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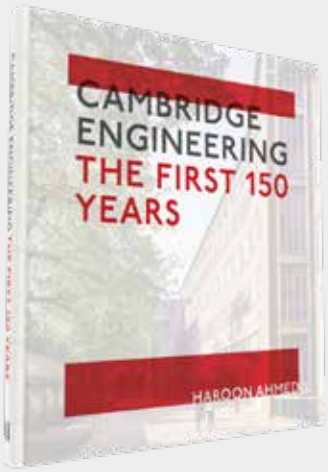
DEPARTMENT OF ENGINEERING NEWS

UNIVERSITY OF CAMBRIDGE

In this issue



Cambridge Engineering The First 150 Years

"The history of engineering told in this book shows that Cambridge Engineering has come a long way in nearly 150 years. Its reach and impact continues to accelerate. Even my wildest predictions for the next 150 years are likely to fall short of what this unique international community of engineers will achieve."

Ann Dowling
Dame Ann Dowling is President of the Royal Academy of Engineering and was Head of the Department of Engineering from 2009 to 2014.

Copies can be bought at:
profileeditions.com/cambridge-engineering-hb

Cover image: Gaseke's Bridge to Prosperity. Credit: Hannis Whittam.

Note from the editors

We hope you enjoy the photographs in the centre spread which show the prize-winning images from the 2018 Department Photography Competition (kindly sponsored by ZEISS). We are keen to receive entries from you, our alumni, before the deadline of August 30. Perhaps you have some engineering-related photos and video in your archives worth submitting? Please enter at: www.eng.cam.ac.uk/photography-competition

Over the last 15 years that the competition has been running, we have built a wonderful archive of images that we can use throughout our department communications and marketing work. The images are also used by other departments, the central University and some of the colleges, helping us to keep engineering and all its varied beauty visible to many audiences.

The 2018 Head of Department's prize was won by alumnus Hannis Whittam. His photo has made the front cover and is also on page 13. Hannis explains:

"In 2015 I travelled to rural Rwanda with a group of bridge design colleagues from COWI. Over two weeks we worked with the NGO Bridges to Prosperity (B2P) and local community members to construct a 51m pedestrian suspension bridge. The local community told us stories of their children and friends who, on their return home from school during the rainy season, had been swept off the existing crossing and drowned. They told us how the new bridge would give them safe access to healthcare, schools, and the market."

Charlotte Hester and Jacqueline Saggers

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Head's welcome

Credit: Graham CopeKoga

The Department of Engineering Language Unit is 25 years old and has recently decided to change its name to the 'Centre for Languages and Inter-Communication', with the convenient acronym 'CLIC'. However, very few people realise what a remarkable resource CLIC represents. What other Engineering Department has a dedicated centre, focussed explicitly on teaching five different languages in a technical context?

The fact that we run CLIC ourselves and integrate it into the structure of our Engineering teaching makes it particularly valuable and effective. Students get credit for improving their languages in three out of the four years of our undergraduate course.

The Royal Academy of Engineering has recently joined with other UK academies to publish a report on the need for 'Languages in the UK'. Communication skills and cross-cultural understanding are key to modern engineering, so the arguments in this report are particularly relevant to our work.

We celebrate the foresight of the colleagues who created the Department of Engineering Language Unit in 1993 and look forward to CLIC continuing to add enormous value to the education that we offer in the future.

L'Unité de Langues du Département d'Ingénierie a vingt-cinq ans et a récemment décidé de se rebaptiser 'Centre pour les Langues et l'Inter-Communication', avec 'CLIC' pour acronyme. Cependant, très peu de gens réalisent la formidable ressource que représente CLIC. Quel autre département d'ingénierie dispose de son propre centre dédié à l'enseignement de cinq langues étrangères dans un contexte technique?

Le fait que nous dirigions nous-mêmes CLIC et que nous l'intégrions dans la structure de nos cours d'ingénierie fait de ce centre un outil particulièrement utile et efficace. Pendant trois années sur quatre de leur cursus, suivre des cours de langue permet aux étudiants de premier cycle d'obtenir des crédits.

L'Académie Royale d'Ingénierie s'est récemment associée à d'autres académies britanniques pour publier un rapport sur le besoin en langues du Royaume-Uni. Les compétences en matière de communication et de compréhension interculturelle sont des éléments clés de l'ingénierie moderne, ce qui rend les arguments de ce rapport particulièrement pertinents pour notre travail.

Nous célébrons la décision visionnaire qu'ont prise nos collègues en créant l'Unité de Langues en 1993 et nous espérons que CLIC continuera d'apporter une valeur ajoutée considérable à notre enseignement à l'avenir.

工程系语言中心从成立至今已经有二十五周年了，最近我们决定将其改称为“语言和交流中心”，简称CLIC。很少有人了解CLIC所具有的出众资源。很少有哪一个工程系设有专门的中心，着重于在技术环境中教授五种不同的语言.

我们自己管理运行CLIC并将其融入我们的工程教学结构中，不仅非常有效，并有独特价值。学生们在本科四年中的三年都有机会提高语言水平并拿到学分。

皇家工程科学院最近与其他英国科学院联合发表关于“语言在英国”的报告。报告中提出沟通技巧和跨文化理解在现代工程中有重要地位，这与我们的工作密切相关。

工程系语言中心组建于一九九三年。我们感谢前辈们的远见卓识，并期待CLIC继续为我们未来提供的教育作出贡献。

Professor Richard Prager FREng, FIET, CEng


Credit: pixabay

Multi-million pound initiative from Microsoft to support AI research at Cambridge

The University of Cambridge has joined with Microsoft to help tackle the problem of 'brain drain' in AI and machine learning research.

As part of the Microsoft Research – Cambridge University Machine Learning Initiative, Microsoft will help increase AI and machine learning research capacity and capability at Cambridge by supporting visiting researchers, postdoctoral researchers, PhD students and interns from the UK, EU and beyond.

The new Initiative builds on more than two decades of collaboration between the University and Microsoft Research Cambridge, and will be based in the Department of Engineering.

AI and machine learning have the potential to revolutionise how we interact with the world, but before these technologies can be widespread and used in industries such as healthcare, education and transportation, there are complex problems that need to be solved.

A shortage of skills in AI and machine-learning, particularly at PhD level and above, has led to many large tech companies recruiting from academia, leaving behind a shortage in research and teaching capacity at universities.

"By focusing on a two-way collaborative initiative for long-term growth, not short-term gain, we are taking a different approach to this problem. We are working with universities to build up AI and machine learning talent and research in the UK," said Chris Bishop, Lab Director, Microsoft Research Cambridge. "Our researchers regularly work together on projects with global impact, and this initiative will help to build on the already strong links between the University of Cambridge and Microsoft."

"Cambridge has a culture of ideas going back and forth between industry and academia, and this agreement with Microsoft is a prime example," said Professor Andy Neely, Pro-Vice-Chancellor for Enterprise and Business Relations at Cambridge. "By working together with industry on issues such as how best to use AI and machine learning, we can not only help solve complex issues for industry, but continue to support world-leading research and train the next generation of leaders in the field."

Last year, the Government and the AI sector agreed a Sector Deal to further boost the UK's global reputation as a leader in developing AI technologies, ensuring the UK remains a go-to destination for AI innovation and investment.

Secretary of State for Digital, Culture, Media and Sport, Jeremy Wright, said: "This new collaboration between Microsoft and Cambridge University will help us continue to develop home-grown AI talent and supports the government's modern Industrial Strategy and £1 billion AI sector deal. It is crucial that we do all we can to capitalise on our global advantage in this technology."

Business Secretary Greg Clark said: "This partnership between one of the world's leading universities and technology developer and Microsoft is a great example of collaboration between business and academia. The UK's leading research and innovation base are driving parts of our modern Industrial Strategy supported with the biggest increase in public research and development investment in the UK's history."

Credit: John Downing

Engineers awarded OBEs

← LEFT: Dr Jennifer Schooling
↑ ABOVE RIGHT: Heba Bevan

Dr Jennifer Schooling and alumna Heba Bevan have both been awarded OBEs in the New Year Honours list.

Dr Schooling's OBE is in recognition of her services to engineering and to digital construction, while Heba's OBE was awarded for her services to innovation, technology and STEM education.

Dr Schooling is Director of Cambridge Centre for Smart Infrastructure and Construction (CSIC) and Chair of the Research Strategy Steering Group at the Centre for Digital Built Britain.

CSIC focuses on how better data and information from a wide range of sensing systems can be used to improve our understanding of our infrastructure, leading to better design, construction and management practices. CSIC has strong collaborations with industry, developing and demonstrating innovations on real construction and infrastructure projects, and developing standards and guidance to enable implementation. Dr Schooling has secured £7.6 million in grant funding from EPSRC and Innovate UK for the Centre.

Dr Schooling is also a Fellow of the Institution of Civil Engineers (ICE) and founding Co-Editor-in-Chief of the Smart Infrastructure and Construction Proceedings journal.

"I'm delighted and honoured to receive this award which also reflects the success of the collaborative nature of CSIC," she said. "I would like to acknowledge the significant contribution made by the many research associates, academics and industry professionals I work with. It's an exciting time for smart infrastructure and digital construction and I look forward to further collaborative work in the coming year."

