.

Microfluidics often require specific training, 'in-house recipes' and can involve complicated external setups such as syringe pumps. The challenge, therefore, lies in simplifying user operation, while ensuring that future microfluidics continue to create possibilities for tissue engineering and next generation drug testing.

When questioned about their usage of 3D culture systems, such as microfluidic chips, the majority of the researchers surveyed did not have previous experience (only 7.1% were familiar with this technique). However, 85.7% of the researchers expressed a clear interest in adopting microfluidic culture, either performing it by themselves (50%) or with collaborators (35.7%).

But the more complex the system, the greater the time needed for system installation and associated training needs. Of the researchers surveyed, 61.9% indicated they would like to see the completion of the preliminary training and setting up of a 3D culture platform within four weeks.

The survey showed that advanced-career researchers (18 out of 42), with more than seven years of experience in their fields, have higher expectations for the complexity, physiological relevance of a 3D culture system, and expressed interest in customisable products.

Dr Huang and her co-authors Elisabeth Gill and Ye Liu believe this stark contrast with the preferences of early-career researchers, points to the need for greater consideration in the design and marketing of 3D culture systems.

"Interesting microfluidic models have been engineered, such as organ- and vasculature-on-a-chip, but microfluidics are not without their weaknesses. Our survey is a first example to take a look at the potential use of microfluidic cell culture technology among biomedical researchers, at a time when there is a clear drive towards more predictive models based on human derived cells rather than animal tests. This is because the latter are not suited as a reference model for validation.

"We hope that the results of our survey can be used as a type of 'quality check' with regards to the functionality of 3D culture options and as a means of encouraging standardisation to be a pathway for regulatory change.

"In order to achieve the ideal 3D culture model and broader uptake, we believe a more 'killer application' may need to be showcased; one which achieves the level of 'baseline' complexity that the biomedical researchers desire, as well as improved system reproducibility, functionality and user friendliness. Any hesitation to do so may be a hurdle for new culture systems to be accepted as valuable tools for fundamental biomedical research and drug screening in an industrial context."

1 A total of 42 researchers completed the questionnaire. They include 15 research group leaders, 24 lab-based researchers and three industrial scientists. Their research covers areas including cancer, neuroscience, stem cell, toxicology, endocrinology and ageing.

→ www.eng.cam.ac.uk/profiles/yysh2

→ Students from Wimbledon High School at the British Paediatric Respiratory Society conference

Credit: Lloyd Mann

Student-led designs could help prevent childhood asthma deaths

Solutions designed by secondary school students as part of an innovative classroom design and technology programme could help reduce the number of unnecessary deaths from childhood asthma.

The programme, called Designing Our Tomorrow, was founded by researchers at the University of Cambridge, and brings real-world problems into classroom design and technology sessions in secondary schools, and encouraging the next generation of UK designers and engineers.

As part of their classroom curriculum, students from different secondary schools have been learning about what makes an effective and useful design. Their goal was to design a type of packaging which would contain everything a young child with asthma would need, whether they're at home, at school or elsewhere; and one which would help reduce anxiety of children with asthma by using child-friendly design themes.

"In other words, we want to make it fun," said Ian Hosking of Cambridge's Department of Engineering, who co-leads the Designing Our Tomorrow (DOT) programme, in collaboration with the Faculty of Education. "We want to re-frame what education can be – projects like these start to form a broader evidence base of what's possible."

Five of the best designs were presented by students from Wimbledon High School GDST at the British Paediatric Respiratory Society conference on Friday June 30 in Cambridge.

Students were not merely designing packaging but an experience. Themes included a monkey character where the inhaler and spacer become a banana that the child can 'feed' the monkey with and then copy themselves. Other themes include a pack shaped like a cat where the inhalers become mice that are stored in a smaller box shaped like a wedge of cheese; and a folding pack that can hang on a door for easy access at home but can be quickly zipped up and put in a bag to take out.

Several of the designs have been made into initial prototypes by UK packaging company DS Smith, with the aim of piloting them in partnership with the NHS in London through the Healthy London Partnership.

"It has been great doing something which is able to change and improve children's lives and help them get better," said Sascha, aged 12 from Wimbledon High, one of the students who presented her design at the conference.

Asthma affects one in 11 children in the UK. On average, there are three children with asthma in every classroom in the UK, and a child is admitted to hospital every 20 minutes due to an asthma attack.

This DOT project has focused specifically on asthma in children under six years of age. It addresses the anxiety that a child feels in the early stages of treatment and the co-ordination of the equipment and their instructions to help ensure compliance with their treatment plan.

"DOT is a fascinating project which aims to bring real-world problems into classroom design and technology sessions in secondary schools," said Sara Nelson from the Healthy London Partnership. "It's one of the more rewarding pieces of work that I have had the pleasure of being involved in during the last year, the one I have learned the most from, and it involved collaborating with an unusual partner for the NHS."

Each of the students was given all of the tools which a child with asthma or their carer would need to manage their condition, including inhalers, spacers, and emergency instructions. Through a set of classroom lessons, the students' way of thinking was developed in order to help them understand how to be creative by breaking fixation through the use of stimulus.

Fixation is a common problem in design – for example, if you're trying to design a new type of chair and all you're shown are other chairs, you'll just end up designing a variant of what already exists. "If I want to design a new chair, the last thing I should look at is a chair," said Bill Nicholl from Cambridge's Faculty of Education, who co-leads the DOT programme.

The students from Wimbledon High also gained valuable experience working with industry by working with DS Smith, who will help refine the students' concepts into something that can be manufactured in large volumes.

"I feel like I am doing something for a purpose and it makes me feel happy that I am helping people," said Charlotte, aged 11. "I feel accomplished and proud of what I have done because it was a long process but it was all worth it."

→

www.eng.cam.ac.uk/profiles/imh29
www.education.designingourtomorrow.com

Credit: NASA/Bill Ingalls

Credit: Canadian Space Agency

Cambridge engineers enter training to become astronauts

↑ ABOVE LEFT: Kayla Barron
ABOVE RIGHT: Dr Jenni Sidey during the second series of aptitude tests

Dr Jenni Sidey, Lecturer in Internal Combustion Engines, and alumna Kayla Barron, who achieved a Master's degree in Nuclear Engineering, have both been recruited as astronauts this summer.

Dr Sidey was chosen as one of two new astronauts by the Canadian Space Agency, following a year-long evaluation. Gates Cambridge Scholar Lieutenant Barron (Peterhouse 2011) joined NASA from the U.S. Naval Academy, where she has been serving as the flag aide to the superintendent.

Dr Sidey has relocated to Houston, Texas, to start the two-year Astronaut Candidate Training Program at the Johnson Space Center as a member of the 2017 NASA astronaut class, alongside Kayla Barron.

The programme includes scientific and technical briefings, intensive instruction in International Space Station (ISS) systems, simulated extravehicular activities (EVAs, or spacewalks), robotics, physiological training, flight training, Russian language courses, and sea and wilderness survival training.

Dr Sidey is one of the Department's ambassadors for Engineering Diversity. She helped form Cambridge Robogals in 2014, an international, not-for-profit, student-run organisation that aims to increase female participation in STEMM. It does this through fun and educational initiatives aimed at girls in primary and secondary school.

Addressing the crowds on Parliament Hill on the day her position was announced, Dr Sidey said: "Back in 1992, Roberta Bondar flew on the Space Shuttle Discovery and when she came back to earth I was fortunate enough to see her speak in Calgary. I remember looking up to her, being excited at the idea of being a scientist, being a Canadian and having the opportunity to explore places beyond our world."

"So today I'm grateful to have had that role model, and that memory makes this moment so powerful for me as a woman and as a Canadian."

While at Cambridge, Kayla – a qualified submarine warfare officer – conducted research on modelling the fuel cycle for a next generation, thorium-fuelled nuclear reactor concept.

