SPRING 2025
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DEPARTMENT OF ENGINEERING

NEWS

UNIVERSITY OF CAMBRIDGE

In this issue

Join Cambridge University Engineers' Association (CUEA)

CUEA is an organisation for all current and past members of the University who are affiliated with Engineering.

The general aim of CUEA is to contribute to improving the effectiveness of current and future engineers who have been or are associated with the Department of Engineering.

Founded in 1928, for many years CUEA operated as a largely independent charity. However, in 2024, it was agreed to transfer the organisation into a charitable trust within the governance of the University, strengthening links with the Department.

Membership of CUEA is free. Sign up at: www.cuea.uk/about/membership

To join the organising committee email: enquiries@cuea.uk

Cover image: Chris Tagnon, the first University of Cambridge student to be awarded a Masters in Motorsport scholarship from the Royal Academy of Engineering and Mission 44. Credit: Mission 44.

Note from the editors

Welcome to the Spring 2025 edition of the Department Newsletter.

We hope you will take up the invitation to join Cambridge University Engineers' Association (CUEA) – see contact details below left.

CUEA are supporting our engineering students by:

- Facilitating alumni to support engineering students in areas complementing the formal curriculum, including projects, work experience and personal development.
- Offering financial and advisory support to student projects ranging from one- or two-person activities via the Department's Dyson Centre for Engineering Design to the Department's large team, multi-year, student-led projects and industry partnership projects.
- Managing a successful mentoring scheme, which is open to alumni as mentors and as mentees, but, most significantly, provides many alumni mentors for undergraduate mentees.
- Providing CV guidance and practice interviews for undergraduates, and recently, a new scheme has been launched to further encourage and recognise practical experience beyond the curriculum.

CUEA also organises events such as the annual alumni dinner, evening lectures and social events in Cambridge and in London, and visits to sites of engineering interest.

Charlotte Hester and Jacqueline Saggers
Email: marketing@eng.cam.ac.uk

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Head's welcome

Welcome to this latest edition of the Department of Engineering News for Spring 2025.

There continue to be some significant developments for the Department since the last edition. The Engineering 'Move West' programme is almost at the end of RIBA stage 1 of design, where we have identified some options for the department of the future, which will start to crystallise over the coming year. The planned total redevelopment of the Roger Needham Building for Engineering has passed RIBA stage 2 now and will hopefully soon be at stage 3, with the current plan to start work in 2026. Construction on the new Whittle Laboratory is on track to complete later this year.

The new MPhil in Electrical Engineering is still in the planning stages but has progressed further through the approvals process and is due to have its first intake of students in Michaelmas term 2026.

The reform of Part I continues to move forwards. Given the complexity of redeveloping many of our labs, coupled with the opportunities associated with a new teaching block in West Cambridge potentially happening somewhat sooner than anticipated, the new Part I should launch in Michaelmas 2027.

Looking through this edition of the newsletter, starting with the cover story, which appears on **page 7**, you will see that one of our ISMM MPhil students, Chris Tagnon, has been awarded a Masters in Motorsport scholarship. This is a joint award from the Royal Academy of Engineering and Sir Lewis Hamilton's charitable foundation Mission 44.

On **pages 4 and 5** are two examples of where AI is being used as a tool. In the first case, a wearable smart choker has been developed by Professor Luigi Occhipinti from Electrical Engineering – it uses a strain sensor integrated with graphene layers to pick up tiny movements in the throat for speech recognition even in the absence of any sound. It uses a neural network to recognise the electrical signals that arise when specific words are spoken, based on the movement of the throat. The second story is on the development of a machine learning algorithm to detect heart murmurs in dogs, which becomes an increasing issue as dogs age. Ultimately, this paves the way towards targeted healthcare and less invasive testing and will assist vets and owners with treatment planning.

On **page 9** is a precis on some work carried out by Dr Dante McGrath of the Centre for Climate Repair on work the Centre is involved in in trying to prevent further mass coral bleaching events at the Great Barrier Reef. There has been an unprecedented number of these mass bleaching events in recent years, which are largely associated with the stress induced as a result of rising sea temperatures.

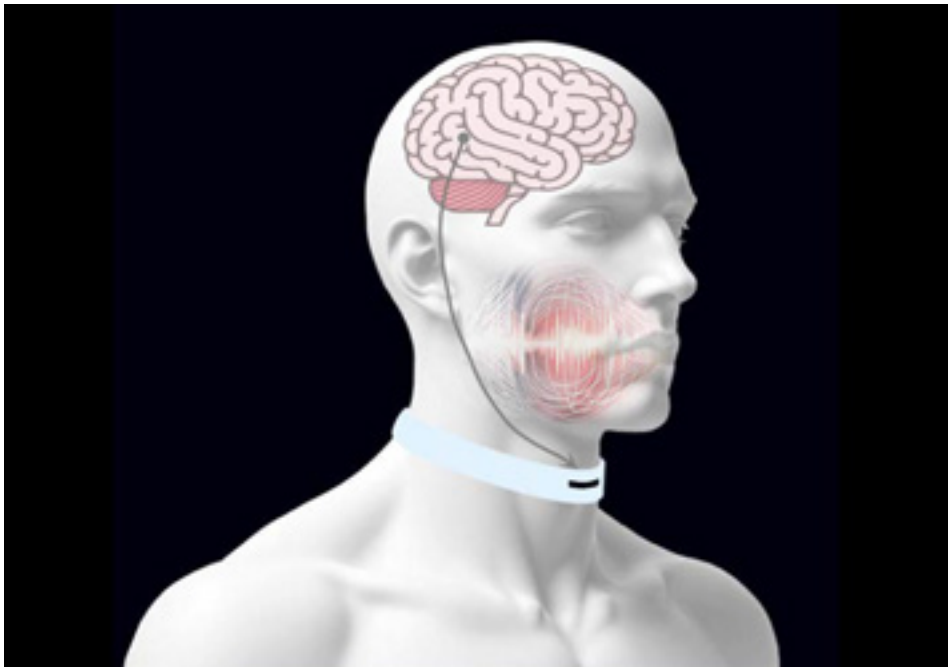
On **page 15** you will see the work being undertaken by our own Dr Brian Sheil on a third-year project, which involves building a 13-metre-long bridge, where we are taking a problem-based learning approach to a civil engineering construction problem. This highly innovative approach is very much appreciated by our students and it is an opportunity not only to learn, but to test new and old ideas and to hear from some industry experts.