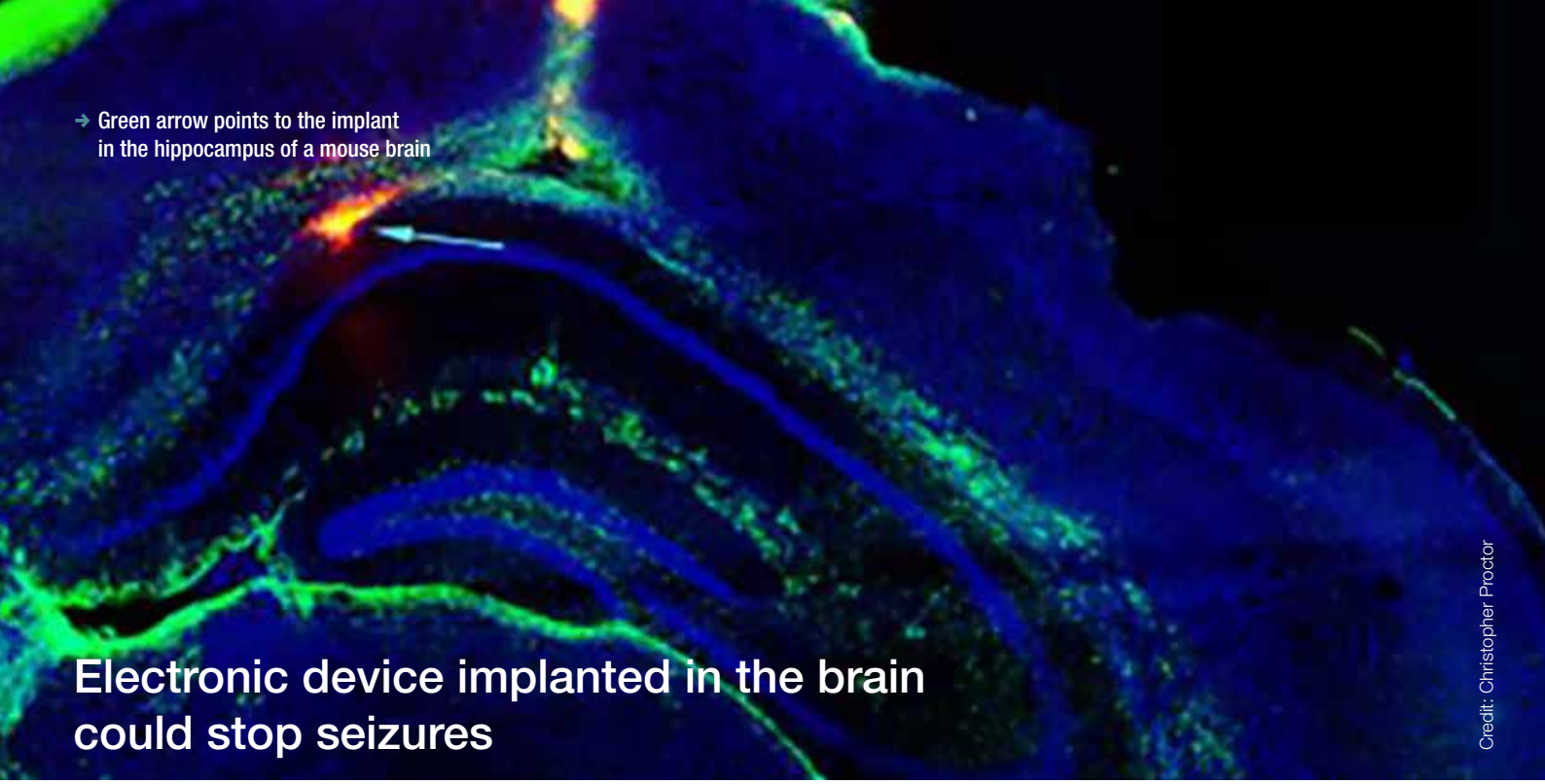
It was during her PhD at Cambridge, that Heba, a former CSIC student, developed and deployed new smart sensing technology, UtterBerry. Heba set up UtterBerry Ltd in 2013 and the company has gone from strength to strength, with its products now being used on projects such as Crossrail.

UtterBerry produces miniature, wireless, ultra-low power sensors combined with artificial intelligence. They are designed for infrastructure monitoring. The technology offers AI capabilities so that it can be self-calibrating and capable of analysing data in real time.

In 2016, Heba was invited by the Department for International Trade (DIT) to visit Shenzhen, Chongqing and Hong Kong as part of the UK-China TechHUB 2016 (a programme supported by the DIT). This was in order to demonstrate the potential of the UtterBerry devices to the Chinese government and world-leading hi-tech companies and investors, including China Resources Group, Huawei and China Mobile.

> "I'm delighted and honoured to receive this award which also reflects the success of the collaborative nature of CSIC. I would like to acknowledge the significant contribution made by the many research associates, academics and industry professionals I work with.
>
> Dr Jennifer Schooling

www-smartinfrastructure.eng.cam.ac.uk
www.cdbb.cam.ac.uk
utterberry.com



→ Green arrow points to the implant in the hippocampus of a mouse brain

Credit: Christopher Proctor

Electronic device implanted in the brain could stop seizures

Researchers have successfully demonstrated how an electronic device implanted directly into the brain can detect, stop and even prevent epileptic seizures.

The researchers, from the University of Cambridge, the École Nationale Supérieure des Mines and INSERM in France, implanted the device into the brains of mice, and when the first signals of a seizure were detected, delivered a native brain chemical which stopped the seizure from progressing. The results, reported in the journal *Science Advances*, could also be applied to other conditions including brain tumours and Parkinson's disease.

The work, funded by the European Union, represents another advance in the development of soft, flexible electronics that interface well with human tissue. "These thin, organic films do minimal damage in the brain, and their electrical properties are well-suited for these types of applications," said George Malliaras, Cambridge's Prince Philip Professor of Technology in the Department of Engineering, who led the research.

While there are many different types of seizures, in most patients with epilepsy, neurons in the brain start firing and signal to neighbouring neurons to fire as well, in a snowball effect that can affect consciousness or motor control. Epilepsy is most commonly treated with anti-epileptic drugs, but these drugs often have serious side effects and they do not prevent seizures in three out of 10 patients.

In the current work, the researchers used a neurotransmitter which acts as the 'brake' at the source of the seizure, essentially signalling to the neurons to stop firing and end the seizure. The drug is delivered to the affected region of the brain by a neural probe incorporating a tiny ion pump and electrodes to monitor neural activity.

When the neural signal of a seizure is detected by the electrodes, the ion pump is activated, creating an electric field that moves the drug across an ion exchange membrane and out of the device, a process known as electrophoresis. The amount of drug can be controlled by tuning the strength of the electric field.

"In addition to being able to control exactly when and how much drug is delivered, what is special about this approach is that the drugs come out of the device without any solvent," said lead author Dr Christopher Proctor, a postdoctoral researcher in the Department of Engineering. "This prevents damage to the surrounding tissue and allows the drugs to interact with the cells immediately outside the device."

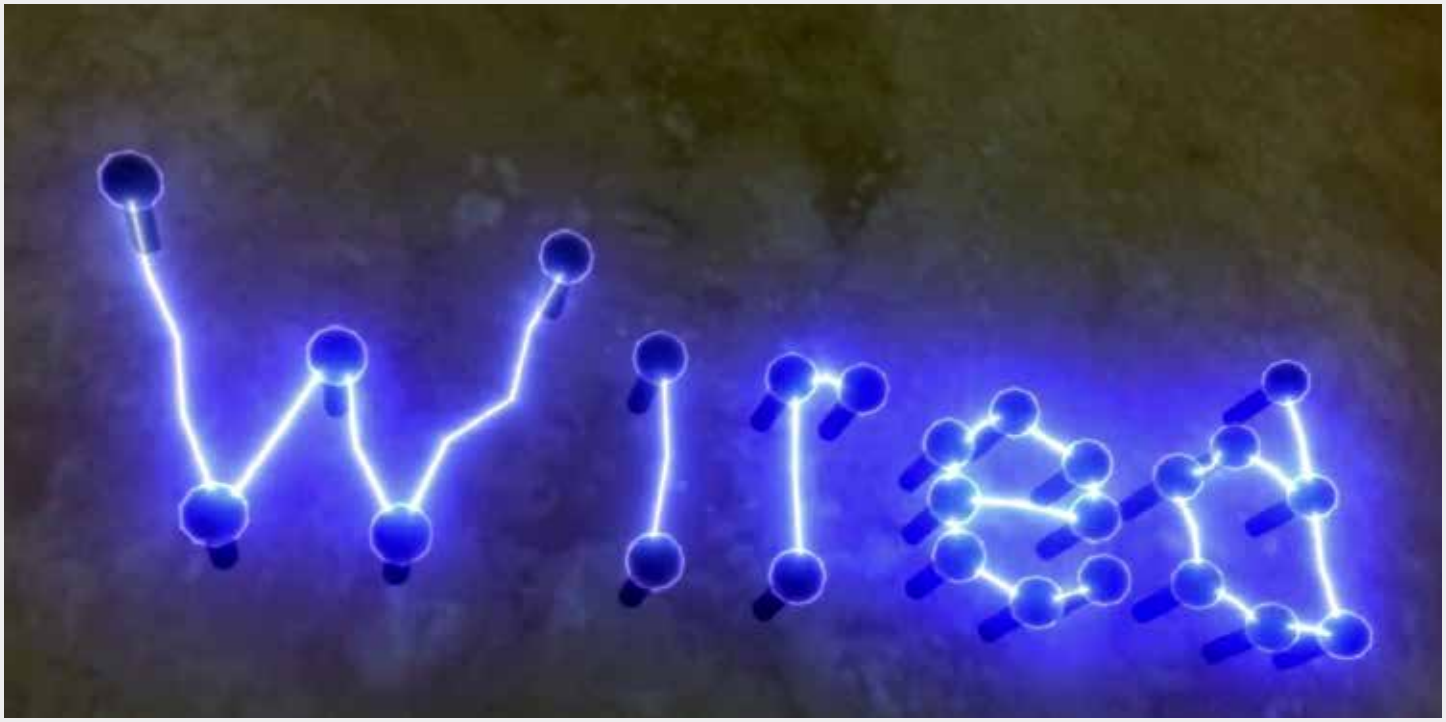
The researchers found that seizures could be prevented with relatively small doses of drug representing less than 1% of the total amount of drug loaded into the device. This means the device should be able to operate for extended periods without needing to be refilled. They also found evidence that the delivered drug, which was in fact a neurotransmitter that is native to the body, was taken up by natural processes in the brain within minutes which, the researchers say, should help reduce side effects from the treatment.

Although early results are promising, the potential treatment would not be available for humans for several years. The researchers next plan to study the longer-term effects of the device in mice.

Professor Malliaras is establishing a new facility at Cambridge which will be able to prototype these specialised devices, which could be used for a range of conditions. Although the device was tested in an animal model of epilepsy, the same technology could potentially be used for other neurological conditions, including the treatment of brain tumours and Parkinson's disease.

Meanwhile, Professor Malliaras is also leading a £10 million interdisciplinary collaboration to target the most challenging of cancers, such as those of the pancreas, brain, lung and oesophagus. The Interdisciplinary Research Collaboration (IRC) involves researchers from Imperial College London, University College London and the Universities of Glasgow and Birmingham.

Funded for six years by the Engineering and Physical Sciences Research Council, the aim of the project is to develop an array of new delivery technologies that can deliver almost any drug to any tumour in a large enough concentration to kill the cancerous cells.



Credit: Diarmid Campbell

New video game teaches teens about electricity

A new video game, designed by researchers, gives teenagers an understanding of electricity by solving puzzles in a bid to encourage more of them to study engineering at university.

The game, called Wired, is available to download and play for free, and teaches the key mathematical concepts underpinning electricity. Electricity affects all of us every day, but is difficult to teach as it is abstract, difficult to visualise and requires lots of practice to master.

"A video game is an ideal way to teach students about electricity as it allows players to visualise the underlying concepts and the relationships between them," said Diarmid Campbell, Senior Teaching Associate (Games Technology), and the game's designer. "It provides a structure for incremental challenges, each one building on previous ones, and there is a set of tried and tested motivational techniques that can encourage people to push through tricky areas."

Mr Campbell spent close to two decades in the gaming industry, developing titles for PlayStation, Xbox and PC. He now develops video games to inspire more teenagers to study engineering.