Speaking at the NASA astronaut Announcement Ceremony from Johnson Space Center, Kayla said: "I think we (the Astronaut Candidates) all share the common bond of having come from some amazing teams that really challenge us.

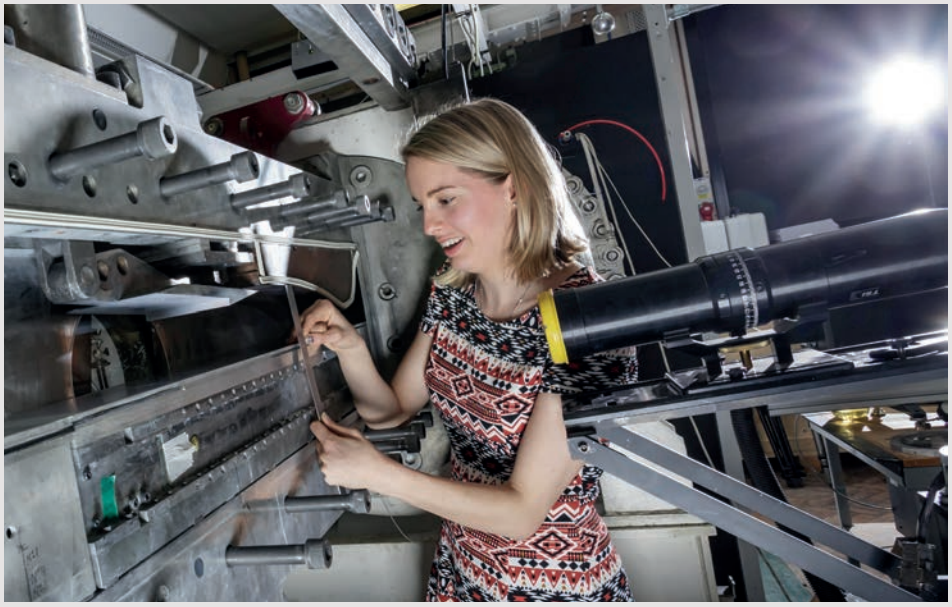
"For me, I'm a submarine warfare officer so I was lucky enough to be part of the navy's team that operates in confined spaces with limited resources in the hostile environment of the ocean, so I think there are definitely a few parallels with what astronauts are doing on the space station and what we'll need to learn how to do in order to be successful on long duration, deep space exploration missions."

"Back in 1992, Roberta Bondar flew on the Space Shuttle Discovery and when she came back to earth I was fortunate enough to see her speak in Calgary. I remember looking up to her, being excited at the idea of being a scientist, being a Canadian and having the opportunity to explore places beyond our world.

Dr Jenni Sidey

www.asc-csa.gc.ca/eng/astronauts/canadian/active/bio-jennifer-sidey.asp
www-engineeringdiversity.eng.cam.ac.uk
robogals.org
www.nasa.gov/astronauts/biographies/barron-kayla

→ PhD student Charlotte Coles sets up an experiment in the supersonic wind tunnel in the Baker Building



Athena SWAN Silver Award

Positive steps taken by the Department of Engineering to promote a culture in which all staff and students feel valued, respected and supported, have been acknowledged by the Athena SWAN scheme.

The Silver Award honours the significant progress the Department has made since it received the Bronze Award in 2013 and recognises the Department's comprehensive plan to ensure that this progress is sustained.

The Equality Challenge Unit's Athena SWAN Charter is a national scheme originally established to support and advance women's careers in STEMM subjects – science, technology, engineering, maths and medicine. The scheme was recently expanded to address gender equality more broadly, rather than just focusing on barriers to progression for women.

To better reflect the expansion of the Athena SWAN Charter and help promote inclusivity in the Department more broadly, the Women in Engineering initiative will be known as 'Engineering Diversity'. While a focus will remain on improving the experience of women in engineering, it is hoped that Engineering Diversity will encourage more members of the Department to get involved in the initiative.

The Silver Award submission and related initiatives are co-ordinated through the Department's Athena SWAN Self-Assessment Team (SAT). This group is led by Head of Department, Professor David Cardwell and Deputy Head of Department (Teaching), Dr Claire Barlow, supported by Secretary to the Faculty Board, Madeline McKerchar.

The SAT also includes an academic 'champion' from each Division, plus postdoc and student members, who consulted widely about the development of the submission and action plan.

Department achievements that have been officially recognised by the Silver Award include:

- The appointment of four new female lecturers and a female professor in the past 12 months. This is highly significant given the low proportion of academic women engineers currently in the sector
- The introduction of a peer mentoring scheme for new researchers which is helping to improve the experience of postdocs
- An increase in the proportion of women who are admitted to the Tripos and the year-on-year growth in the proportion of women awarded firsts at BA level and distinctions in the MEng
- The positive impact the Women in Engineering initiative has had on increasing the visibility of female engineers, overcoming subconscious bias and providing role models, as demonstrated by the Inspirational Women Engineers poster competition currently displayed outside the Department's library.

Professor David Cardwell said: "To achieve the Silver Award, the SAT undertook an honest appraisal of the Department using data from the 2015 staff survey and many other sources plus feedback from staff and students. This enabled the SAT to identify priorities and to produce an action plan to address these challenges.

> "Achieving the Silver Award shows potential staff and students that we are committed to creating a supportive and inclusive working environment.
>
> Professor David Cardwell, Head of Department

"Achieving the Silver Award shows potential staff and students that we are committed to creating a supportive and inclusive working environment. It also enhances our grant-winning potential: some government bodies require research partners to hold a Silver Award – and now we can say that the Department of Engineering is one of them."

Over the next three years, the SAT will carry out an action plan which aims to continue to improve the working environment for all members of the Department, as well as raising the public consciousness of engineering as an exciting and diverse discipline.

→

www.ecu.ac.uk/equality-charters/athena-swan
www-womeninengineering.eng.cam.ac.uk
www.eng.cam.ac.uk/profiles/dc135

Institute for Manufacturing
Design Show 2017

The Institute for Manufacturing's (IfM) 2017 Design Show challenges Manufacturing Engineering Tripos (MET) students to develop a new product, with real business potential.

Teams of three or four students in the first year of the two-year MET course have spent the past year working on their projects. Having first identified a customer need, they then researched the market, developed original design concepts and created a full business plan. The students are also encouraged to produce and show working prototypes wherever possible.

The MET course is a programme for 3rd and 4th-year Engineering students who have successfully completed the first two years of an engineering degree.

The 2017 projects are outlined below, summarised by the students in their own words:

↑ Slabstic Team (from left): Sarah Wolman, Sam Ellwood, Jack Bennett, Alkistis Kyriakopoulos.

Slabstic

Slabstic is a super low-cost process for manufacturing volume-efficient paving slabs to improve the standard of living in refugee camps and other off-grid areas, entirely on-site, using only plastic waste and other readily available materials.

The basic principle is simple: plastic and sand are stirred and heated inside an oil drum (which can be easily found in most areas), and this mixture is then put into a mould. The plastic melts and acts as a binder which adheres to the sand, forming a very strong material. Starting from this basic concept of casting the slab, our research has focused on optimising the process for efficiency and practicality in the face of low-resource manufacturing environments.

The slabs will be produced on site, in the case of refugee camps, within the camp by the refugees themselves, using only materials found where they live.

WaxWorks

WaxWorks aims to demonstrate design and manufacturing processes using the medium of wax in order to bridge the educational gap that exists between the manufacturing industry and school curriculums around the country.

WaxWorks has adopted a service business model, delivering value entirely through the workshops that we host with our unique production kit. The WaxWorks kit resembles a real life manufacturing production line and consists of a storage module, a melting module, adaptable casting moulds, a freezing module and a drilling module.

EcoButts

EcoButts has designed, tested and manufactured a greener filter for cigarettes that is non-toxic, made from natural materials and biodegrades within six months to ease the environmental problems caused by current filters.