Then on **page 21** is a report on a technique for optical quality control of metal surfaces, known as Directional Reflectance Microscopy (DRM), being developed by Dr Matteo Seita. This simple, low-cost imaging process can be used to elucidate information about the microstructure of materials, which can then be used in quality control applications.

Throughout the rest of the newsletter, you will see a range of stories about faculty, alumni and undergraduates, and as always, I hope you will find something interesting.

Professor Colm Durkan FIET, FInstP

→ Micromovements in the throat are captured by an ultrasensitive strain sensor integrated into a smart choker, comprising a textile substrate with an overlying structured graphene layer



Credit: Mr Zibo Zhang from University College London

Graphene-based wearable strain sensor can detect and broadcast silently mouthed words

A wearable 'smart' choker for speech recognition has the potential to redefine the field of silent speech interface (SSI), say researchers – thanks to embedded ultrasensitive textile strain sensor technology.

Where verbal communication is hindered, such as in locations with lots of background noise or where an individual has an existing speech impairment, SSI systems are a cutting-edge solution, enabling verbal communication without vocalisation. They are a type of electronic lip-reading using human-computer interaction.

In new research led by the University of Cambridge, an overlying structured graphene layer is applied to an integrated textile strain sensor for robust speech recognition performance, even in noisy environments.

Worn around the neck, the smart choker captures micromovements in the throat, which are then picked up by the strain sensor as an electrical signal and fed into brain-inspired computer software models for processing and speech recognition. It can pick up even silently mouthed words and broadcast them, which could help someone who is unable to speak, following laryngeal surgery, for example.

The smart choker's unique structure features ordered thorough cracks on graphene-coated textiles. The structured graphene layer significantly enhances the sensitivity of the strain sensor. It can dynamically respond to throat micromovements, enabling the capture of information-rich speech signals. These signals are then processed through a computationally efficient neural network, with a record accuracy of 95.25% in speech decoding.

The results, reported in the journal *npj Flexible Electronics*, offer a promising, non-invasive solution for practical, wearable SSI systems, paving the way for seamless, natural silent communication in diverse settings.

The proposed SSI system is robust and able to decode a wide range of words, while swiftly adapting to new users and vocabularies. The technology was recently showcased as a live demonstration at the IEEE BioSensors 2024 conference, attracting the attention of 180+ participants to the event.

The research was led by Professor Luigi G. Occhipinti, Director of Research in Smart Electronics, Biosystems and AI, and Head of the Occhipinti Group in the Electrical Engineering Division at the Department of Engineering and the Cambridge Graphene Centre.

Professor Occhipinti said: "Our user-friendly smart choker demonstrates a remarkable ability to efficiently perform in real-world scenarios with users of different genders, geographical and ethnic backgrounds, across new and potentially ambiguous words of varying lengths and familiarity, and at varying reading speeds.

"Our SSI system operates with high precision and computational efficiency in distinguishing the speech of different users against different types of noise, caused by sensor imperfections, the external environment, and or from the users' own body movements while wearing the device.

"Furthermore, the fabrication method of our ultrasensitive textile strain sensor technology is biocompatible, simple, low cost, and scalable. It is also adaptable to prolonged use and can withstand more than 10,000 stretching-releasing cycles while maintaining stable and reliable electrical functionality.

"Put simply, the synergy of our sensor design and neural network optimisation sets a new standard in wearable silent speech communication technologies, offering a comfortable smart choker with groundbreaking potential."

> The synergy of our sensor design and neural network optimisation sets a new standard in wearable silent speech communication technologies, offering a comfortable smart choker with groundbreaking potential.
>
> Professor Luigi G. Occhipinti

→ **Open access paper:**
www.eng.cam.ac.uk/smart-choker

→ Huxley, a healthy Havanese, undergoes a physical examination at the Queen's Veterinary School Hospital, Cambridge

Credit: Jacqueline Garget

AI algorithm accurately detects heart disease in dogs

Researchers have developed a machine learning algorithm to accurately detect heart murmurs in dogs, one of the main indicators of cardiac disease, which affects a large proportion of some smaller breeds such as King Charles Spaniels.