Players of Wired will get an intuitive understanding of circuits, the logic of switches, voltage, current and resistance. They do this not by analysing circuits, as in textbooks, but by wiring up circuits to solve problems.

"Most educational games are delivered through the classroom and only need to be more fun than the lesson they are replacing," said Mr Campbell. "Wired will be delivered through gaming websites, so it needs to be at least as fun as other video games that people play. We are not gamifying education; we are edu-fying, and perhaps even edifying, a game."

In many areas of physics, people already have an intuitive understanding of how things behave before they learn about them more formally. For instance, people have been throwing balls around since they were toddlers so when they learn about projectiles and Newton's laws of motion they have an intuition to guide them in how to apply the equations.

Since electricity is invisible and isn't something we encourage kids to play with, this intuition isn't there in the same way. Students can learn the mathematics, but may not have the intuition to know how to apply it. "Students are often told that electricity behaves like water flowing through pipes – which gets you some of the way there, but actually, people don't really understand how water behaves either," said Mr Campbell. "How many people can tell you why the shower changes temperature when you flush the toilet?"

According to Mr Campbell, Wired bridges this gap, giving players an intuitive understanding of how electricity behaves and gets players solving problems that are not usually encountered until A-level physics.

The project was supported by The Underwood Trust.

The game is currently available on Mac and Windows.

An installable version can be downloaded at: store.steampowered.com/app/885470/Wired/

A browser version of the game can be played at: wiredthegame.com

Watch the trailer:
youtu.be/pU56azLsWNM

What makes a faster typist?

Credit: pixabay

The largest-ever dataset on typing speeds and styles finds that the fastest typists make fewer errors, and they often type the next key before the previous one has been released.

Based on 136 million keystrokes from 168,000 volunteers, the data was collected by researchers from Aalto University in Finland and the University of Cambridge.

Volunteers from over 200 countries took the typing test, which is freely available online. Participants were asked to transcribe randomised sentences, and their accuracy and speed were assessed by the researchers.

Unsurprisingly, the researchers found that faster typists make fewer mistakes. However, they also found that the fastest typists also performed between 40% and 70% of keystrokes using rollover typing, in which the next key is pressed down before the previous key is lifted. The strategy is well-known in the gaming community but has not been observed in a typing study. "Crowdsourcing experiments that allow us to analyse how people interact with computers on a large scale are instrumental for identifying solution principles for the design of next-generation user interfaces," said study co-author Dr Per Ola Kristensson, Reader in Interactive Systems Engineering at the Department of Engineering, University of Cambridge.

Most of our knowledge of how people type is based on studies from the typewriter era. Now, decades after the typewriter was replaced by computers, people make different types of mistakes. For example, errors where one letter is replaced by another are now more common, whereas in the typewriter era typists often added or omitted characters.

Another difference is that modern users use their hands differently. "Modern keyboards allow us to type keys with different fingers of the same hand with much less force than what was possible with typewriters," said co-author Anna Feit from Aalto University. "This partially explains why self-taught typists using fewer than 10 fingers can be as fast as touch typists, which was probably not the case in the typewriter era."

The average user in the study typed 52 words per minute, much slower than the professionally trained typists in the 70s and 80s, who typically reached 60-90 words per minute. However, performance varied largely. "The fastest users in our study typed 120 words per minute, which is amazing given that this is a controlled study with randomised phrases," said co-author Dr Antti Oulasvirta, also from Aalto University. "Many informal tests allow users to practice the sentences, resulting in unrealistically high performance."

The researchers found that users who had previously taken a typing course actually had a similar typing behaviour as those who had never taken such a course, in terms of how fast they type, how they use their hands and the errors they make – even though they use fewer fingers.

The researchers found that users display different typing styles, characterised by how they use their hands and fingers, the use of rollover, tapping speeds, and typing accuracy.

For example, some users could be classified as 'careless typists' who move their fingers quickly but have to correct many mistakes; and others as attentive error-free typists, who gain speed by moving hands and fingers in parallel, pressing the next key before the first one is released.

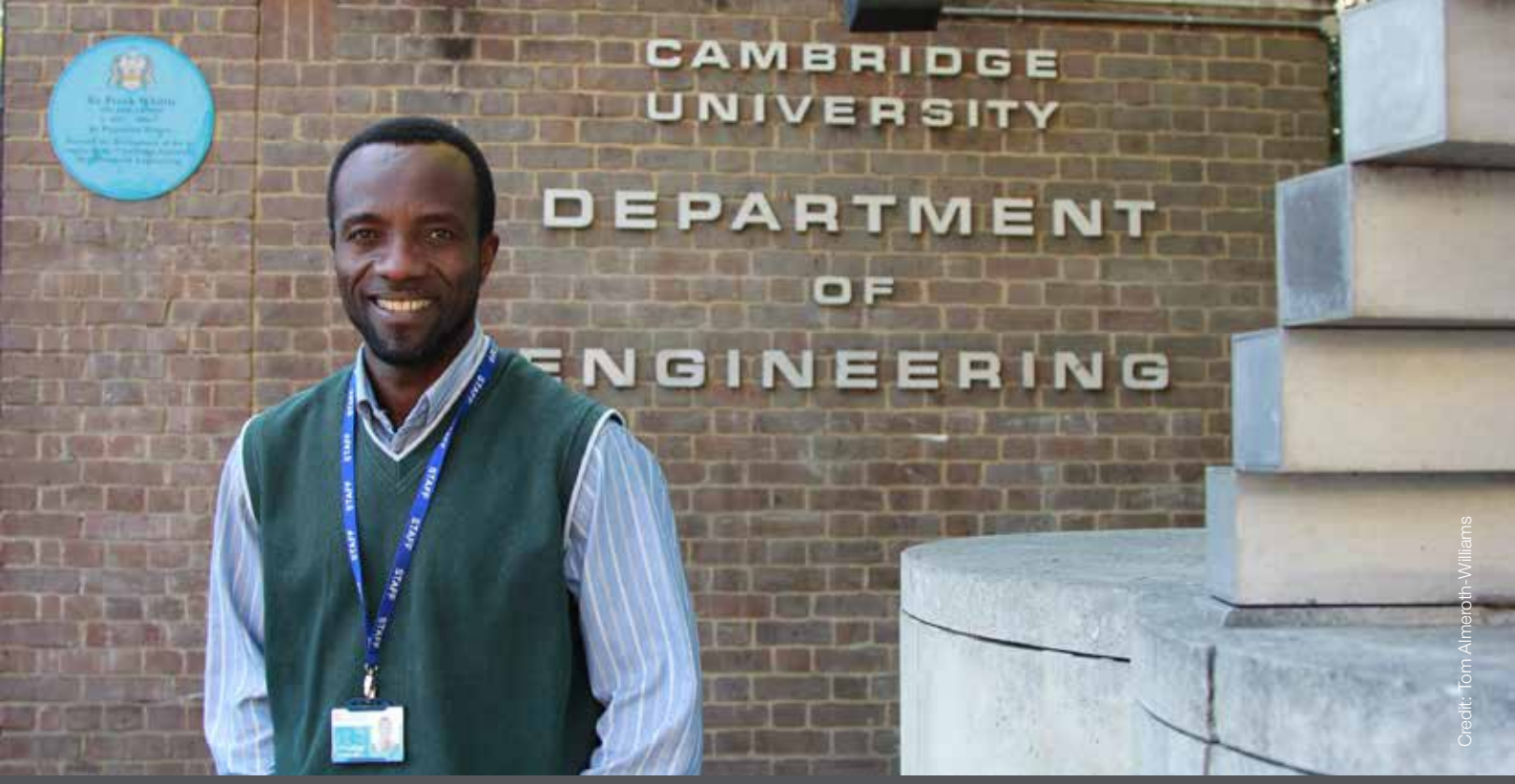
It is now possible to classify users' typing behaviour based on the observed keystroke timings which does not require the storage of the text that users have typed. Such information can be useful, for example, for spell checkers, or to create new personalised training programmes for typing.

"You do not need to change to the touch typing system if you want to type faster," said Feit. "A few simple exercises can help you to improve your own typing technique."

The anonymised dataset is available at: userinterfaces.aalto.fi/136Mkeystrokes

> Crowdsourcing experiments that allow us to analyse how people interact with computers on a large scale are instrumental for identifying solution principles for the design of next-generation user interfaces.
>
> Dr Per Ola Kristensson

Try the test online:
typingmaster.research.netlab.hut.fi



Credit: Tom Almeroth-Williams

The researcher shaping the future

↑ The System Designer – Dr Alexander Komashie

Dr Alexander Komashie is a Senior Research Associate in Healthcare Systems Design and is part of the Department's Engineering Design Centre. He discusses his route to Cambridge, his inspiration and his motivation.

The NHS and other health systems in the developed world have made great progress in health technology and diagnostics. But if you have excellent clinicians, medication and technology in a badly designed system, patients are likely to have bad experiences.

I seek a better understanding of how healthcare delivery services operate as a system and then work out how to design them effectively using an engineering systems approach.

I arrived in England in 2002 to do my Master's degree in Advanced Manufacturing Systems in London. I had a passion for mechanical engineering design but in one lecture I heard Dr Ali Mousavi declare that "Systems Engineers should run the government. We should make the big decisions". I was taken aback and by the end of the day, I had said goodbye to mechanical engineering and embraced systems engineering.

My PhD, in part, looked at ways of improving patient experience of care delivery without compromising the experience of staff. I used queuing theory to demonstrate how a focus on improving patient experience can impact on staff and proposed a model for understanding the trade-offs.

Moving to Cambridge has added another dimension to my interest in systems. I now see design, as an approach to solving problems, as fundamental to systems that consistently deliver good value to the end users, including in healthcare. To improve patient experience, we need to design better delivery systems.

During the early phases of projects I spend time with patients in focus groups exploring their experiences of the care delivery systems they have used. I also interview doctors, nurses and managers in the NHS to explore their experiences of providing care in the system. This can be a very powerful, challenging and motivating experience.

Last year, I also became a postdoctoral interdisciplinary fellow of The Healthcare Improvement Study Institute, so I'm now also working on the Cambridge Biomedical Campus.

I'm normally based in the Department of Engineering with the Cambridge Engineering Design Centre. While others seek to 'transport' what works in engineering into healthcare, our approach is to *translate* what works in engineering into healthcare, learning from clinicians whilst challenging the status quo.

“Moving to Cambridge has added another dimension to my interest in systems. I now see design, as an approach to solving problems, as fundamental to systems that consistently deliver good value to the end users, including in healthcare. To improve patient experience, we need to design better delivery systems.

Dr Alexander Komashie

www.cam.ac.uk/bhmresearchers
www-edc.eng.cam.ac.uk

→ Angela on return from a successful IED clearance operation in Helmand Province, Afghanistan

ALUMNI UPDATE

Meet Major Angela Laycock from the Royal Engineers

Major Angela Laycock (Emmanuel, 2001) has spent her career in The British Army working on tasks ranging from building infrastructure to searching for improvised explosive devices (IEDs).