Our filters are made from a natural fibre blend of flax, hemp and cotton, with charcoal additions to ensure the filter remains a powerful barrier to the toxic substances in cigarettes. They will be wrapped in organic hemp rolling papers before being distributed to consumers.

WEB Composites

Educational and exciting to watch, the WEB composites weaving machine scales down an industrial process, and allows it to be used in design studios and universities.

This is especially relevant for design enthusiasts who have a natural curiosity towards studying and examining mechanical processes. WEB Composites also targets universities and educational institutions that value the importance of the practical aspect to learning and strive to offer well-rounded knowledge and experiences to their students.

D6 Modular Shelving Solution

This project provides a new end-of-life recycling solution; transforming waste paper into furniture such as bookshelves and coffee tables.

The overall vision was to produce a product that could act as an end-of-life solution for waste paper before it is no longer a viable material.

Plarn

Plarn Co. has developed an original, innovative system to automate the recycling of hazardous waste plastic bags by spinning them into a fine, strong, weaveable yarn.

The end solution is a modular machine, to be distributed as a kit, which in turn cuts, tensions and spins the bag into yarn.

ReFuse

ReFuse is an educational recycling machine designed to inspire the next generation of engineers and scientists. Bringing industrial processes into the classroom, ReFuse converts plastic milk bottles into fusible beads.

ReFuse offers a hands-on demonstration of a recycling process, making learning engaging, memorable and enjoyable. Unlike traditional classroom learning, which rarely links to real-world applications, our equipment allows the demonstration of concepts used every day in industry. To achieve this, we have focused on downsizing a large-scale extrusion process to a level that can be explored in the classroom.

Focusing on recycling milk bottles (material: HDPE) into fusible beads, ReFuse can be used as the centre of interactive lessons and workshops to introduce children to materials science and manufacturing.

The Big Picture

Aimed at individual consumers and businesses in the food and beverage industry, this is art revolutionised. By reusing wine-stained corks, our machine creates spectacular, personalised, contemporary artwork whilst upcycling waste.

Our overall aim has been to create a working prototype that successfully produces a 30x30 cork piece of art.

BotTile

BotTile is a machine that repurposes waste PET bottles into roof tiles, therefore giving people living in inadequate housing a chance to improve their quality of life.

Our business is founded on principles of sustainable development and puts people and the planet before profits. We engage multiple stakeholders: those who live in inadequate housing, those who earn a living by salvaging waste for sale, and those who aspire to build small businesses.

The long term vision of BotTile Inc is to improve global housing through better roofing, while enabling economic empowerment and promoting social mobility.

↑ ReFuse Team (from left): Jenny Shepherd, James Porter, Luka Novovic, Cheri Chung

↑ BotTile Team (from left): Alice Kavanagh, Akos Fenemore, Ekaterina Essina, Hampton Guo Shen Tao

H2Flow

The Still2Flow is an innovative solar water still, used to purify water in economically underdeveloped villages. By partnering with water-based organisations, we aim to impact as many families as possible.

The basic technology behind the Still2Flow is simple to keep costs low. Sunlight is reflected onto a distillation chamber using a parabolic mirror, and this energy is then used to boil dirty water. Pure water will evaporate, which is then collected in a container through condensation for personal use.

The product is built to a size catered specifically towards five-person households, although the modular design means that our product can easily be scaled up or down.

→ www.ifm.eng.cam.ac.uk/education/met/design

View all the photos from the Design Show: www.flickr.com/photos/cambridgeuniversity-engineering/albums

Supporting high-achieving black students

↑ Undergraduates via Target Oxbridge (L-R): Timi Sotire, Bez Adeosun, Michael Harvey (Engineering), Daniel Oluboyede, Leah Grant and Fopé Jegede.

The University is sponsoring Target Oxbridge, a free programme which aims to increase successful undergraduate applications from black students.

Target Oxbridge provides 16–18 year old black African and Caribbean students with positive role models and practical advice. The development programme runs over the course of a year and involves residential visits and academic sessions. When they visit Cambridge, participants will have an immersive experience of life at the university, including taking part in tutorials and meeting both staff and current students.

Since 2012, 46 Target Oxbridge students have already gone on to receive offers from the two universities. Eleven former participants are currently studying at Cambridge and have welcomed the new sponsorship.

The University's support, alongside Oxford's, will help Target Oxbridge to expand its places from 45 to 60 in 2018, double the number available in 2016.

The programme is run by Rare, a specialist diversity recruitment company, and its patron is Cambridge alumna, Zadie Smith, who has previously said: "Going to Cambridge changed my life. Nothing I have done would have been possible without it. I want more people from backgrounds like mine to have that life-changing experience. That's what Target Oxbridge is about".

Jon Beard, Cambridge's Head of Undergraduate Recruitment, said: "We're delighted to be strengthening our relationship with Rare through our sponsorship of Target Oxbridge, and look forward to welcoming to Cambridge more of the high-achieving aspirational black students that the programme supports. The University and the Colleges are committed to widening participation by raising aspirations and attainment. Working with partners including the Sutton Trust, The Brilliant Club and Target Oxbridge is an important part of our approach."

Michael Harvey, an Engineering student at Homerton College, said: "Coming from a background in which you weren't expected to study at a place like Cambridge and then making it here gives a constant feeling of accomplishment. To know that you're working among some of the best thinkers of the future, to know you're at that level and to be encouraged to push even further is great. Once you're here the sky is really the limit, anything is achievable.

"It may seem a daunting task to get in from the outside, but anyone with the right attitude can achieve and excel here. My advice for people thinking of applying would be to put in the work because the rewards are more than worth it."

> "Anyone with the right attitude can achieve and excel here. My advice for people thinking of applying would be to put in the work because the rewards are more than worth it.
>
> Michael Harvey, Engineering student

www.targetoxbridge.co.uk
www.undergraduate.study.cam.ac.uk/find-out-more/widening-participation

ALUMNI UPDATE

Meet the energy leader of tomorrow

Engineering alumnus Faraz Ahmad (Churchill 2006) has been selected by the World Energy Council onto its exclusive Future Energy Leaders programme.

Faraz is one of just 37 participants globally to have secured a place on the FEL-100 programme designed to inspire, grow and develop the world's energy leaders of tomorrow.

Currently living in the United States, Faraz now works as an Operations Director for GE Oil & Gas. He hopes through his work with the World Energy Council to inspire students to pursue a career in the energy sector.

Faraz, what does it mean to you to have been selected to take up a place on the FEL-100 programme?

I'm tremendously honoured and humbled to have been selected as one of the 37 global candidates for the Future Energy Leader programme of the World Energy Council. This is a one-year appointment with the possibility of renewal for up to three years. It is an opportunity for me to contribute to the World Energy Council's mission and be part of a unique platform of energy professionals to help shape future energy solutions and frameworks.

I'm excited at the opportunity to build on the creative ideas from the network and the innovative potential we have as participants to challenge conventional thinking and explore new strategies. It also allows me to further my professional development, particularly in relation to critical issues on the energy agenda.

What is first on the agenda for you as part of the programme?

I'm joining the task force on energy efficiency, which will study demand response and prosumers (producer/consumer), as well as the potential impact on energy efficiency following the implementation of these concepts. In particular, the taskforce will analyse the role of information and communication technologies in energy efficiency management by reviewing existing implementation and adaptation of efficiency concepts. The objective will be a final publication on the future potential, both in terms of magnitude and geographical spread. This is a fantastic fit for my education and experience across engineering, electronics and the energy sector.

What did you enjoy the most about your studies at Cambridge and how has this helped you in your career?

I studied Engineering at Cambridge and completed Electrical and Information Sciences during my Part II Tripos, graduating in 2006. I spent my third year as part of the Cambridge-MIT Exchange where I studied at MIT, completing classes in Electronic Engineering, Computer Science and also Management at the MIT Sloan School of Management.