The research team, led by the University of Cambridge, adapted an algorithm originally designed for humans and found it could automatically detect and grade heart murmurs in dogs, based on audio recordings from digital stethoscopes. In tests, the algorithm detected heart murmurs with a sensitivity of 90%, a similar accuracy to expert cardiologists.

Heart murmurs are a key indicator of mitral valve disease, the most common heart condition in adult dogs. Roughly one in 30 dogs seen by a veterinarian has a heart murmur, although the prevalence is higher in small breed dogs and older dogs.

Since mitral valve disease and other heart conditions are so common in dogs, early detection is crucial as timely medication can extend their lives. The technology developed by the Cambridge team could offer an affordable and effective screening tool for primary care veterinarians and improve quality of life for dogs. The results are reported in the *Journal of Veterinary Internal Medicine*.

"Heart disease in humans is a huge health issue, but in dogs it's an even bigger problem," said first author Dr Andrew McDonald from Cambridge's Department of Engineering. "Most smaller dog breeds will have heart disease when they get older, but obviously dogs can't communicate in the same way that humans can, so it's up to primary care vets to detect heart disease early enough so it can be treated."

Professor Anurag Agarwal, also from Cambridge's Department of Engineering, who led the research, is a specialist in acoustics and bioengineering. "As far as we're aware, there are no existing databases of heart sounds in dogs, which is why we started out with a database of heart sounds in humans," he said. "Mammalian hearts are fairly similar, and when things go wrong, they tend to go wrong in similar ways."

The researchers started with a database of heart sounds from about 1,000 human patients and developed a machine learning algorithm to replicate whether a heart murmur had been detected by a cardiologist. They then adapted the algorithm so it could be used with heart sounds from dogs.

The researchers gathered data from almost 800 dogs who were undergoing routine heart examination at four veterinary specialist centres in the UK. All dogs received a full physical examination and heart scan (echocardiogram) by a cardiologist to grade any heart murmurs and identify cardiac disease, and heart sounds were recorded using an electronic stethoscope. By an order of magnitude, this is the largest dataset of dog heart sounds ever created.

"Mitral valve disease mainly affects smaller dogs, but to test and improve our algorithm, we wanted to get data from dogs of all shapes, sizes and ages," said co-author Professor Jose Novo Matos from Cambridge's Department of Veterinary Medicine. "The more data we have to train it, the more useful our algorithm will be, both for vets and for dog owners."

The researchers fine-tuned the algorithm so it could both detect and grade heart murmurs based on the audio recordings, and differentiate between murmurs associated with mild disease and those reflecting advanced heart disease that required further treatment.

"Grading a heart murmur and determining whether the heart disease needs treatment requires a lot of experience, referral to a veterinary cardiologist, and expensive specialised heart scans," said Professor Novo Matos. "We want to empower general practitioners to detect heart disease and assess its severity to help owners make the best decisions for their dogs."

Analysis of the algorithm's performance found it agreed with the cardiologist's assessment in over half of cases, and in 90% of cases, it was within a single grade of the cardiologist's assessment. The researchers say this is a promising result, as it is common for there to be significant variability in how different vets grade heart murmurs.

"The grade of heart murmur is a useful differentiator for determining next steps and treatments, and we've automated that process," said Dr McDonald. "For vets and nurses without as much stethoscope skill, and even those who are incredibly skilled with a stethoscope, we believe this algorithm could be a highly valuable tool."

Written by Sarah Collins

Open access paper:
www.eng.cam.ac.uk/dog-heart-sounds

Engineer awarded prestigious Royal Society Career Development Fellowship

Credit: Aisha Ife

Electrical engineer Dr Stephanie Adeyemo is among the first cohort of eight outstanding Career Development Fellows (CDFs) announced by the Royal Society – aimed at addressing underrepresentation in UK STEM academia.

The Royal Society Career Development Fellowships are currently running as a pilot for talented researchers from Black and Mixed Black heritage who have just completed their PhDs. They offer up to £690,000 in research funding to undertake high-quality research and a comprehensive programme of mentoring, training and networking opportunities over four years, supporting award holders in establishing a successful research career in the UK.

This first cohort are undertaking groundbreaking research that can benefit society and further human understanding.

Dr Adeyemo, who completed her PhD in Engineering at Cambridge, is a Junior Research Fellow in Electrical Engineering at Newnham College. Her research focus – *engineering novel ultrabroadband polarisation-sensitive terahertz detectors* – aims to improve the bandwidth performance of terahertz detectors highly sensitive to the polarisation of terahertz waves.

Dr Adeyemo's novel terahertz detector will be the foundation for a high-speed terahertz camera suited for high-resolution imaging technologies in medical and security applications. Terahertz technologies are now entering real-world applications, and her novel terahertz detector will undoubtedly play a major role in these applications.

"Detecting a broader terahertz bandwidth with a polarisation-sensitive detector is of great importance," said Dr Adeyemo. "It allows us to fully exploit and maximise all the advantageous features of the entire terahertz frequency band, which is beneficial for the advancement of future technologies."

She added: "Terahertz waves are non-destructive and can penetrate through many non-conducting materials, which makes it exciting for imaging applications. Also, the rapid increase in data traffic, due to the growing usage of online services, has sparked a great interest in terahertz for future generations of resilient wireless communication to deliver higher data rates, as today's 5G technology lie just below terahertz frequencies."