Now a professionally qualified engineer in the Royal Engineers, Angela currently works for 170 (Infrastructure Support) Engineer Group which consists of military engineers and reservists with specialisms in infrastructure.

Angela, how did you get into engineering?

I'd always liked maths and science at school, but I didn't know very much about engineering until I started to look at degree options at sixth form. Civil engineering appealed to me as it was maths and physics, but with a point: to design and build something at the end. During my A-Levels at Welbeck – The Defence Sixth Form College I was encouraged to apply for an Oxbridge place to study engineering. Having not even thought about going to university prior to Welbeck, I was lucky to be offered a place at Emmanuel College where I graduated with the MEng in Civil, Structural and Environmental Engineering.

What did you enjoy most about your Cambridge degree?

The breadth of the general engineering part of the degree has been useful throughout my career. Understanding electrical and mechanical engineering has certainly helped me to become a better civil engineer as I understand the broader parts of the project.

The ability to compete in high level sport whilst studying was also a great opportunity and I'd encourage others to do the same. At Cambridge, I rowed for my college, the University and also the Army. I'm now a cross country mountain biker and I ride for the Army and a civilian team at National Elite level. University is also a great way to build networks and relationships that you'll find yourself coming back to throughout your career, so get to know your fellow students and staff.

How has your career progressed since graduating?

I'd always been keen to join the Royal Engineers as the job varied from building bridges to blowing things up. After Sandhurst, where I was awarded the Sword of Honour for being the top student, I went straight out to Germany where I was deployed to Iraq to command and manage construction projects in Basra.

When I returned from an operational tour in Afghanistan, I suffered problems with my digestive system which was thought to be Crohn's disease and I thought I would be medically discharged from the Army. Luckily, I was able to use the time during my professional training to fully recover and rebuild my fitness.

I completed my professional engineer training in the Army during a two-year course where I studied for an MSc in Military Engineering and worked towards gaining chartered status. During the course, I went on a site placement to the Battersea Power Station Redevelopment Project to gain the experience required to sit the Chartered Professional Review with the Institution of Civil Engineers.

I'm now a Chartered Civil Engineer and I provide specialist engineering advice across the Ministry of Defence. I currently work for 170 (Infrastructure Support) Engineer Group where I look at overseas national infrastructure, how it is connected, and how best to prioritise repair and reconstruction following events such as hurricanes and earthquakes. This year, I move on to Sub-Unit Command where I will manage either a Specialist Team Royal Engineer (STRE) who conducts operation design tasks or a squadron of combat engineers in a regular Royal Engineers Regiment.

What is your advice for women considering a career in engineering?

The construction site is still very male dominated, but just as there are now more women in the design office, there is no reason why more don't work onsite. I found that the men I worked with on a construction site respected my qualifications and the knowledge that I brought. I was able to explain why it was important that things had to be built like they were designed, and I made sure they were working safely. I'd advise anyone to get to know the people you work with, especially the supervisors and project managers. Once they understand the value that you can add it doesn't matter what sex you are.

I really enjoy engineering as it is all around us and it is the reason why things either stand up or fall down. It is great to stand back at a finished project and say, "I helped build that".

Credit: Nick Saffell

The man who helped to preserve Stephen Hawking's iconic voice

Computer officer Peter Benie began programming computers when he was ten. A chance meeting in 2009 led to him playing a key part in the upgrading of the world's most famous synthesised voice. The task involved thinking like a computer.

Shortly before Stephen Hawking died in March 2018, he approved and used a new version of his iconic voice that precisely replicated it. Peter was part of the team that developed this updated version by mirroring the original hardware.

Stephen Hawking lost his ability to speak in the 1980s. The voice that became Stephen's trademark was a speech synthesiser which he operated, by blinking, from a screen fitted to his chair. Advanced at its time, its robotic qualities became Stephen's trademark. This was the voice we heard talking about black holes and cosmology.

Everything physical eventually wears out. After 30 years in use, the hardware was approaching the end of its life. Other much more sophisticated speech synthesiser systems had been developed—but Stephen remained steadfastly loyal to what had become his authentic voice. He didn't want it changed in any way.

My involvement was a matter of chance. In 2009 I met Stephen's graduate student, Sam Blackburn, at the Centre for Mathematical Studies. I was an IT manager working for the Department of Engineering and Sam was Stephen's Graduate Assistant. During a conversation about something mundane, Sam explained that the hardware Stephen used was failing.

When geeks get together, the conversation quickly turns to technology. Soon we were talking about how to create software to emulate the original voice system. This knotty problem is just the kind of puzzle I like solving. And I knew that in taking it on I'd have the bonus of working with some really bright people.

Modern synthesised voices sound more fluent. The hardware that made Stephen's voice was at the limits of technology when it was new. It needed a microprocessor and a specialist digital signal processor (DSP) but was only just capable of producing the voice. Modern computers are orders of magnitude faster so they can run a much more sophisticated model of a voice.

The project to upgrade Stephen's voice went far wider than Cambridge. We had help from some people in the USA, Eric Dorsey and Patti Price, who worked on the original voice system. They analysed the software voice and compared it against the original hardware to check that they really were the same. We also got a spare hardware board from its designer, Hari Vyas—it had been sitting in his garage gathering dust.

It was my task to develop the software emulator. This meant writing thousands of lines of code required to simulate the hardware of the original system. That's not very much but we did it without schematics for the hardware or source code for the software.

All we had is the machine code—a form suitable for computers, not people. By careful examination, I figured out its overall programme structure, and then looked at the detail of how it interacted with the outside world to infer how the hardware must work. To use a very simple analogy, it's a bit like working out exactly how a cake has been cooked to arrive at precisely the same taste and texture.

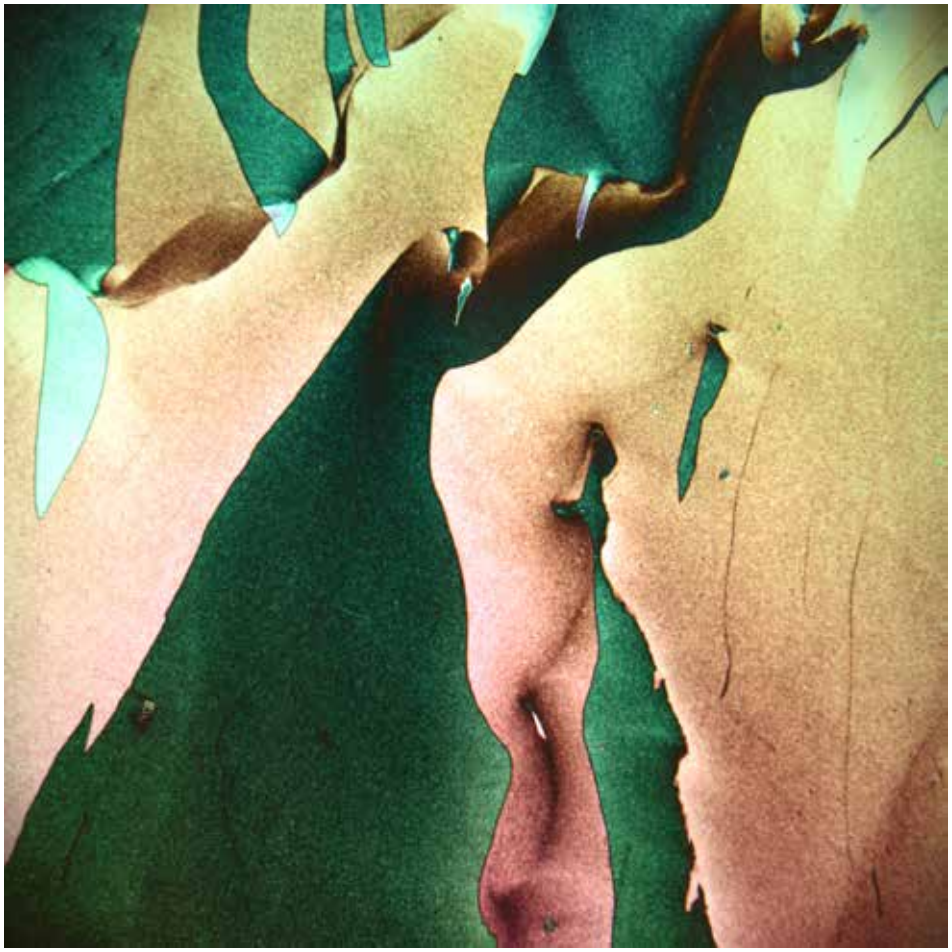
I met Stephen only once. That was when we demonstrated the fully-working software voice. We had a prototype that sounded right-ish just before Christmas 2017, but we knew Stephen had very high standards and we wanted to be completely sure that he would accept the voice. We held off demonstrating it until it was exactly right.

In January 2018, we demonstrated our latest version. We'd measured it and confirmed that it really is the same as the original voice. Stephen liked it—and, naturally, we were thrilled.

In March 2018, Stephen died and the world lost an incredible individual. He never got the chance to speak in public using his upgraded system, but he used it right up until he died. I'm proud to be part of the team that preserved his voice. The voice is part of his identity—you wouldn't use it for someone else—so effectively the voice died with him.

Written by Alex Buxton

medium.com/this-cambridge-life



→ First Prize, Dr Kun Li: Desert vs forest, who is winning?

Engineering artistry on show

The variety and beauty of engineering has been captured in prize-winning imagery submitted into our 2018 ZEISS Photography Competition.

First Prize was awarded to Dr Kun Li, Research Associate in the Cambridge Centre for Photonic Devices and Sensors (CPDS). His microscopic image showed liquid crystal molecules between cross-polarisers. It was taken when Dr Li was examining the uniformity of the structural 'floor' of nanoscale grooves for rod-shaped liquid crystal molecules to rest on. The thin liquid crystal layer can modulate the polarised light and selectively attenuate certain wavelength ranges within the visible spectrum, producing various colours depending on the modulated phase values.

Dr Ivor Day and Dr Anna Young from the Whittle Laboratory won **Second Prize** with a catch-all splatterboard that shows the aftermath of multiple wind tunnel tests using paint. The flow patterns on turbine aerofoils are often visualised by applying paint to the surfaces and then blowing air over them in a wind tunnel. By using different coloured paints on different parts, it is possible to observe the movement of air on the aerofoil surface. In general, only a small fraction of the paint remains on the surface, the rest is blown downstream.