I really enjoyed the intellectual challenge of solving real world problems. I appreciated the rigorous education on the fundamentals of each discipline and enjoyed applying this to real case studies.

I particularly enjoyed the applied classes and projects in my fourth year on control systems, digital signal processing and management of technology. The interdisciplinary nature of the course has proven very useful to my career, as I have dealt with a wide range of technologies and applications. Understanding the engineering fundamentals behind each application is a skill that I have had to apply to a host of problems. These include areas linked to my specialisation such as communications, controls and robotics but also wider engineering fields of power generation, materials and manufacturing processes.

Describe your career since graduation

My fourth year MEng project was completed in collaboration with Cambridge Silicon Radio plc (now acquired by Qualcomm), who were a semiconductor company providing wireless chips for mobile phones and consumer electronics. This led to a permanent role based in Cambridge. In 2011, I joined GE Energy and completed several assignments across multiple industries in different countries; power generation, renewables, grids, rail, mining and marine. I was the Strategy Director for the Subsea Systems and Drilling business unit of GE Oil & Gas in 2013. Last year, I was accepted onto GE's newly formed Accelerated Leadership Programme. I relocated to Houston, USA, to manage operations in the offshore drilling business which manufacture and service Blow Out Preventers (BOPs). The BOP controls the well pressure during drilling to prevent an uncontrolled release. I'm responsible for the deployment of the BOP monitoring systems across GE's global installed fleet.

www.worldenergy.org

→ From left, team CUBE: Zhi Hao Kok, James Liew, industry tutor Niki Fanouraki, Julian Ting and Ziqing Liew. Credit: Chartered Institute of Building (CIOB)

Cambridge leap to second place in hotly contested final of construction competition

A team of Cambridge Engineering students have finished second place in a global competition which challenged them to manage a virtual construction company.

Team CUBE – Ziqing Liew, Julian Ting, Zhi Hao Kok and James Liew – entered the final of the Chartered Institute of Building (CIOB) Global Student Challenge in Hong Kong recently, and battled against five other student teams from the UK, China and Australia. It was the first time that the University of Cambridge had entered a team.

The competition tested the teams' strategic, marketing and financial skills. It is run as an online interactive game and utilises MERIT (Management Enterprise Risk Innovation and Teamwork). The game is designed so that each team member takes on a role such as managing director or financial manager.

Unlike earlier periods of the competition, in which the teams were given one week to make decisions for each round, the finals stretched team CUBE to their limits as decisions had to be made within an hour, sometimes within 45 minutes.

Julian Ting said: "As the only team from a university which entered the competition for the first time, let alone the finals, I sincerely think we made a solid attempt at tackling the challenges we faced. Looking back at the competition, although we made some mistakes in hindsight, we have not committed ourselves to glaring blunders despite the time pressure.

"Thanks to our strengths in analysis and pattern recognition, we were able to turn the tides in our favour and outbid our rivals in the subsequent rounds, rising from fifth place to second place."

James Liew, leader of team CUBE, added: "We would definitely recommend other Cambridge undergraduates to participate next year as the finals were truly a rewarding experience. In Hong Kong, apart from the competition, our team also attended mentoring sessions, where we got to meet and have discussions with distinguished industry leaders.

"We would like to express our gratitude to Laing O'Rourke' Construction Centre, Civil Engineering division and Atkins for sponsoring our entry fees and T-shirts. We would also like to thank our mentor Niki Fanouraki, from Atkins, for providing useful insights and getting through sleepless nights with us during the competition."

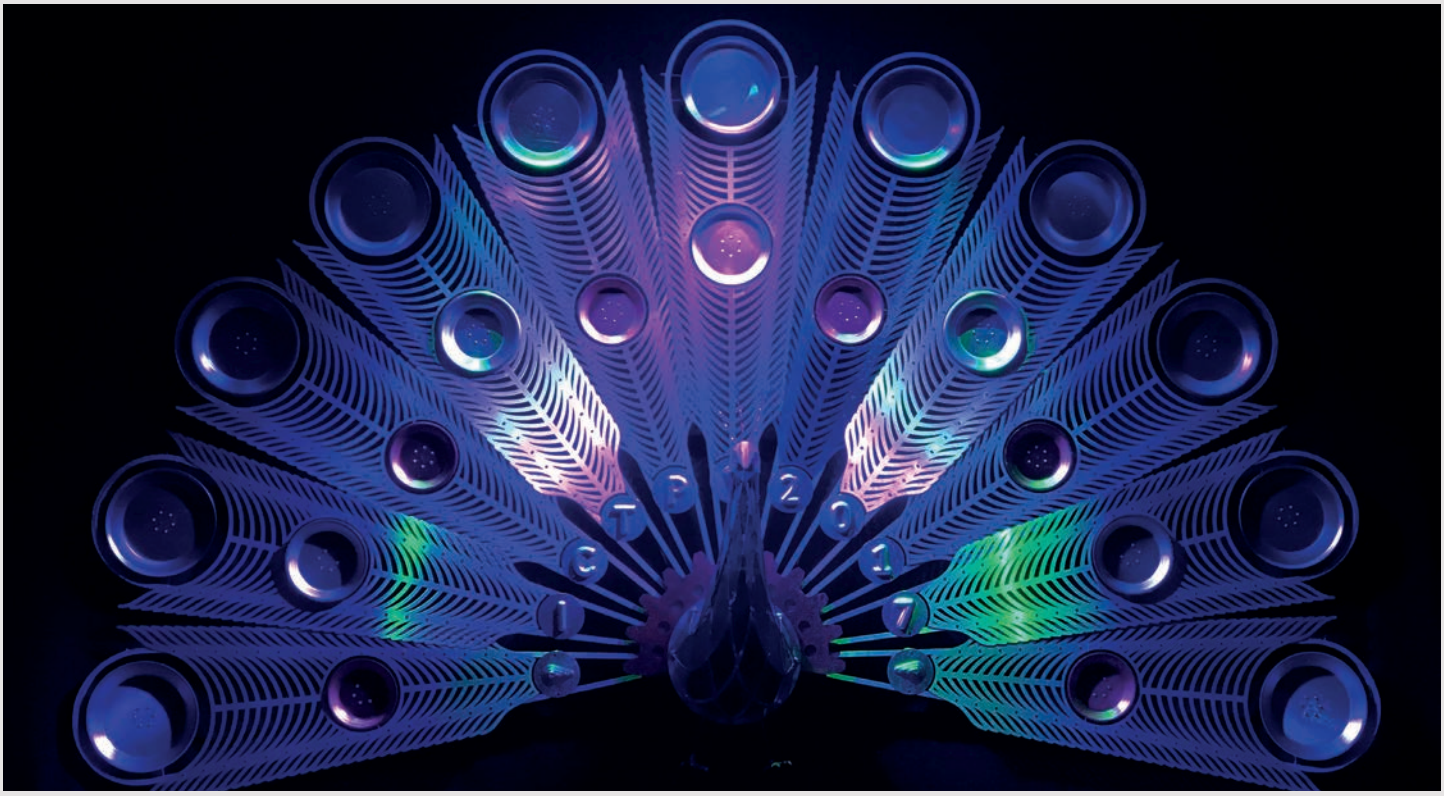
Team CUBE's academic tutor, Dr Ioannis Brilakis, recruited the Cambridge team through the construction modules (Constructionarium, 4D16 and 4D4). He said: "I encourage all Part IIA and IIB students to participate in this competition in the coming year if they really want to get a feel of what it is like to manage a construction company."

Team CUBE's industry tutor Niki Fanouraki, a geotechnical engineer at Atkins, said: "This was a suspenseful competition with the University of Cambridge gaining second place and valuable experience in its first-ever Global Student Challenge MERIT game, let alone the final phase.

"There was good preparation, planning and decision-making, fantastic camaraderie among the team members, and an exceptional demonstration of resilience when the team rebounded from fifth to second place. After the closing ceremony, there was already talk of assembling a new team for next year's MERIT competition."