The CDF scheme was launched in response to 11 years' worth of higher education data, which shows Black heritage researchers leave academia at higher rates than those from other groups.

The impact of this higher attrition rate is pronounced at senior levels of academic careers. Analysis of the 2022/23 Higher Education Statistics Authority data, undertaken by Jisc on behalf of the Royal Society, shows just 3% of Black heritage staff were working at F1 professor level. This compares to 13% of White STEM academics working at professor level, 7% Asian, 6% Mixed and 5% Other.

The CDFs will have access to networking and mentoring opportunities supported by the Black British Professionals in STEM (BBSTEM) network.

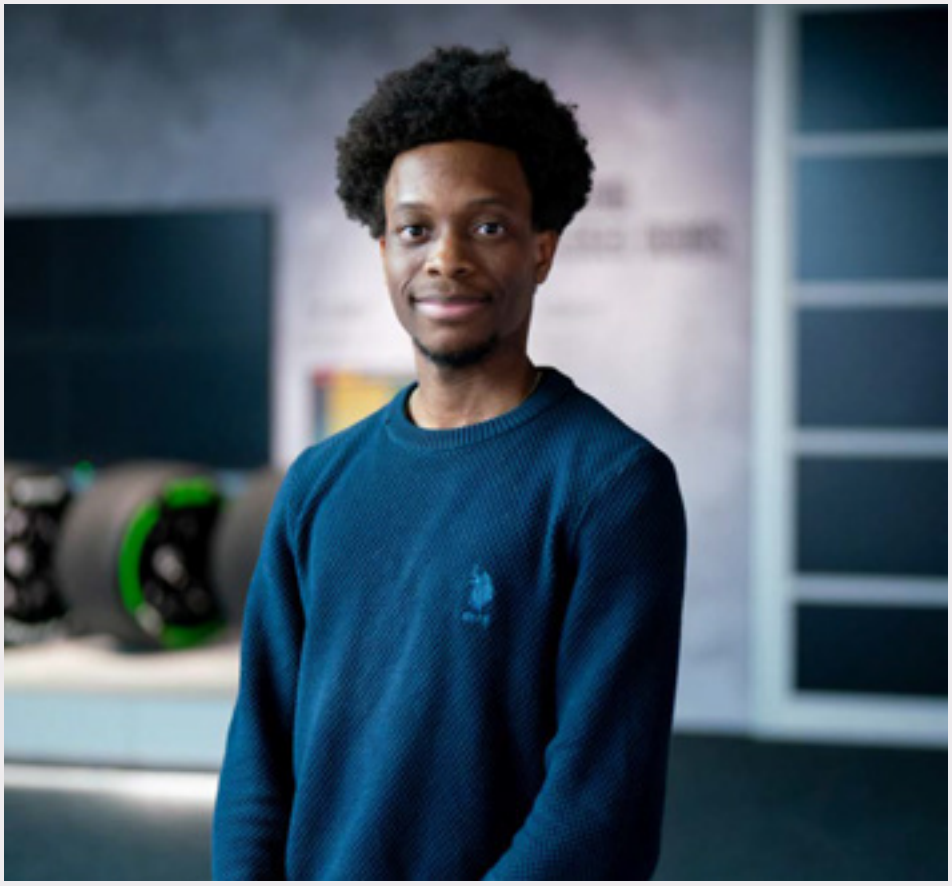
Dr Adeyemo is also a co-founder of AfriteQ Academy and Cambridge Terahertz Network. At AfriteQ Academy, she is joined by her sister and fellow engineer Lois Adeyemo in organising programmes and mentorship schemes to encourage and equip young students to pursue careers in engineering. At Cambridge Terahertz Network, Dr Adeyemo and PhD student Yuxuan Liu organise talks in the terahertz field and bring together terahertz researchers from across the University, and city, to discuss challenges and progress in the field.

"I am excited to be among the inaugural cohort of the Royal Society Career Development Fellowship," said Dr Adeyemo. "I believe this scheme is timely and I hope to see its ripple effect in the near future, where talented researchers from underrepresented backgrounds can confidently pursue an academic career and become leaders in their fields."

Sir Adrian Smith, President of the Royal Society, said: "We need an academic system where talented researchers can build a career, whatever their background. But we know that is not the case in the UK today – particularly for researchers of Black heritage.

"The variety and quality of research being undertaken by this first cohort of Royal Society CDFs suggests a bright future ahead if we can ensure more outstanding researchers develop their talents and follow their research passions. I hope this pilot and the support it offers can be a launchpad to achieve that."

Student backed by Formula 1 star Sir Lewis Hamilton



Credit: Mission 44

Chris Tagnon is the first University of Cambridge student to be awarded a Masters in Motorsport scholarship from the Royal Academy of Engineering and seven-time Formula 1 world champion Sir Lewis Hamilton's charitable foundation Mission 44.

Chris – who is currently studying an MPhil in Industrial Systems, Manufacture and Management (ISMM) at the Institute for Manufacturing (IfM), part of the Department of Engineering – will receive financial and careers support as part of the scholarship programme.

The programme aims to encourage more students from Black or Mixed Black backgrounds to study for a masters in motorsport engineering or associated discipline, and address the underrepresentation of Black people in UK motorsport. He is one of eight UK graduates to be awarded the scholarship this year.