PhD candidate Cyan A. Williams' image of multiple colours drawn from natural materials secured **Third Prize**. Cyan's work in the Cambridge Graphene Centre aims to functionalise cellulose nanocrystals with graphene to produce coloured materials that are biocompatible, renewable and environmentally-friendly. These materials could be used for conductive inks, coloured conductive materials, visibly-responsive sensors and security paper with multiple security checks. A perfectly-ordered film would have a uniform structure and colour. In the image, the structure of the film was 'disrupted' by carbon black. However, if graphene – a two-dimensional form of carbon which conducts electricity – was used instead, it would have had a lower disruptive effect.

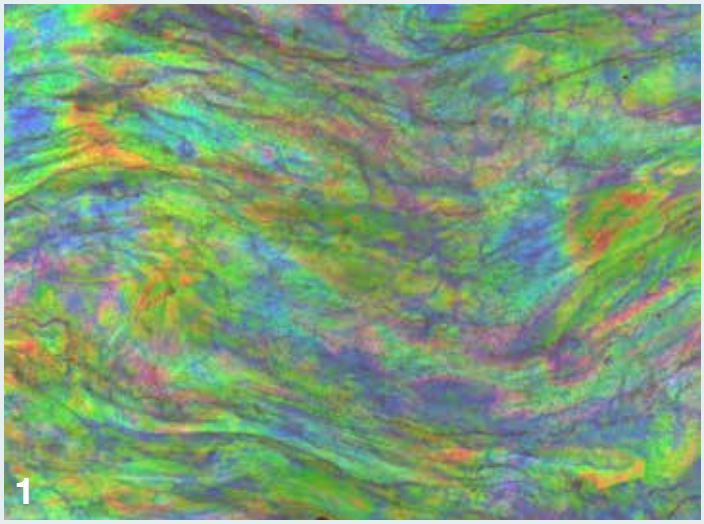
'Nanotube bouquet' won the **SEM Prize**. It was captured using a scanning electron microscope by Sarah Jessl, PhD student, NanoManufacturing, at the Institute for Manufacturing (IfM). A casual glance suggests the carbon nanotubes are in a ball; but actually they are in a bunch, forming a hexagonal honeycomb, which when viewed from the top appears as a symmetrical bud. The Carbon nanotubes are seamless rolled-up graphene sheets that have extraordinary mechanical and electrical properties. Organising these nanotubes into specific structures allows researchers to tweak their properties to certain applications such as energy storage and sensors.

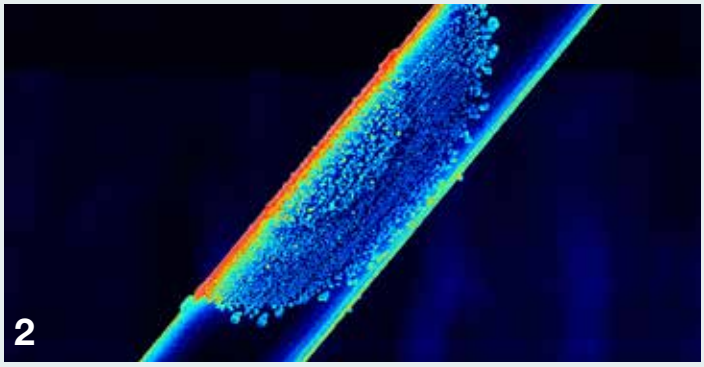
Alumnus Hannis Whittam won the **Head of Department Prize** with a photo taken during the construction of a new pedestrian suspension bridge. In 2015, Hannis travelled to rural Rwanda with colleagues from global consulting company COWI. Over a period of two weeks, they worked with the NGO Bridges to Prosperity (B2P) and the local community to construct the bridge. The local community shared stories about their children and friends who, on their return home from school during the rainy season, had been swept off the existing crossing and drowned. Beneath the new bridge you

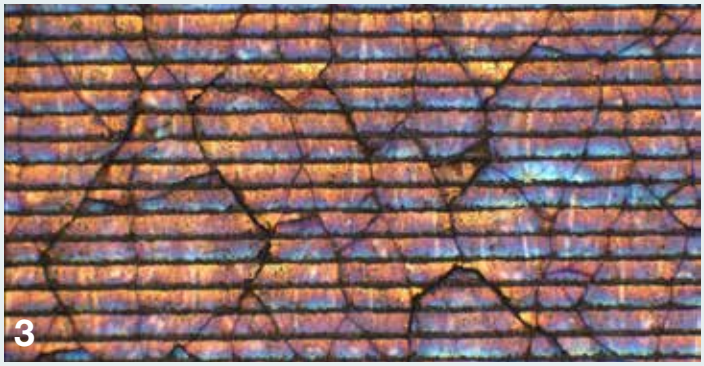
can see the pre-existing crossing still in use – a narrow steel beam that got swept away every time the heavy rains came. This is Hannis' favourite photo. "I love the contrast between the old and new bridges, and the number of locals in the shot show just how busy the river crossing is," he said.

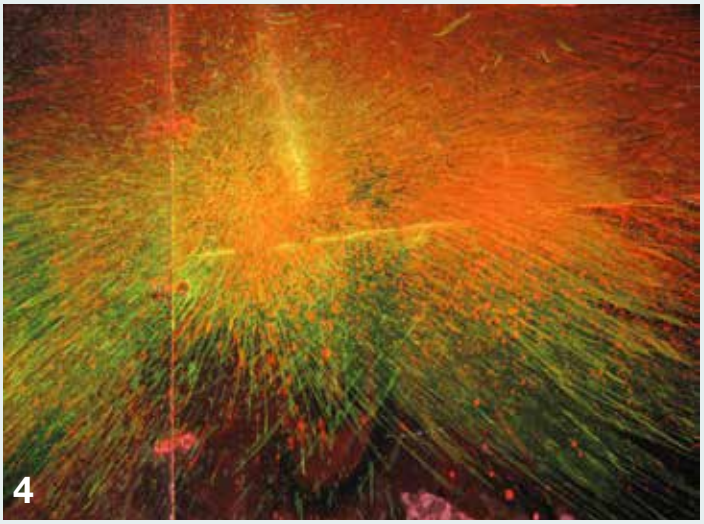
The competition, sponsored by ZEISS (Scanning electron microscopy division), international leaders in the fields of optics and optoelectronics, has been held annually for the last 15 years. The panel of judges included Roberto Cipolla, Professor of Information Engineering; Allan McRobie, Professor of Structural Engineering; Dr Kenneth Png, Senior Applications Engineer at ZEISS Microscopy Customer Centre Cambridge; Dr Claire Barlow, interim Head of Department; and Philip Guildford, Director of Strategy and Operations.

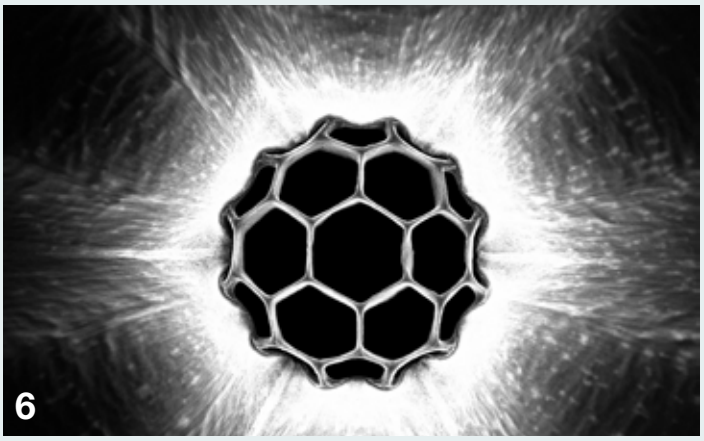
"The competition celebrates the range and reach of engineering in dazzling images: in one photograph we see an exquisite nanoscale structure created in our clean rooms and, in the next, an elegant bridge built from scratch in rural Rwanda," said Philip Guildford. "The creativity and impact of our staff, students and alumni seems boundless."











1: Third Prize, Cyan A. Williams: Sea of imperfection

2: Dr D T L Galhena and Stephen Hodge: Map Lichen

3: Shortlisted, Daniel Gortat: Rainbow Lizard

4: Second Prize, Ivor Day and Anna Young: Aftermath of a flow visualisation experiment

5: Head of Department Prize, Hannis Whittam: Gaseke's Bridge to Prosperity

6: SEM Prize, Sarah Jessl: Nanotube bouquet

The winning images and video can be viewed on the Department's Flickr and YouTube pages:

www.eng.cam.ac.uk/Flickr

www.eng.cam.ac.uk/YouTube

The brain's natural painkilling system – a possible alternative to opioids?

Credit: pixabay

Researchers from the UK and Japan have identified how the brain's natural painkilling system could be used as a possible alternative to opioids for the effective relief of chronic pain, which affects as many as one in three people at some point in their lives.

The team, led by the University of Cambridge, have pinpointed an area of the brain that is important for endogenous analgesia – the brain's intrinsic pain relief system. Their results, published in the open access journal *eLife*, could lead to the development of pain treatments that activate the painkilling system by stimulating this area of the brain, but without the dangerous side-effects of opioids.

Opioid drugs such as oxycodone, hydrocodone and fentanyl hijack the endogenous analgesia system, which is what makes them such effective painkillers. However, they are also highly addictive, which has led to the opioid crisis in the United States, where drug overdose is now the leading cause of death for those under 50, with opioid overdoses representing two-thirds of those deaths.

"We're trying to understand exactly what the endogenous analgesia system is: why we have it, how it works and where it is controlled in the brain," said Dr Ben Seymour of Cambridge's Department of Engineering, who led the research. "If we can figure this out, it could lead to treatments that are much more selective in terms of how they treat pain."

Pain, while unpleasant, evolved to serve an important survival function. After an injury, for instance, the persistent pain we feel saps our motivation, and so forces us towards rest and recuperation which allows the body to use as much energy as possible for healing.

"Pain can actually help us recover by removing our drive to do unnecessary things – in a sense, this can be considered 'healthy pain'," said Dr Seymour. "So why might the brain want to turn down the pain signal sometimes?"

Dr Seymour and his colleagues thought that sometimes this 'healthy pain' could be a problem, especially if we could actively do something that might help – such as try and find a way to cool a burn.

In these situations, the brain might activate the pain-killing system to actively look for relief. To prove this, and to try and identify where in the brain this system was activated, the team designed a pair of experiments using brain scanning technology.

In the first experiment, the researchers attached a metal probe to the arm of a series of healthy volunteers – and heated it up to a level that was painful, but not enough to physically burn them. The volunteers then played a type of gambling game where they had to find which button on a small keypad cooled down the probe. The level of difficulty was varied over the course of the experiments – sometimes it was easy to turn the probe off, and sometimes it was difficult. Throughout the task, the volunteers frequently rated their pain, and the researchers constantly monitored their brain activity.

The results found that the level of pain the volunteers experienced was related to how much information there was to learn in the task. When the subjects were actively trying to work out which button they should press, pain was reduced. But when the subjects knew which button to press, it wasn't. The researchers found that the brain was actually computing the benefits of actively looking for and remembering how they got relief, and using this to control the level of pain.