→

www.eng.cam.ac.uk/profiles/ib340
gsc.ciob.org
www.construction.cam.ac.uk



↑ The majestic metal peacock sculpture which was unveiled during the theatrical performance

Creating a legacy

Cambridge hosts world's leading conference on shaping metal

A conference dubbed the 'Olympics of Metal Forming' was hosted by the Department of Engineering, including a new activity to attract more young people into the metals industry.

This was the first time the five-day International Conference on the Technology of Plasticity (ICTP) had been held in the UK, and it was attended by 600 delegates from across the globe.

A highlight of the conference was an opening theatrical performance at the Cambridge Corn Exchange, which celebrated metal forming in the UK. It was presented by actor Sir Tony Robinson and staged by theatre producer Julius Green, with multiple acts including dance and music performances by pupils from Parkside Federation Academies in Cambridge.

The performance was based on a newly written book by Julian Allwood, Professor of Engineering and the Environment, and chairman of ICTP 2017, tracing the story of metal forming to its origins.

To celebrate the conference and to leave a lasting legacy, Cambridge architect David Carmichael worked with the Department of Engineering to design and build a majestic metal peacock sculpture which was unveiled during the theatrical performance. It is now positioned in the grounds of the Department and was created using several new processes, originally developed by the University of Cambridge under the leadership of Professor Allwood.

More than 600 pupils from schools in the Cambridge area were invited to attend the opening ceremony, rubbing shoulders with the world's leading researchers and industrialists who gathered to discuss the advances being made in forming metals into cars, aircraft, medical devices, coins and much more.

The conference was sponsored by many industrial partners.

Professor Allwood said: "Metal forming – the art and science of shaping metal – has a low public profile but a high impact on our everyday lives. Our cars, offices, bicycles, coins, jewellery, drink cans and rail track are all made by metal forming and the art of metal forming is still evolving today.

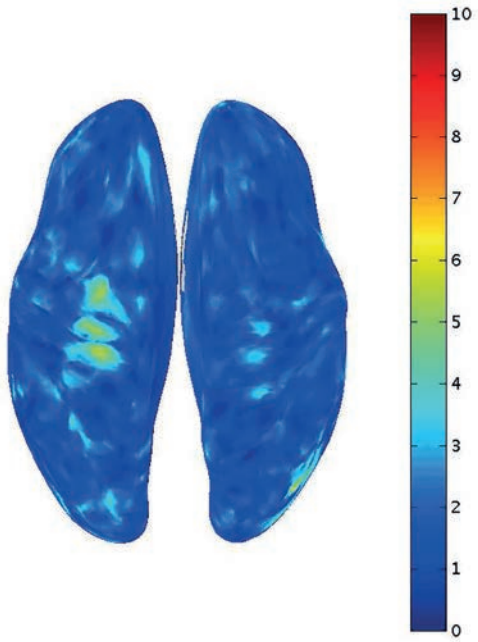
"The conference programme featured the presentation of 408 papers as the world's leading researchers shared their most important advances to inspire the next generation.

> "ICTP is the world's leading conference on shaping metal, but this is the first time this community has specifically aimed to connect to teenagers before they choose their A-level subjects.
>
> Professor Julian Allwood

"ICTP is the world's leading conference on shaping metal, but this is the first time this community has specifically aimed to connect to teenagers before they choose their A-level subjects. The committed support of our industrial sponsors has allowed us to bring together a world-beating creative team to deliver a spectacular theatrical event that will also lead to a fantastic legacy film."

Watch the opening theatrical performance:
youtu.be/_Vlu5i4UEaI
www.ictp2017.org/conference

→ Measurement of brain activity in a patient with phantom limb pain



Credit: Osaka University

Cause of phantom limb pain in amputees, and potential treatment, identified

Researchers have been exploring whether engineering could play part in a potential treatment for phantom limb pain, as an alternative to drugs.

The researchers, led by a group from Osaka University in Japan in collaboration with the Department of Engineering, have discovered a potential method of treating phantom limb pain – which occurs in the vast majority of individuals who have had limbs amputated – using artificial intelligence techniques.

The researchers also found that a 'reorganisation' of the wiring of the brain is the underlying cause of the chronic, and currently untreatable, pain in those with amputations and severe nerve damage.

Using a brain-machine interface to train a group of 10 individuals to control a robotic arm with their brains, they found that if a patient tried to control the prosthetic by associating the movement with their missing arm, it increased their pain, but training them to associate the movement of the prosthetic with the unaffected hand decreased their pain.

Their results, reported in the journal *Nature Communications*, demonstrate that in patients with chronic pain associated with amputation or nerve injury, there are 'crossed wires' in the part of the brain associated with sensation and movement, and that by mending that disruption, the pain can be treated. The findings could also be applied to those with other forms of chronic pain, including pain due to arthritis.

In most cases, individuals who have had a hand or arm amputated, or who have had severe nerve injuries which result in a loss of sensation in their hand, continue to feel the existence of the affected hand as if it were still there. Between 50 and 80 per cent of these patients suffer with chronic pain in the 'phantom' hand, known as phantom limb pain.

Study co-author Dr Ben Seymour, from Cambridge's Computational and Biological Learning Laboratory, within Information Engineering, said: "Even though the hand is gone, people with phantom limb pain still feel like there's a hand there – it basically feels painful, like a burning or hypersensitive type of pain, and conventional painkillers are ineffective in treating it. We wanted to see if we could come up with an engineering-based treatment as opposed to a drug-based treatment."

In the study, Dr Seymour and his colleagues, led by Takufumi Yanagisawa from Osaka University, used a brain-machine interface to decode the neural activity of the mental action needed for a patient to move their 'phantom' hand, and then converted the decoded phantom hand movement into that of a robotic neuroprosthetic using artificial intelligence techniques.

"We found that the better their affected side of the brain got at using the robotic arm, the worse their pain got," said Yanagisawa. "The movement part of the brain is working fine, but they are not getting sensory feedback – there's a discrepancy there."

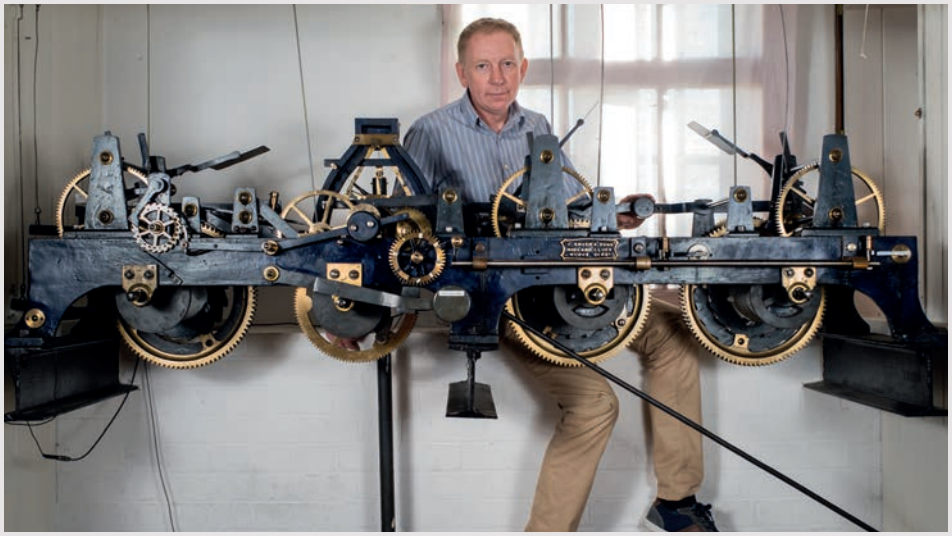
The researchers then altered their technique to train the 'wrong' side of the brain: for example, a patient who was missing their left arm was trained to move the prosthetic arm by decoding movements associated with their right arm, or vice versa. When they were trained in this counter-intuitive technique, the patients found that their pain significantly decreased. As they learned to control the arm in this way, it takes advantage of the plasticity – the ability of the brain to restructure and learn new things – of the sensorimotor cortex, showing a clear link between plasticity and pain.