"Being awarded the scholarship is such a great feeling – especially with the link to Lewis Hamilton," he said. "I started watching Formula 1 with my dad when I was about three years old, and that was around the time Lewis came into it, so I've only ever known it with him as a driver. He's been a massive inspiration for me, with what he's achieved in his career both on and off the track.

"His work to help diversify motorsports is already having a great impact. As scholars we're being given the tools and the sort of opportunities that we need to maximise our potential, and I think that's beneficial not just for us as Black engineers, but also for the whole industry as it widens the talent pool teams get to hire from."

Chris, who is studying at King's College, said he chose the ISMM course at Cambridge to develop a strong foundation in engineering management, and to learn transferable skills that can be applied to the motorsport sector as well as wider afield.

He said: "I've loved motorsport since I was a kid, and now my MPhil is focused on using the same kind of precision-led innovation. Some of the top Formula 1 engineers have come through Cambridge, and I'm really enjoying the learning experience at the University. Performance simulation is definitely where my interest lies – collecting the data, analysing it and continually making improvements.

"I'd like to work at the intersection of motorsport and wider industry, bridging the gap and applying the specialised engineering know-how to impactful applications, like venture development in aerospace, energy or clean mobility. But the ultimate dream is to be a team principal in Formula 1 – there are only 10 in the world!"

The scholarship also offers awardees the benefit of several networking events throughout the year, where they will have the opportunity to meet industry professionals and gain additional experience and knowledge about the sector.

Written by Stephen Bevan

> "I've loved motorsport since I was a kid, and now my MPhil is focused on using the same kind of precision-led innovation. Some of the top Formula 1 engineers have come through Cambridge.
>
> ISMM student Chris Tagnon

→ Asmay Gharia holds a proof-of-concept microelectroporation on a chip. This device uses microfluidics and microelectronics to efficiently insert cargo such as DNA, proteins, or even viruses into cells

Innovative method has the potential to 'revolutionise' biomedical science

Final-year PhD student Asmay Gharia has been announced as the winner of an innovation award given in recognition of his groundbreaking method that has the potential to revolutionise the field of biomedical science.

Asmay, who is a part of the National Institutes of Health (NIH) Oxford-Cambridge Scholars Program, has developed a novel technique for cellular electroporation that promises to enhance the efficiency and effectiveness of gene modification.

Asmay's technique can shrink down the electroporation process (used to modify cells via an electric pulse) with the aid of a conducting polymer that enables the creation of small, low-cost devices that can efficiently modify cells, anywhere, using only a few volts.

His innovative method, which has already attracted significant interest and acclaim within the scientific community, has been honoured by the International Biomedical Research Alliance (IBRA) with the 2024 John and Alice O'Shea Innovation Award for Novel Solutions in Biology or Medicine.

Asmay's discovery comes at an important time, given recent advances in personalised cell therapies, wherein a patient's cells are engineered into a living treatment, such as CAR-T cell therapy – personalised immunotherapy for cancer, which is already commercially available.

"We are exploring several cell types with therapeutic potential. While T cell-based therapies (e.g. CAR-T) are better known and commercially available, they haven't historically worked well in solid tumours," said Asmay.

"We are working with groups at the National Cancer Institute in the US to explore other cell types, like macrophages, that work better in solid tumours but are difficult to modify."

Asmay spent the first two years of his PhD (2020-22) in the Department of Engineering's Bioelectronics Laboratory designing, fabricating and testing early prototypes of his electroporation technology.

He said: "The huge benefit of our technology is that we maintain high efficiency in difficult-to-transfect cell types, which can open a new frontier in the types of cells feasible for use in cancer therapy.

"Despite their great promise, cell therapies are incredibly expensive, ranging from $500,000 to $2 million per patient due to complex logistics and expensive production equipment.

"Devices such as ours will enable decentralised bioproduction of these treatments, reducing research costs and improving accessibility to cutting-edge personalised treatment around the world."

He added: "It is an incredible honour to receive the John and Alice O'Shea Innovation Award in recognition of my research in high efficiency bioelectronic cell engineering systems. My long-standing goal has been, and continues to be, reshaping manufacturing of personalised therapies to accelerate their development and promote accessibility."

An IBRA spokesperson said: "Asmay Gharia has invented a groundbreaking method for cellular electroporation with the potential to revolutionise the field of biomedical science. His innovative work has already attracted significant interest and acclaim within the scientific community."

Reflecting on his time spent in the Bioelectronics Laboratory under the leadership of Professor George Malliaras, Asmay said that his colleagues in the lab continue to be major sources of support and inspiration to him today.

"Professor Malliaras cultivated a highly collaborative and innovative lab culture of brilliant people who would constantly troubleshoot each other's problems while planning how they are going to change the world," he said. "It was the perfect environment to take scientific risks while learning how to be an engineer and a scientist."

→ Real-world experiments on marine cloud brightening and fogging have taken place at the Great Barrier Reef – techniques that could temporarily protect it from the worst of the Australian summer heat

Dr Alejandro Tagliafico/Southern Cross University

Buying time: can science save the Great Barrier Reef?

If we don't stop global temperatures – both on land and at sea – from rising, the Great Barrier Reef could become a coral graveyard. A team of scientists has decided to do something about it.