Knowing what this signal should look like, the researchers then searched the brain to see where it was being used. The second experiment identified the signal in a single region of the prefrontal cortex, called the pregenual cingulate cortex.

"These results build a picture of why and how the brain decides to turn off pain in certain circumstances, and identify the pregenual cingulate cortex as a critical 'decision centre' controlling pain in the brain," said Dr Seymour.

This decision centre is a key place to focus future research efforts. In particular, the researchers are now trying to understand what the inputs are to this brain region, if it is stimulated by opioid drugs, what other chemical messenger systems it uses, and how it could be turned on as a treatment for patients with chronic pain.


Credit: Pexels

Introducing the lettuce peeling robot

Researchers have developed what is believed to be the first robotic lettuce leaf peeling system of its kind.

"There is a growing need to develop automated robotic solutions for agriculture due to increasing demand for food, changing climate conditions and decreasing availability of manual human labour," said PhD student Luca Scimeca. "Our lettuce and stem detection algorithm demonstrates a robot which is robust to clutter, varying lighting conditions, and camera distance, as well as to variations in produce size, shape and orientation."

The novel machine vision pipeline and suction removal/vacuum system, developed in the Department's Machine Intelligence Laboratory, is capable of performing the peeling process – with full leaf removal – 50% of the time, with the process taking an average of 27 seconds to complete.

Sorting crops, such as lettuces, and removing the outer leaves after harvesting is a task currently performed by farm workers. For farm workers this is a very easy task, but for robots, it is a challenging vision and manipulation task and which has so far been difficult for robotic technologies to grasp.

But now the automated removal of lettuce leaves has moved a step closer to reality, after the research team, led by Dr Fumiya Iida, Reader in Robotics, addressed the challenges of handling this soft, fragile produce. Their creation of a 3D-printed circular nozzle, mounted on the end of a robotic arm and tested with a suction system, acts as the single vacuum suction point. It is designed to grab a leaf and remove it from the main body of the lettuce using a tearing action, without causing damage to the produce.

Crucial to the accuracy of the leaf tearing is the use of computer vision to locate and determine the positioning of the lettuce. It does this by first detecting the lettuce stem with the aid of a 2D web camera placed directly above and within the assumed field of vision. In cases where the stem cannot be found, an action will be taken to flip the lettuce over by applying a horizontal force and rolling the lettuce with a soft pad attached to the robot arm. Better positioning of the lettuce can then be achieved with the outer leaf on top and with minimal risk of damage.

The lettuce and stem detection algorithm was tested on 180 pictures of individual lettuces taken with the web camera at heights of between 70cm and 100cm. A total of 10 different iceberg lettuces were used in different positions, and with varying light direction and intensity, with some positioned alongside background objects arranged to represent clutter. In addition, 30 frames were taken after storing the produce for three days, resulting in changes in stem colour. The lettuce detection algorithm was able to accurately locate the centre of the lettuce with 100% accuracy and the stem detection algorithm achieved a detection accuracy of 81.01%. As a result of these findings, the research team were able to identify the optimum lettuce leaf removal point.

Luca Scimeca, from the Biologically Inspired Robotics Laboratory (BIRL), worked on the vision system. He said the robot could be applied to many other crops, such as cauliflower, which is far less fragile and which poses less challenges when it comes to computer vision analysing its orientation.

"Lettuce leaf peeling is an interesting robotics problem from an engineering perspective because the leaves are soft, they tear easily and the shape of the lettuce is never a given," he said. "The computer vision we have developed, which lies at the heart of our lettuce peeling robot, can be applied to many other crops, such as cauliflower, where similar information would be required for the post-processing of the produce.

"However, further work is needed to integrate the three stages: vision detection, rolling system and leaf tearing/removal, into one single end-to-end solution. We propose an approach using a two arm Baxter robot, where the pose estimation and peeling process is combined."

The research was funded by the UK AHDB, the EPSRC CDT in Sensor Technologies, and G's Growers. The research was published in *IEEE Robotics and Automation Letters*.

Watch the robot in action:
youtu.be/paBwuTmNj3s
divf.eng.cam.ac.uk/birl

ALUMNI UPDATE

Meet global sustainability leader Bradley Hiller

Credit: Bradley Hiller

Dr Bradley Hiller's passion to help transition the world onto a more sustainable pathway has led to a number of opportunities – but he says there's much more to do.

In 2018, Bradley received two honours recognising his outstanding contributions to the field of sustainable development. He was announced joint recipient of the Emerging Sustainability Leader Award at the World Sustainability Forum in Beijing, China, and was one of 12 global scholars to be awarded an AsiaGlobal Fellowship to study Asian perspectives on global issues (including sustainable development challenges), hosted by the Asia Global Institute at the University of Hong Kong.

Bradley, you completed both your MPhil in Engineering for Sustainable Development (2008) and your PhD in Sustainable Development (2012) at the Centre for Sustainable Development (CSD). What were the benefits of studying here?

My MPhil research was focused on geothermal energy potential in East Africa as a low-carbon source to help promote sustainable development. It was conducted in collaboration with the German Development Bank. My PhD research was focused on the sustainability of large-scale ecosystem restoration and livelihood improvement interventions in China, Turkey and North Africa, and was conducted in collaboration with the World Bank.

The CSD offered an excellent platform for me to pursue these research interests and provided me with holistic perspectives, equipping me with tangible skills to tackle today's increasingly complex global challenges. One of the CSD's many strengths is the opportunity it provides students to apply mixed methods research approaches (combining quantitative and qualitative methods) to explore various aspects of social, environmental and economic issues associated with engineering-related challenges.

During my PhD, I worked as an associate consultant at the Cambridge Institute for Sustainability Leadership (CISL) alongside former Deputy Director, Aled Jones, to calculate the proportion of total institutional investment going towards 'green' investment. Institutional investors are the world's largest asset holders, so influencing their investment priorities can have a huge impact on sustainability measures and green development. Our findings were presented by HRH Prince of Wales at a meeting of institutional investment leaders in order to identify opportunities to improve green investment.

While undertaking my PhD, I also contributed to a BBC World documentary entitled *Hope in a Changing Climate*, directed by filmmaker John D. Liu and the BBC's Jeremy Bristow. The documentary was aired at the 2009 Copenhagen Climate Conference of Parties and later on BBC World. I was responsible for conducting research and ensuring the script was fact-based.

What other research have you been involved in since completing your PhD?

For the past six years, I have worked in the international development sector, consulting to the World Bank and Asian Development Bank. Recently I worked as part of a specialised team at the World Bank, where we assessed the potential of groundwater as a foundational resource to support sustainable development in Sub-Saharan Africa. At the Asian Development Bank, I work as part of a specialist team which has developed, and is now implementing, an organisation-wide operational framework on climate change to 2030. We hope that this can help transition Asia towards a low-carbon climate resilient development pathway.

What would your message be to those who are considering a career in sustainability?

Today, many indicators taken at the global scale – from climate change and biodiversity loss to land degradation and nitrogen/phosphorous pollution – confirm that human activities are exceeding some of the earth's sustainable limits. This is despite many citizens around the world remaining unserved or underserved when it comes to basic services and human rights. And herein lies one of our great contemporary sustainable development challenges; how to more equitably develop as a global community whilst retaining (or recovering) functional ecosytems.

The needed reform of some of our human-designed systems must occur at a rate and scale unprecedented until now. Hence we need a coalition of emerging sustainability champions to help drive innovative and effective solutions to these challenges. I draw inspiration from Minor Myers Jr, who stated: "Go into the world and do well. But more importantly, go into the world and do good". In this vein, we welcome all interested contributors to join the sustainable development journey.

Cambridge spin-out raises £1.2 million

A Department spin-out developing tiny but powerful sensors has secured £1.2 million in seed funding.

Cambridge Enterprise, the Cambridge Angels and Cambridge Capital Group have completed an initial round of investment in Sorex Sensors Limited.

Sorex Sensors was founded by Professor Andrew Flewitt, Dr Mario de Miguel-Ramos and Professor Bill Milne from Cambridge with co-founders Dr Marina Cole and Professor Julian Gardner from the University of Warwick and Professor Enrique Iborra from the Universidad Politécnica de Madrid.

Sorex Sensors has developed a novel mass sensor which is based on Film Bulk Acoustic Resonator (FBAR) technology. It has several advantages over existing sensors:

- It has high mass sensitivity, down to 1 femtogram (the weight of the average virus particle)
- It is extremely small, being about the same as a human hair in diameter, and can be arranged into arrays (on the same chip) to measure different targets simultaneously
- The sensors have an incredibly low power requirement, allowing them to be operated from a coin cell, battery, mobile phone or even by energy harvesting from an RFID device.

FBARs are manufactured using standard CMOS processes and are currently produced in their billions for the telecoms industry each year as filters and multiplexers, rather than sensors.

Sorex Sensors is initially focusing on film thickness measurement in deposition systems, particle monitoring and specific gas molecule sensing in consumer goods. However, the numerous advantages and versatility of this technology open up a wide range of opportunities in a variety of fields, from explosive detection to biological sensing research equipment. With the low power requirements and the possibility of combining different sensor targets on a single chip, such as particulates and gases, Sorex Sensors has the potential to deliver unique advantages in emerging markets around the Internet of Things.

The company has licensed patents from Cambridge Enterprise and the University of Warwick and will have ongoing collaborations with the University of Cambridge, the University of Warwick and the Universidad Politécnica de Madrid. Its core IP has been granted in the USA and EU.

Sorex Sensors' Director Professor Andrew Flewitt said: "The really exciting aspect of the Sorex Sensors' technology

is that the same device can be tailored to specifically detect a wide range of targets. This allows detection of combinations of targets to be simply realised on a single chip at low cost, such as airborne particulates and pollutant gases. Coupling this with a mobile phone could allow a personal air quality monitoring device."

sorexsensors.com

New alliance to drive innovation and boost construction

The Centre for Digital Built Britain (CDBB) at the University of Cambridge has joined a new alliance to transform the way that infrastructure in the UK is designed, built and used.

The Transforming Construction Alliance brings together the expertise of the MTC (Manufacturing Technology Centre), BRE (Building Research Establishment) and the CDBB, specialising in digital, manufacturing, building performance standards and construction technology.

The Alliance has been awarded £72 million by Innovate UK to deliver the Core Innovation Hub, a key investment to transform productivity in the construction sector within the Transforming Construction Programme, funded from the Industrial Strategy Challenge Fund.

The Hub will act as the focal point for construction-related innovation and will strengthen links between the research base and businesses. It will support collaboration to develop and commercialise digital and manufacturing technologies for the construction sector to enable the schools, hospitals and infrastructure of the future to be built with strong levels of safety, quality and energy performance.

Through the Hub, the CDBB will continue its development of a framework, pilot projects and set of principles to guide the development of digital twins for built assets and infrastructure, to ensure that the data is interoperable, supporting better integration of services across the built environment.