Although the results are promising, Dr Seymour warns that the effects are temporary, and require a large, expensive piece of medical equipment to be effective. However, he believes that a treatment based on their technique could be available within five to 10 years.

"Ideally, we'd like to see something that people could have at home, or that they could incorporate with physio treatments," he said. "But the results demonstrate that combining AI techniques with new technologies is a promising avenue for treating pain, and an important area for future UK-Japan research collaboration."

→ www.neuroscience.cam.ac.uk/directory/profile.php?bseymour

The engineer who keeps the clock ticking



Credit: Paul Ashley Photography

He never intended to take a PhD — or to present television documentaries. Dr Hugh Hunt, Reader in Engineering Dynamics and Vibration, is an all-rounder who combines his interest in things that bounce and spin with a passion for music and mending things.

At Trinity College, I'm Keeper of the Clock. The clock tower is one of the oldest parts of the college. The bells you hear striking every quarter of an hour date from 1610. The current clock mechanism was installed in 1910. It has a double three-legged gravity escapement. Someone has been looking after Trinity's clock, winding and resetting it, for more than 400 years. For now, that person is me — with help from many others. Follow @clockkeeper on Twitter!

We need to look after things. With climate change, we must learn to be more resourceful and extend the lifespan of the stuff we own. To fix things, you need to understand how they work. If a key jams on your keyboard, instead of chucking it out, you can take it to bits. As Dame Edna Everage said about fashion: why throw it away, possums, if you can still wear it?

I'm fascinated by things that bounce and spin — the dynamics of rigid bodies. Back in 1999, Professor Mark Warner and I were invited to give a lecture called 'Spinning into Space' for National Science Week. We did lots of on-stage experiments and won an Institute of Physics award. Requests to do more lectures poured in.

I've learned to say yes to invitations — especially for outreach events. It's vital to share your enthusiasm. By jumping in at the deep end, I learned that I'm quite good at getting young people excited about science and engineering. I give lectures to audiences of up to 800, organised by initiatives such as Maths Inspiration and The Training Partnership. My talks have an element of chaos but, like any pantomime, it's all well-rehearsed.

My props include bouncing balls and boomerangs. Over the years I've acquired dozens of objects that help me demonstrate the basics of spin and angular momentum.

Public lectures paved the way to television appearances. In 2011, I researched and presented the two-hour Channel 4 show *Dambusters: Building the Bouncing Bomb*. It was watched by an estimated 5 million people and won a major award. I also presented a programme about the design of the Zeppelin which terrorised the British population in the First World War. More documentaries are in the pipeline.

I grew up in Melbourne, Australia. Dad was an engineer professor but more interested in theoretical mechanics than in making things. I was a bit different: I made all kinds of things starting with rabbit hutches and progressing to a complete refurbishment of the garden shed, including the electrics — which is how I learned the hard way about health and safety.

Music is important to me. I'm one of five children and we all played instruments. Mine was the French horn. I studied engineering at Melbourne University but being part of the Choral Society was what I enjoyed most. It made me realise that it's important to do something you love doing.

I didn't plan to do a PhD. When I graduated I went to work for an engineering company in Melbourne. At the end of my first year there was a party. One of my former professors came up to me. In that blunt Aussie way, he said: "Hunt, you're an idiot, you should be doing a PhD." Two weeks later, application forms from Cambridge University arrived in the mail. I guess he'd asked for them to be sent to me so I filled them in. Peter Joubert, if you're reading this, thanks!

For 20 years I've been working on how to make trains quieter. The CrossRail project in London is brilliant. I think you'll find the trains are quiet and the ride is smooth, which is good news for those living and working up above. There are lots of hotels, hospitals and recording studios along the route of CrossRail. The PiPmodel that I've been developing with some great students has been very useful.

My current research includes looking at ways of cooling the planet. I got into this through a project called SPICE (Stratospheric Particle Injection for Climate Engineering). SPICE investigates the benefits, risks, costs and feasibility of Solar Radiation Management through the deployment of reflective aerosols in the stratosphere. It's all pretty scary, but if we do nothing we face desertification, flooding and sea-level rise.

Another geoengineering project has caught my attention recently. How can we extract non-CO2 greenhouse gases — such as methane and nitrous oxide — from the atmosphere? These gases are almost as important as CO2 for climate change and they are easier to dispose of. But we have to come up with a way of handling about one cubic kilometre of air per second if we're going to make any meaningful difference. We need to be doing the research now.

www.eng.cam.ac.uk/profiles/hemh1
medium.com/this-cambridge-life

Credit: The Adecco Group

Graduate becomes ‘CEO for One Month’

↑ The Adecco Group CEO Alain Dehaze hands alumnus Ed Broadhead his contract for the position of global ‘CEO for One Month’

A Cambridge Engineering graduate has been appointed as global ‘CEO for One Month’ of The Adecco Group.

Ed Broadhead (Homerton 2017) was chosen from 117,500 applicants from 48 countries and will now help run a Fortune 500 company for one month under the guidance of Alain Dehaze, global CEO of The Adecco Group.

Ed impressed the jury with a combination of genuine passion, openness and learning agility including strong communication skills, which make him a natural entrepreneur and leader.

He will shadow CEO Alain Dehaze on a day-to-day basis, attending international business reviews with top management, contributing to strategy meetings, offering fresh ideas about innovation, global staffing and labour market trends, and attending investor meetings.

Prior to being appointed to the position, Ed spent four weeks as ‘CEO for One Month’ of The Adecco Group UK and Ireland. He was chosen from eight finalists following a rigorous assessment day where he impressed with his initiative and excellent people skills.

“I’ve enjoyed the ‘CEO for One Month’ programme since the very first day: living a top leader life within The Adecco Group UK leadership team at my age is unique and gave me an unparalleled experience,” said Ed.

“Not only could I practise skills such as teamwork, collaboration, and problem solving, but I could also learn more about the workforce solutions world, and really appreciate the passion for people this business requires. I cannot wait to start working with Alain Dehaze and to continue this amazing journey.”

The Adecco Group CEO Alain Dehaze said: “Ed has all the credentials to become a successful leader and I look forward to working closely with him. The goal of ‘CEO for One Month’ is to bridge the gap between school and work by giving young people unique on-the-job experience and skills training.

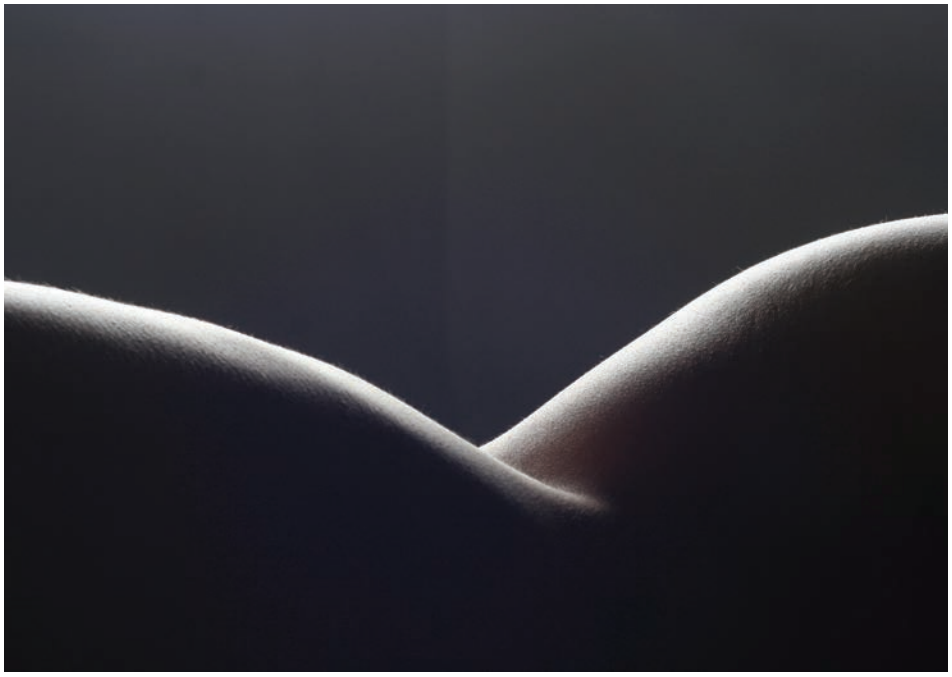
“Our aim is to inspire them to keep dreaming and to keep working towards their dreams, while we also benefit from their dynamism and fresh ideas. We hope this programme encourages other employers to find new ways to offer opportunities to young people, boosting their talent pipelines and, eventually, shaping a better future together.”