The Great Barrier Reef is an Australian – and global – icon. The world's largest coral reef system is filled with an abundance of marine life and is one of the world's most popular tourist destinations.

But due to the impacts of human-caused climate change, this wonder of the natural world is at risk. Extreme heatwaves, which are becoming more severe and more frequent, cause corals to suffer and possibly die in what are known as coral bleaching events.

"It's a bit embarrassing to admit, but Finding Nemo really inspired me as a kid," said Dr Dante McGrath, postdoctoral researcher in the Centre for Climate Repair, based in Cambridge's Department of Engineering. "When the film came out, I thought how much I wanted to go and see the Great Barrier Reef for myself. I grew up in Australia, and I was lucky to have that childhood dream come true not long after the film came out, and it was everything I'd dreamed it would be."

The focus of Dr McGrath's work is marine cloud brightening, a technique that sprays a salty mist into the sky to increase the reflectivity of low-lying clouds at sea, so that more sunlight is bounced back into space, providing a temporary cooling effect. Specifically, he studies seawater droplets and how to spray them using specialised nozzles to encourage the process of cloud condensation.

Last year, at the height of the Australian summer, Dr McGrath was part of a team led by Southern Cross University that spent nearly a month on the Great Barrier Reef, carrying out real-world experiments on marine cloud brightening and fogging: techniques that could temporarily protect the reef from the worst of the Australian summer heat. The experiments, led by Professor Daniel Harrison of Southern Cross University, were conducted as part of the Cooling and Shading subprogramme of the Reef Restoration and Adaptation Program (RRAP).

It is a worrying time for coral reefs. In April 2024, after a year of extreme heat in the world's oceans, the US Government's National Oceanic and Atmospheric Administration (NOAA) declared a global mass bleaching event for just the fourth time on record, and the second time in the past decade.

The Great Barrier Reef has been a frontline for bleaching events. In the three decades before 2016, just two mass bleaching events were documented on the reef, but since 2016, the UNESCO World Heritage Site has suffered five mass bleaching events.

"Coral bleaching is a natural phenomenon, but now, bleaching happens so frequently that the corals don't have enough time to recuperate and respawn, so large parts of the reef have this white, ghostly quality to them," said Dr McGrath. "If we don't do something about it, the whole reef could be lost."

Recent modelling studies have suggested that marine cloud brightening could buy the Great Barrier Reef valuable time while we transition away from fossil fuels. "None of us on this project, or anyone working on marine cloud brightening, believes it's a substitute for getting away from fossil fuels as quickly as we can," said Dr McGrath. "Cutting emissions has got to be our number one priority, but we're reaching the point where we can't wait any longer for that to happen."

In January 2024, Dr McGrath joined Harrison and his Southern Cross University colleagues, along with the rest of the RRAP team, as they set out from Townsville in Queensland aboard two small research vessels to continue the fogging and marine cloud brightening experiments that RRAP has been conducting since 2020.

Marine cloud brightening is not without its critics, and it has potential risks as well as benefits. The work of the RRAP team, however, is not focused on solar 'geo-engineering' proposals for cooling and shading the whole planet, but is localised and temporary, and relies on relatively benign sea salt particles. Dr McGrath likens the team's marine cloud brightening work to the relief provided by a parasol or a large tree on a hot sunny day.

During the research trip, the team was usually up at first light to prepare the sprayers and begin their tests well before the worst of the day's heat. Typically, they would spray the salty mist for between four and six hours from sprayers on the deck of the larger of the two boats, while the smaller boat followed along behind, tracking and monitoring the plume. In addition, drones and a small aircraft were deployed to measure cloud and atmospheric properties.

"To get up close and personal with the reef, it really hits home how fragile the reef is, and how important it is that we do everything we can to save as much of it as we can," said Dr McGrath.

Written by Sarah Collins

Read the full article at:
www.eng.cam.ac.uk/great-barrier-reef
Watch the video:
youtu.be/MxHSCVmUktI

Credit: Wordware

↑ Wordware co-founders Robert Chandler (CTO), left, and Filip Kozera (CEO), right

ALUMNI UPDATE

AI start-up founded by Cambridge alumni raises $30 million

An alumni duo behind the founding of Wordware – a full-stack operating system for AI development – have secured $30 million in seed funding to transform how AI solutions are built and deployed.

Filip Kozera (CEO) and Robert Chandler (CTO) met nearly 10 years ago while reading deep learning at the University of Cambridge.

Their company, Wordware, enables anyone to create, iterate and deploy AI agents using plain English. By introducing natural language as the new programming language for AI, Wordware empowers domain experts and engineers to collaborate seamlessly in building sophisticated AI solutions.

This latest funding announcement – a $30 million seed round led by Spark Capital, with participation from Felicis, Y Combinator, Day One Ventures, and notable angels – is one of the largest seed rounds in Y Combinator's history.

Wordware has hundreds of thousands of users, and customers like Instacart, Runway, Metadata, AiSDR and more.

"As AI becomes more powerful, communicating our creative vision to it becomes more nuanced, not less," said Filip. "Imagine trying to explain to AI exactly what database to retrieve information from or how you want a design to capture your brand's essence – that's prompt engineering."