Professor Andy Neely, Pro-Vice Chancellor for Enterprise and Business Relations at the University of Cambridge and Director of the CDBB, said: "The Alliance brings together three trusted organisations with strong research, development and engagement programmes to deliver the evidence base and value case for change, alongside those who will benefit most from it.

"CDBB will collaborate widely to deliver a digital programme that will create the framework to underpin the future built environment and grow export opportunities for the UK."

Credit: pixabay

Digital Manufacturing on a Shoestring project secures £1.6 million

The University of Cambridge has been awarded £1.6 million grant funding to help support the translation of digital capabilities into the manufacturing sector.

The funding, awarded by the Engineering and Physical Sciences Research Council (EPSRC), will support the *Digital Manufacturing on a Shoestring [Digital Shoestring]* project which will be led by Duncan McFarlane, Professor in Industrial Information Engineering, and also involves the University of Nottingham and a significant number of industrial organisations.

Working with a wide range of industrial partners, the project will address a common concern, that recent developments in digital manufacturing are unlikely to be accessible by SMEs, owing to the associated capital cost of upgrading industrial computing and communication environments.

It proposes a radically different approach to the digital evolution of a manufacturing operation by focussing predominantly on non-industrial solutions to industrial automation and information challenges. It will seek to exploit very low-cost commercially available technologies for mobile computing, sensing and Artificial Intelligence (AI), and will tackle the challenges associated with integrating these safely and securely into a small scale manufacturing environment.

The investment marks the continuation of EPSRC's longstanding commitment to foster inter and multi-disciplinary collaboration and support business innovation via digital transformation. It arose out of work conducted by the Connected Everything Network Plus, which was established to create a multi-disciplinary community focussed on industrial systems in the digital age.

Professor Duncan McFarlane said: "This research is focussed on drastically reducing entry barriers for adopting automation systems – especially with small manufacturers in mind. We will exploit the fact that automation is developing at a faster rate outside industry than within it – so that off-the-shelf devices and equipment from other domains can potentially provide a low cost avenue."

Professor Philip Nelson, EPSRC's Executive Chair, said: "The adoption of advanced ICT techniques in manufacturing provides an enormous opportunity to improve growth and productivity within the UK.

"The effective implementation of these new technologies requires a multi-disciplinary approach and these projects will see academic researchers working with a large number of industrial partners to fully harness their potential, which could generate impact across many sectors."

Embracing digital capabilities to transform industries across the UK economy was emphasised in the Government's modern Industrial Strategy, with AI being one of the Grand Challenges in which the UK can lead the world in years to come. In the Artificial Intelligence Sector Deal publication, it was confirmed that AI has the potential to solve complex problems fast, and in so doing, free up time and raise productivity.

> This research is focussed on drastically reducing entry barriers for adopting automation systems – especially with small manufacturers in mind.
>
> Professor Duncan McFarlane

www.digitalshoestring.net

PhD student recognised by Forbes' 30 Under 30 list

PhD student Catherine Richards has been named on Forbes' prestigious 30 Under 30 Europe list for 2019.

The list comprises the most impressive young entrepreneurs and 'bold risk-takers bringing new ideas to Europe'.

Catherine, 29, features in Forbes' Manufacturing and Industry category, recognising those who are 'creating the products, methods and materials of tomorrow'. The Australian was chosen for her leadership and impact in engineering, business and policy following her ongoing research at the University of Cambridge and her nine years' professional experience at government corporation Hunter Water and Fortune 500 corporation ExxonMobil, where, according to Forbes, she helped develop oil and gas well technology that boosted efficiency while reducing the risk of environmental hazards.

"I feel very honoured to have made the Forbes 30 Under 30 list and it's inspiring to know that there's such a diverse group of young leaders and innovators doing fantastic things in so many areas across the world," said Catherine. "I'm thrilled to have joined this dynamic global community."

Catherine is part of The Use Less Group, based in the Department of Engineering. The Group, led by Julian Allwood, Professor of Engineering and the Envrionment, carries out world-leading research into the sustainable use of materials, energy and resources.

Catherine's research seeks to enable industry to make a practical transition to sustainability. This is a new area of research for the Group and combines data science, complex systems modelling and policy analysis to invent a novel decision-making tool that will enable risk-based prioritisation of effective resource use interventions at a national level. Her research is funded by the General Sir John Monash Foundation, Origin Foundation and Cambridge Trust.

Catherine said: "My research aims to address issues related to the level of abstraction and uncertainty in the current sustainability agenda. I'm working at the forefront of an emerging area – and initiating a new area for my research group – by exploring the relationship between resource use and societal collapse for use as an alternate lens to resolve these issues."

Following the completion of her PhD in 2020, Catherine plans to work in a consulting role where she can utilise her skill set to solve a diverse range of problems and influence positive change in business and policy.

"I started my career as an engineer and over the years my passion for business and policy has bloomed, while specialising in resource dynamics and sustainability," she said. "My PhD research is a perfect match for my experience to date and for my future career plans, and I hope that the outputs will stimulate a powerful new way for us to address resource use and sustainability issues in society. I'm passionate about enhancing both economic and social progress by transforming industry and governmental processes with innovative technology and initiatives."

www.uselessgroup.org

ALUMNI UPDATE

Designer of custom-fit 3D printed flip flops runs a marathon in them!

Chris Bellamy studied Engineering from 2008–2012, specialising in the Manufacturing Engineering Tripos.

Following four years working at Jaguar Land Rover, Chris moved to Canada and started working for technology company Wiivv (pronounced weave), which is transforming footwear and apparel for every human body. Wiivv insoles and sandals are created uniquely for each customer, based on measurements taken from the award-winning Wiivv app.

Chris is the Lead Engineer at Wiivv Wearables looking after product engineering. He has developed the Wiivv custom-fit sandal.

Chris ran the 2018 Boston Marathon wearing the sandals he had engineered in a time of 2:59:36.

"During our Kickstarter campaign, I made the bet that if we raised over $500,000, I would run a marathon in the sandal. Much to my surprise, we blew through that target, and during the last year of design and engineering I knew that every decision I made would be under my feet during the marathon!

"The sandal held up better than I could possibly imagine. It really was the ultimate test for my engineering skill and our product. Our work to create the most comfortable biomechanically optimised sandal on the market paid off. I didn't have any pain and was able to race along the marathon unhindered – quite remarkable.

"We definitely aren't recommending our customers run marathons in their Wiivv Custom-fit sandals, it's just an example of what the comfort and biomechanical optimisation has made possible. It's just like a sports car being able to drive at 200mph; you'll never drive it that fast, but knowing that it can, matters!"

Wiivv's custom-fit technology allows customers to capture their foot data from Wiivv's app using their smartphone. Wiivv then uses computer vision and machine learning to automatically process the customer's data, and use it to generate a biomechanically optimised sandal or insole design.

"The Wiivv custom-fit sandal uses a customer's biometric data to create 3D printed custom arch support and position the sandal straps. The end result is an incredibly comfortable and supportive sandal, that is as convenient and good looking as a flip flop!

"Our insole customers kept on telling us they wished there was a way they could use their Wiivv insoles in their sandals, so we decided to make it happen. We were able to use all of our learning around 3D printing and mass customisation from our insole product to develop our sandal. We also have the world's largest database of foot data, which we could use to inform every design decision in creating the sandal."

Wiivv is on course to produce 1 million unique products made in America and around the world by 2020.

There are around 14 billion feet in the world and every single one is unique. Unfortunately, cost, investment, and technology constraints have meant that, until now, people have had to match their feet to the nearest brand and size bucket that best fits their foot and preferences. In addition to this, 8 in 10 people experience foot or back pain, and it is reported that up to 50% of people wear the wrong size shoes.

The footwear market is a $450 billion market with over 20 billion pairs of shoes being produced globally each year. The United States has the highest per capita shoe consumption at 6.9 pairs of shoes per person each year. The normal return rate for the industry is between 20% and 35% – Wiivv's is less than 5%.

Wiivv sees a huge opportunity to deliver perfectly fitting footwear ordered from the comfort of your own home. Being able to capture foot data from a smartphone, in addition to adaptive manufacturing techniques like 3D printing are, according to Wiivv, the keys that will unlock the delivery of custom products at mass produced volumes. Wiivv sandals can currently be ordered in the UK, Spain, USA and Canada at http://wiivv.com

"The Wiivv custom-fit sandal uses a customer's biometric data to create 3D printed custom arch support and position the sandal straps. The end result is an incredibly comfortable and supportive sandal, that is as convenient and good looking as a flip flop!"

Alumnus Chris Bellamy

The boat that Alastair Gregory built

When Alastair Gregory finished writing up his PhD last summer, he found himself with a window of time before he began his postdoctoral researcher post. He decided to build a boat.

This is Alastair's second boat build and for him it is an enjoyable challenge which he hopes might also show the undergraduates how a project like this can be achieved, and how the Dyson Centre for Engineering Design can support such an endeavour in terms of space and equipment. He says, "So much of design is like play, making mistakes and getting it wrong is one of the ways you learn. The Dyson Centre is all about enabling the students to do just that."

The Dyson Centre for Engineering Design is a modern workspace where engineering students can come together outside of the classroom to think, experiment, design, build and exchange ideas. It is a space for hands-on learning, access to information, and the encouragement of creativity and innovation. There are numerous resources for students to use including 3D printing, laser cutting, plasma cutting, Computer Aided Design (CAD) systems, metalwork bench spaces and woodwork bench spaces.

Alastair's PhD was in biomedical engineering and his supervisor was Dr Anurag Agarwal. During his undergraduate degree, Alastair specialised in fluid mechanics and acoustics and his PhD explored breathing in the chest, how wheezing sounds are produced, and understanding the mechanism behind those sounds – the aim being to improve diagnosis of what the sounds mean. Stethoscopes are very cheap and not invasive but they are also not able to accurately identify one sound from another, so Alastair and his team in the Acoustics Lab aim to improve them whilst taking advantage of the fact that they are so easy to use.

Alastair concentrated on studying wheezing sounds for his PhD and he found a mechanism for identifying them. He is continuing with this work, but broadening this research as part of his Junior Research Fellowship in Engineering at Magdalene College. To date, Alastair has concentrated on understanding sound mechanisms and he is now moving on to look at how to diagnose, based on those sounds, using machine learning-based approaches.

> So much of design is like play, making mistakes and getting it wrong is one of the ways you learn. The Dyson Centre for Engineering Design is all about enabling the students to do just that.
>
> Alastair Gregory

Watch our interview with Alastair:
youtu.be/9ACemjyd92o

acoustics.eng.cam.ac.uk/about-us
www.dysoncentre.eng.cam.ac.uk

→ From left, Cambridge undergraduates Yana Lishkova, Chris Barrott and Alexander Johnson

Credit: Marshall Aerospace and Defence Group

Internships: understanding more about aviation

Three engineering undergraduates completed an internship at Marshall Aerospace and Defence Group in Cambridge.