The Adecco Group’s ‘CEO for One Month’ is part of its Way to Work programme. The global initiative strives to address high youth unemployment through work experience opportunities, internships and career support, giving young talent a career kick-start and boosting their skills, confidence and employability.

> “Ed has all the credentials to become a successful leader and I look forward to working closely with him. The goal of ‘CEO for One Month’ is to bridge the gap between school and work by giving young people unique on-the-job experience and skills training.”
>
> The Adecco Group CEO Alain Dehaze

Follow Ed’s global ‘CEO for One Month’ journey: twitter.com/ed_broadhead

Watch our interview with Ed: youtu.be/BuBVRRQ5vM4



The Seduction of Curves

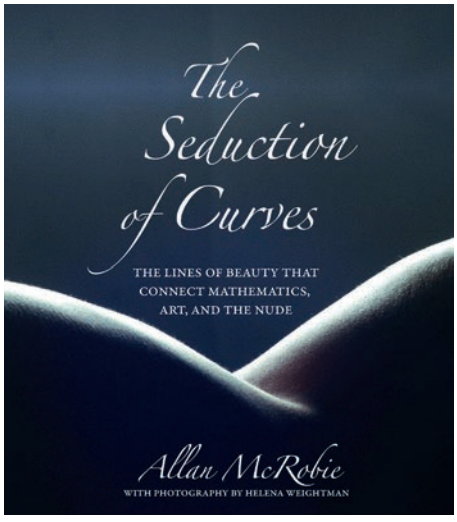
The Lines of Beauty That Connect Mathematics, Art, and the Nude

A lavishly illustrated book that explores the language of curves that spans the human body, science, engineering, and art.

Curves are seductive. These smooth, organic lines and surfaces – like those of the human body – appeal to us in an instinctive, visceral way, in a way that straight lines, or the perfect shapes of classical geometry, never could.

In this lavishly illustrated book, Allan McRobie takes the reader on a fascinating exploration of the beautiful curves that shape our world – from our bodies to Salvador Dalí's paintings and even to the space-time fabric of the universe itself.

The book focuses on seven curves – the fold, the cusp, the swallowtail, and the butterfly, plus the hyperbolic, elliptical, and parabolic 'umbilics'. It describes how the origins of their taxonomy can be traced back to mathematician René Thom's catastrophe theory.



In an accessible discussion illustrated with photographs of the human nude, McRobie introduces these curves and then describes their role in nature, science, engineering, architecture, art, and other areas.

The reader learns how these curves play out in everything from the stability of oil rigs to the study of distant galaxies to rainbows, from the patterns of light on pool floors, and even to the shape of human genitals. McRobie also discusses the role of these curves in the work of artists such as David Hockney, Henry Moore, and Anish Kapoor, with particular attention given to the delicate sculptures of Naum Gabo and the final paintings of Dalí, who said that Thom's theory 'bewitched all of my atoms'.

A unique introduction to the language of beautiful curves, this book may change the way you see the world.

Allan McRobie is a Reader in the Department of Engineering where he teaches stability theory and structural engineering with specialist interests in dynamics and stability. It was during a life drawing class at the Department (classes that McRobie had introduced to broaden the horizons of the Engineering students), that he first recognised the strong unifying resonances that exist between his lecture notes on stability theory and the shapes in front of his eyes.

"Not only can life drawing help you to understand the more difficult mathematical aspects of stability theory but if you understand the maths of stability theory, it changes the way you see the life model – and the world around you," he said.

"You start to notice shapes and features that you hadn't previously noticed. It is a two-way process, with a genuine synergy between the maths and the model."

Before joining the University of Cambridge, McRobie worked as an engineer in Australia, designing bridges and towers.

Reviews

"McRobie, a mathematician with a deep knowledge of the visual arts and the human body's curves, has written a startlingly original book. The Seduction of Curves is a probing exploration of the parallels between nature and the constructed world – and the most striking illustrated mathematics book I've ever seen." – Michael Harris, author of *Mathematics without Apologies: Portrait of a Problematic Vocation*

"This is a mathematics book, a science book, and an art book – a seductive and richly illustrated work of cultural synthesis, in which the visible and hidden folds and surfaces of our bodies are described by modern geometry and connected to engineering, optics, and other applications." – Michael Berry, University of Bristol

Take a look inside the book at:
vimeo.com/236094081
press.princeton.edu/titles/11108.html

→ Hannah with one of the robots she uses to study how humans learn motor skills

Women in Engineering
An interview with PhD student Hannah Sheahan

As part of our Women in Engineering series, we meet Hannah Sheahan, PhD Candidate in the Computational and Biological Learning Lab (CBL).

Hi Hannah, how did you get into engineering?

At high school I became interested in maths and physics, mainly because it was the first time I'd been encouraged to think and problem solve. However when I thought about applying to university, dealing only with numbers every day seemed like it might be a little dreary, so I ultimately chose Engineering because it could provide technical challenge as well as a creative outlet through design.

Thankfully, I enrolled, despite some less than favourable advice from my high school careers advisor. "What could a female do in engineering?" she laughed, when I told her my plan.

What are you doing now and what are your plans for the future?

I moved to Cambridge from New Zealand in 2014 to start a PhD in the Computational and Biological Learning Lab with Professor Daniel Wolpert.

Starting out as a mechatronics engineer, I now work towards understanding the fundamental mechanisms behind the brain's ability to control movement and learn motor skills.

At the moment I use human-robot interaction to see how people learn to move in new physics environments. Hopefully, as we discover more about how the brain learns motor control, technology can be designed to help people overcome differences in their physical abilities.

What motivates you?

Generally speaking I'm easily frustrated by inequalities. Studying motor control under an engineering framework enables me to tackle several at once: I'm developing research with potential to improve function and access to general society for people with motor disabilities, while also challenging gender and class inequality simply by succeeding as a female engineer from a lower socioeconomic background. Engineering can be used to build all sorts of bridges, and some of them are social.

What has helped your career?

Female role models in STEM have been hugely influential on me. The first time I remember being challenged at school was because of a high school math teacher who let me choose problems I found difficult or interesting in the textbook for homework. She turned math into my favourite class, and without that support I probably wouldn't have considered a career as an engineer. Later on, leadership and academic scholarships helped instil confidence that while there were few women in my field, there were successful engineers around who believed in me.

How have you overcome challenges and knockbacks in your career?

When starting my undergraduate engineering degree, and then again beginning my PhD in Cambridge, I experienced quite substantial feelings of intellectual inadequacy. Couple this with a tendency towards anxiety and being noticeably different – one of the only women in my course or lab, and you have the perfect recipe for Imposter Syndrome. Thankfully, as soon as I started openly discussing these feelings, I realised how common they were and eventually reasoned that they probably weren't grounded in truth.

How have you managed to balance family life and other interests with your career?