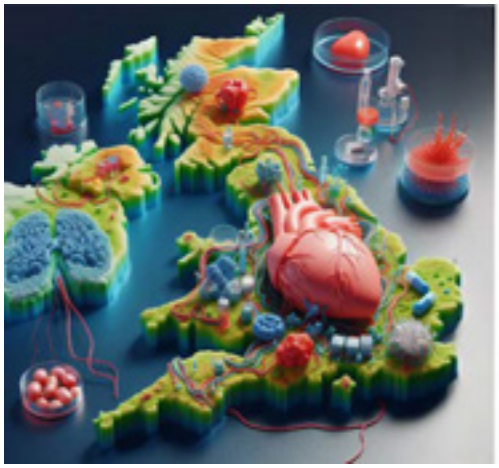
"We're transforming this challenge into an opportunity by making English the new programming language for AI, allowing anyone to orchestrate AI with their unique taste and vision," he added.

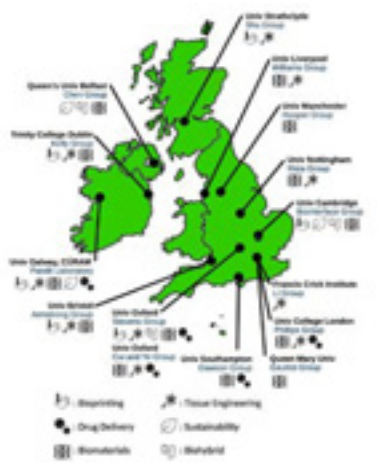
Wordware's development environment functions as a unified workspace where domain experts and engineers can collaborate seamlessly. This enables teams to experiment and bring their ideas to production using Wordware API in weeks and even days (instead of months).

> "With Wordware, making English the new programming language for AI allows anyone to orchestrate AI with their unique taste and vision."
>
> Alumnus Filip Kozera

www.wordware.ai

→ LEFT: Graphic abstract generated with AI. RIGHT: A non-exhaustive regional breakdown of biomanufacturing and biofabrication groups from around the UK and Ireland as of March 2024





Credit: [LEFT] Microsoft Copilot AI

On a pathway to better healthcare – biomanufacturing and biofabrication in the UK and Ireland

We are in the midst of Industry 4.0, where technological convergence, including AI, robotics, and the Internet of Things, has significantly enhanced production efficiency. However, Industry 4.0 is a machine-centred revolution that omits human factors and sustainability.

Industry 5.0 seeks to add human, environmental and social aspects back into the equation by emphasising human-centric processes and personalisation.

As we transition into this Fifth Industrial Revolution (Industry 5.0), researchers warn that more ethical and sustainable practices in life sciences and healthcare are needed – with biomanufacturing and biofabrication being viable solutions.

Propelled by cutting-edge research and development, these emerging fields are rapidly growing in the UK and Ireland, revolutionising healthcare and driving innovation. Examples include the creation of next-generation drugs derived from living organisms, and 3D bioprinting for tissue and organ regeneration.

Writing in the journal *Bio-Design and Manufacturing*, the research team, from across the UK and Ireland, say biomanufacturing and biofabrication techniques should be developed and used to address existing "unethical and unsustainable" practices in the healthcare system. Examples include but are not limited to the millions of scientific procedures being carried out on animals in the UK today, and the long-term consequences of the healthcare industry's large carbon footprint.

The researchers highlight 3D bioprinting (a popular technology capable of 3D printing living tissues), tissue engineering and directed assembly as techniques that can transform bioscience and healthcare – bringing multiple benefits while prioritising sustainability and affordability, and adhering to ethical standards.

"These techniques can be applied *in vitro* to model healthy and disease phenotypes, creating *in vivo* tissue and organ replacements, or fabricating sustainable biomaterials," said first author, Cambridge Engineering PhD student Jack F. Murphy. "Biomaterials are already used widely in medical devices, such as stents and dental implants, but more recently, the focus has been on bioactive biomaterials that interact with living systems and elicit a biological response, such as promoting tissue regeneration."

In 2023, a report by the World Health Organization (WHO) identified 3D printing as an emerging technology that could help solve global health challenges by increasing the supply of organs and tissues for drug screening and transplantation within the next 10 years.

Similarly, in 2023, the UK Department for Science, Innovation and Technology recognised engineering biology as one of the "critical technologies" that will have a large impact on the UK economy by 2030.

Shery Huang, Professor of Bioengineering at the Department of Engineering, University of Cambridge, said: "As we transition through Industry 4.0 and into Industry 5.0 – where we witness humans working with advanced technologies and AI-powered robots – the need for a swift adoption of biomanufacturing and biofabrication techniques has never been greater, especially if we are to meet the national strategies for both the UK and Ireland."

In their review, the researchers provide a snapshot of key biomanufacturing technologies currently being developed and used by research groups from across the UK and Ireland:

- Bioprinting
- Drug delivery
- Biomaterials
- Tissue engineering
- Sustainability
- Biohybrid.

They say there is an urgent need for new initiatives to be established to translate biofabrication in the UK and Ireland over the next three to 10 years:

- Pursuing engineering biology through biofabrication, which does not involve genetic modification, could fast-forward ethical compliance and public acceptance, providing a quicker return on investment.
- Integrating synthetic biology with biofabrication, alongside advances in tissue and cell engineering, and scalable sustainable manufacturing. This is expected to significantly enhance the value and safety of end products and could streamline regulatory processes.