For 10 weeks, Alex Johnson, Chris Barrott and Yana Lishkova experienced different areas of the aerospace business, working alongside highly skilled engineers and mentors, while also gaining hands-on experience of engineering in the real world.

What's been your best experience during your internship?

Alex: Having the opportunity to walk around the Marshall aircraft hangars and to see the work going on with the C-130's, as well as other aircraft, is not something you get to do every day! I have particularly enjoyed seeing the work that is being done inside and outside the aircraft, as it has inspired me to be part of this engineering set up.

Chris: As part of my rotation in the Hercules Technical Support Group, I assisted with surveys of the aircraft and gained invaluable knowledge. It was great fun being on the flight deck during an engine test, which was both fascinating and unlike anything I've ever done before.

What part of the experience has been most beneficial?

Chris: The most beneficial part has been gaining real work experience at a highly respected and well-known aerospace engineering company, and seeing how we can apply what we have learned at university to real projects. I feel that I can return to university now with a much clearer idea of what I want to specialise in.

Yana: I've observed how a project is started, carried out, tested and certified in the aeronautical industry, which is subject to different military standards and procedures. I've also obtained invaluable CAD training which was not something I'd expected to get prior to starting.

How did this internship help with your university course?

Alex: At university, my course usually focuses on the theoretical side of engineering, and the internship has allowed me to use that knowledge in the context of an industrial setting and to gain some practical understanding of my course.

Yana: This internship has enabled me to make a more educated decision for my master's course at university, as well as for my future career path. My mentor has not only provided guidance within the company, but has also taken time to discuss with me the future academic and career options.

Would you consider a career in the aerospace industry?

Alex: I've been interested in engineering and more specifically aerospace since a young age. But as a result of working at Marshall Aerospace and Defence Group, I have experienced aerospace engineering applied in an industrial setting, and I understand more clearly how the industry works and what sort of skills I would need to succeed. I will definitely be working towards a career in aerospace in the future.

Chris: Now that I have worked in different departments, I can see which area best suits me. I feel much more confident in making a future career decision and aerospace is exactly where I want to be.

Would you recommend the Marshall internship to others?

Chris: If anyone wants to get a variety of experience in different engineering disciplines, and also get up close with some of the aircraft here, this internship is perfectly suited.

Yana: Getting work experience at Marshall before completing your degree is incredibly valuable, and I would strongly recommend getting this experience in order to have a better chance of securing a job post-graduation. The internship role is a paid position too which is ideal.

If you are an employer interested in discussing summer internship opportunities for Cambridge undergraduates, please email placements-coordinator@eng.cam.ac.uk

→
marshalladg.com
www.placements.eng.cam.ac.uk

Honours, awards and prizes

Sir Misha Black Medal

The 40th Anniversary Sir Misha Black Medal for Distinguished Services to Design Education has been awarded to P. John Clarkson, Professor of Engineering Design.

He received the Medal at a ceremony held in London, where he delivered a short address on his philosophy on design education and the demands facing design and engineering educators in a rapidly changing society.

Rising Star 2018

Alumna Dr Tara Shirvani has been named one of 2018's UK Rising Stars in Science and Engineering.

WeAreTheCity's Rising Star Awards honour the UK's female talent pipeline below management level. Tara has forged a successful career and is a known expert in green transport and infrastructure solutions, digital and artificial intelligence strategies for mobility, and Middle Eastern energy politics.

Professor's prestigious award

Florin Udrea, Professor of Semiconductor Engineering, is the joint winner of the Royal Society Mullard Award 2018.

Awarded to Professor Udrea FREng and Professor Julian Gardner FREng (University of Warwick) for their work as renowned academics and serial entrepreneurs, together they founded and led Cambridge CMOS Sensors, which is the most successful Cambridge University spin-out in the physical sciences, active in environmental and air quality sensors.

Alumnus awarded the Milne Medal

The British Group of the International Association for Bridge and Structural Engineering's (IABSE) 2018 winner of the coveted Milne Medal is alumnus John Parker.

As Director of Building Structures at WSP in the UK, John has been involved in many of the company's high-profile projects. He led the structural engineering team for The Shard, the London Bridge station redevelopment and HS2's Old Oak Common station.

Recipient of two Fellowships

Dr Luca Magri has been awarded the Hans Fischer Fellowship and the Bernard Lewis Fellowship.

The Hans Fischer Fellowship is for outstanding and talented early-career international scientists who intend to explore innovative, high-risk topics in their scientific research areas together with a Technische Universität München (TUM) Research Group. The Bernard Lewis Fellowship was established to encourage high quality research in combustion by young scientists and engineers.

Talent recognised with award

Alumnus Daniel Dowek has been named Young Structural Engineering Professional of the Year.

He was presented with the award by IStructE (The Institution of Structural Engineers) in recognition of outstanding talent, and for his work on the prize-winning Coastal House project in Devon. Daniel has also worked as Project Engineer for the design and construction of the Weston Tower, Westminster Abbey.

New Fellows announced

Two researchers are among the new Fellows announced by the Royal Academy of Engineering, in recognition of their outstanding contributions.

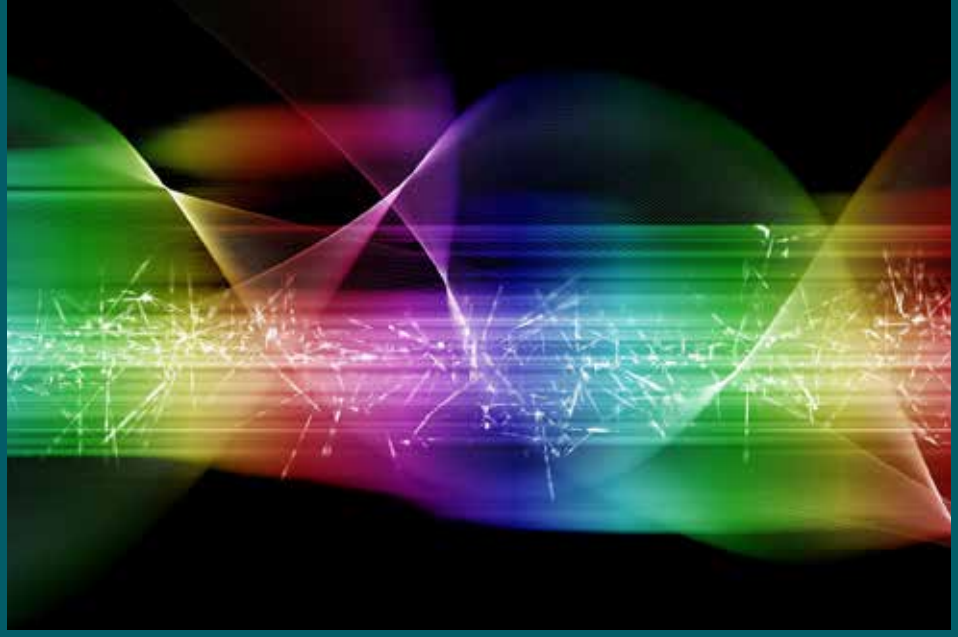
They are Robin Langley, Professor of Mechanical Engineering and Head of the Division of Mechanics, Materials and Design (pictured above), and Professor Andy Neely, Pro-Vice-Chancellor for Enterprise and Business Relations.

Top honour for emeritus professor

Emeritus Professor of Electromagnetism, Archie Campbell, has been honoured with a Lifetime Achievement Award.

The 2018 ICMC (International Cryogenic Materials Conference) Lifetime Achievement Award recognises those who have advanced the knowledge of cryogenic materials through the quality and innovative nature of their work. It also recognises the impact the recipient has had on their field of work and their worldwide reputation.

Cambridge partners in new €1 billion European Quantum Flagship



Credit: pixabay

The University of Cambridge is a partner in the €1 billion Quantum Flagship, an EU-funded initiative to develop quantum technologies across Europe.

The Quantum Flagship is one of the most ambitious long-term research and innovation initiatives of the European Commission. It is funded under the Horizon 2020 programme, and will have a budget of €1 billion over the next 10 years.

The Quantum Flagship is the third large-scale research and innovation initiative of this kind funded by the European Commission, after the Graphene Flagship – of which the University of Cambridge is a founding partner – and the Human Brain Project. The Quantum Flagship work in Cambridge is being coordinated by Professor Mete Atature of the Cavendish Laboratory and Professor Andrea Ferrari, Director of the Cambridge Graphene Centre.

Quantum technologies take advantage of the ability of particles to exist in more than one quantum state at a time. A quantum computer could enable us to make calculations that are well out of reach of even the most powerful supercomputers, while quantum secure communication could power 'unhackable' networks made safe by the laws of physics.

The long-term research goal is the so-called quantum web, where quantum computers, simulators and sensors are interconnected via quantum networks, distributing information and quantum resources such as coherence and entanglement.

The potential performance increase resulting from quantum technologies may yield unprecedented computing power, guarantee data privacy and communication security, and provide ultra-high precision synchronisation and measurements for a range of applications available to everyone, locally and in the cloud.

The new Quantum Flagship will bring together academic and industrial partners, with over 500 researchers working on solving these problems, and help turn the results into technological opportunities that can be taken up by industry.

In close partnership with UK, Italian, Spanish, Swedish universities and companies, Cambridge will develop layered quantum materials and devices for scalable integrated photonic circuits, for applications in quantum communication and networks.

Cambridge is investigating and refining layered semiconductors just a few atoms thick, based on materials known as transition metal dichalcogenides (TMDs). Certain TMDs contain quantum light sources that can emit single photons of light, which could be used in quantum computing and sensing applications.

These quantum light emitters occur randomly in layered materials, as is the case for most other material platforms. Over the past three years, the Cambridge researchers have developed a technique to obtain large-scale arrays of these quantum emitters in different TMDs and on a variety of substrates, establishing a route to build quantum networks on compact chips. The Cambridge team has also shown how to electrically control emission from these devices.

Additionally, the researchers have found that TMDs can support complex quasi-particles, called quintons. Quintons could be a source of entangled photons – particles of light which are intrinsically linked, no matter how far apart they are – if they can be trapped in quantum emitters.

These findings are the basis of the work being done in the Quantum Flagship, aimed at the development of scalable on-chip devices for quantum integrated photonic circuits, to enable secure quantum communications and quantum sensing applications.

"Quantum technology is a key investment area for Europe, and layered materials show great promise for the generation and manipulation of quantum light for future technological advances," said Professor Ferrari. "The Graphene Flagship led the way for these large European Initiatives, and we are pleased to be part of the new Quantum Flagship. The Flagships are the largest and most transformative investments in research of the European Union, and will cement the EU leadership in future and emerging technologies."

qt.eu
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