Honestly, I haven't always been very good at keeping balance. In the past when I've become particularly fascinated by something I've tended to develop tunnel vision. Now I'm trying to keep everything in moderation, including moderation. Sport helps a lot. I have no excuse not to exercise since I study human movement, but playing football for the University and running in the summer forces me outside to breathe some fresh air and focus completely on something simple for a few hours.

I believe it's critical to make time for friends in different fields to ensure your subject doesn't become all you think or know about – they do their best to stop me becoming a boring person.

Do you have any advice for women considering a career in engineering?

I'm a strong believer than work should be soul restoring, not soul destroying – so my main piece of advice would be to choose a career path you're passionate about. What engineering offers is a toolkit of skills to help design a different world, one that meets the needs of women as well as men, which is ultimately empowering.

Watch our interview with Hannah:
youtu.be/AeJP9AW-KNg

www.eng.cam.ac.uk/profiles/hrs40
www.eng.cam.ac.uk/profiles/dw304
www-engineeringdiversity.eng.cam.ac.uk

Honours, awards and prizes

Lecturer Dr Jenni Sidey has been honoured with the Royal Academy of Engineering's (RAEng) Young Engineer of the Year Award

She is one of five young engineers to win the RAEng Engineers Trust Young Engineer of the Year competition in recognition of the 'major impact' she has made in the field early on in her career.

Lecturer recognised for teaching excellence

Dr James Moultrie has been awarded one of the University of Cambridge's Pilkington Prizes - awarded to individuals who have shown teaching of exceptional quality. Senior Lecturer in Design Management at the Institute for Manufacturing (IfM), Dr Moultrie is one of just 12 individuals from across the university to receive the award.

Professor receives Knighthood from the Italian Republic

Professor Andrea Ferrari has been awarded the decoration of Knight Officer of the Order of the Star of Italy.

The order was awarded by Pasquale Terracciano, Ambassador of Italy to The United Kingdom, on June 19, on behalf of the President of Italy, in recognition of Professor Ferrari's contributions to science as well as his promotion of Italian science and scientists. The ceremony was attended by former Italian Prime Minister and President of the European Commission, Romano Prodi.

Professor Ferrari is the founding Director of the Cambridge Graphene Centre and of the EPSRC Centre for Doctoral Training in Graphene Technology.

Superconductivity expert awarded Early Career Fellowship

Dr Mark Ainslie of the Bulk Superconductivity Group has secured a five-year £1.1 million Early Career Fellowship from the EPSRC.

Dr Ainslie will build a research team to develop portable, high magnetic field charging of bulk superconductors for practical engineering applications.

Engineer's career honoured with Sir Frank Whittle Medal

Emeritus Professor Andrew Schofield has received a prestigious medal by the Royal Academy of Engineering in recognition of sustained achievement throughout his career.

Professor Schofield FREng FRS is responsible for transformational research in soil mechanics and geotechnical engineering and has been a leading voice in the field since the 1960s.

Raspberry Pi wins accolade

Cambridge-based microcomputer maker Raspberry Pi has won Britain's highest award for innovation in engineering, the Royal Academy of Engineering's MacRobert Award.

Among those accepting the award were alumnus Dr Eben Upton CBE, CEO (St John's 1996).

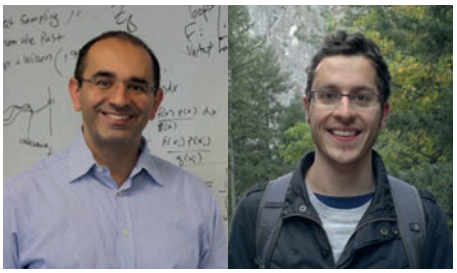
Since its launch in 2012, 14 million Raspberry Pis have been sold, making it the bestselling British computer in history. It was conceived in the Computer Laboratory at the University of Cambridge as a means to spark children's interest in coding and boost applications to study computer science.

Alumnus wins award

Alumnus Keno Mario-Ghae has been announced as a 2017 award winner of the BrightSparks Design Engineers of Tomorrow.

RS Components partnered with Electronics Weekly on its inaugural EW BrightSparks programme to celebrate the achievements of the UK's most talented young electronics design engineers and help to inspire and encourage new entrants to the industry.

Keno, a project engineer at Imagination Technologies, was described in his nomination as 'an exceptional professional'.



Professor and graduate make Smart List

A Cambridge professor and an alumnus have been nominated for the 2017 WIRED Smart List after being identified as individuals who will become 'global forces' in the future.

Professor of Information Engineering Zoubin Ghahramani (left) and alumnus Tim Mamtora, Master Engineer of Integrated Circuit Design at Broadcom in Cambridge, have made WIRED magazine's 'ones to watch' list after being nominated by industry leaders.

Leaf vein structure could hold key to extending battery life

Credit: pixabay

The natural structure found within leaves could improve the performance of everything from rechargeable batteries to high-performance gas sensors, according to an international team of scientists.

The researchers have designed a porous material that utilises a vascular structure, such as that found in the veins of a leaf, and could make energy transfers more efficient.

The material could improve the performance of rechargeable batteries, optimising the charge and discharge process and relieving stresses within the battery electrodes, which, at the moment, limit their life span. The same material could be used for high performance gas sensing or for catalysis to break down organic pollutants in water.

To design this bio-inspired material, an international team comprising scientists from China, the United Kingdom, United States and Belgium is mimicking the rule known as 'Murray's Law' which helps natural organisms survive and grow.

According to this Law, the entire network of pores existing on different scales in such biological systems is interconnected in a way to facilitate the transfer of liquids and minimise resistance throughout the network. The plant stems of a tree, or leaf veins, for example, optimise the flow of nutrients for photosynthesis with both high efficiency and minimum energy consumption by regularly branching out to smaller scales. In the same way, the surface area of the tracheal pores of insects remains constant along the diffusion pathway to maximise the delivery of carbon dioxide and oxygen in gaseous forms.

The team, led by Prof Bao-Lian Su, a life member of Clare Hall, University of Cambridge and who is also based at Wuhan University of Technology in China and at the University of Namur in Belgium, adapted Murray's Law for the fabrication of the first ever synthetic 'Murray material' and applied it to three processes: photocatalysis, gas sensing and lithium ion battery electrodes. In each, they found that the multi-scale porous networks of their synthetic material significantly enhanced the performance of these processes.

Professor Su said: "This study demonstrates that by adapting Murray's Law from biology and applying it to chemistry, the performance of materials can be improved significantly. The adaptation could benefit a wide range of porous materials and improve functional ceramics and nano-metals used for energy and environmental applications."

Writing in *Nature Communications*, the team describes how it used zinc oxide (ZnO) nanoparticles as the primary building block of their Murray material. The team arranged the ZnO particles through a layer-by layer, evaporation-driven, self-assembly process. This creates a second level of porous networks between the particles. During the evaporation process, the particles also form larger pores due to solvent evaporation, which represents the top level of pores, resulting in a three level Murray material.

The team successfully fabricated these porous structures with the precise diameter ratios required to obey Murray's law, enabling the efficient transfer of materials across the multi-level pore network.

Co-author, Dr Tawfique Hasan, of the Cambridge Graphene Centre, part of the University's Department of Engineering, added: "This very first demonstration of a Murray material fabrication process is incredibly simple and is entirely driven by the nanoparticle self-assembly. Large scale manufacturability of this porous material is possible, making it an exciting, enabling technology, with potential impact across many applications."

The team proved that its Murray material can significantly improve the long term stability and fast charge/discharge capability for lithium ion storage, with a capacity improvement of up to 25 times compared to state of the art graphite material currently used in lithium ion battery electrodes. The hierarchical nature of the pores also reduces the stresses in these electrodes during the charge/discharge processes, improving their structural stability and resulting in a longer life time for energy storage devices.

www.eng.cam.ac.uk/profiles/th270
www.graphene.cam.ac.uk

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