Open access paper:
www.eng.cam.ac.uk/biomanufacturing-biofab

→ EnterpriseTECH STAR students Luke Cullen (left) and Dr Mohammad Saghafifar

Credit: Cambridge Judge Business School

Navigating the journey from technology to market – EnterpriseTECH STAR

Postdoctoral researcher Luke Cullen and research associate Dr Mohammad Saghafifar have been flexing their entrepreneurial mindsets as part of EnterpriseTECH STAR – a programme designed to develop early-stage business ideas on the journey from scientist to entrepreneur.

The 10-week programme, run by the Cambridge Judge Entrepreneurship Centre, combines educational lectures and workshops with personal mentoring sessions from 40 expert mentors. The STAR students begin the programme with a business idea, and the aim is to help them take it to the next stage, whether that is via a place in an incubator or accelerator, winning a competition or attracting pre-seed funding.

Luke Cullen, postdoctoral researcher on the Climate Compatible Growth project, and Dr Saghafifar, Research Associate in Thermo Physical and Thermochemical Energy Storage, were part of the 2024 cohort.

Luke Cullen – Automating accurate carbon emissions reporting

Luke is the founder of Just Decarbonise – a platform for automating carbon emissions estimates in supply chains.

With a background in geophysics and machine learning, Luke has spent the past three years building a model to automate the estimation of greenhouse gas emissions within supply chains.

He takes a systems approach, providing immediate emissions estimates specific to a company, and iteratively reduces the uncertainty as more related data becomes available.

The model is currently trained for the petrochemical industry, and this is where Luke intends to focus his attentions first, his target market being corporate sustainability teams.

He said: "Supply chains are opaque and getting data specific to your products is challenging. Companies are spending resources on product life-cycle assessments but cannot afford to do these assessments for all products and keep them up to date.

"A company's supply chain sits in a system of many possible product paths. I use a systemic structure to reduce the need for company-specific data and exploit the similarities of related data. This could provide a significantly cheaper option for companies.

"Successfully launched and adopted, this technology could form the bedrock for accurate and enforceable carbon footprinting, accelerating our transition to net zero, and saving lives and habitats."

Dr Mohammad Saghafifar – Carbon capture heat battery

Dr Saghafifar is one of the co-founders of Remedium, where he is dedicated to making carbon capture commercially viable. This initiative continues an idea that he presented at the Falling Walls Lab Cambridge in 2023, integrating the process of capturing CO_2 with another value stream, electricity storage, through the development of a carbon capture heat battery.

The battery operates by storing/releasing electricity and capturing CO_2 from high-emitting industries including cement and steel plants. Carbon capture heat battery monetises the variation in price of electricity to drive down the cost of CO_2 capture, and in some cases, makes carbon capture profitable.

Dr Saghafifar said: "Cement and steel industries emit six billion tonnes of CO_2 each year, and carbon capture is the most feasible CO_2 abatement pathway to decarbonise cement and steel. As of today, the global carbon capture capacity is only 43 million tonnes. Based on the IEA World Energy Outlook report, it has to increase to 4,400 million tonnes by 2040 in order to achieve net zero by 2050. The paramount impediment in large-scale implementation of carbon capture is not the technology but its cost. Capturing each tonne of CO_2 costs between $70-$195 in the cement and steel industry.

"Using our technology, businesses can not only eliminate their CO_2 emissions but potentially profit $10-$20 for capturing one tonne of CO_2. The second aspect of our solution at Remedium is our patent-pending enhanced sorbents. Remedium's bench-scale testing shows that its developed sorbents can capture 14 times more CO_2 over their lifetime than a natural sorbent."

He added: "The Cambridge ecosystem has been a significant catalyst in my transformation into an entrepreneur."

Read the full article at:
www.eng.cam.ac.uk/enterprisetech-star

→ Teja Potocnik (left) and Rasha Rezk

Engineers on track to commercialise novel inventions with Enterprise Fellowships

Cambridge engineering graduates are on their journey to start-up and spin-out success with the Royal Academy of Engineering Enterprise Fellowships.

Teja Potocnik and Rasha Rezk are on track to commercialise novel inventions on a 12-month entrepreneurial journey with the Royal Academy of Engineering's Enterprise Hub. They will spend a year developing their skills and knowledge of entrepreneurship, supported by mentors and a training grant of up to £75,000.

Teja Potocnik – Nanomation – automation software for industry-scale manufacturing of nanomaterial semiconductor electronics

Teja recently completed her PhD in Engineering from Cambridge, during which she founded her start-up company, Nanomation. Nanomation's technology enables nanoscale automation, enhancing the efficiency of semiconductor chip manufacturing. The company's solutions facilitate the use of novel semiconductor materials for advanced chips, with the aim of transforming the semiconductor industry.

"This Fellowship provides the crucial support needed to translate my PhD research to reality, marking a significant milestone in my entrepreneurial journey," she said. "It allows me to focus exclusively on my start-up and helps to accelerate the development of cutting-edge solutions in semiconductor manufacturing."

Rasha Rezk – ForCell – a mechanical cell press that provides safe access to the intracellular spaces critical for gene therapies

Rasha's research is at the interface of mechanics and biology. During her postdoctoral work in Cambridge and York, she developed a strong passion for applying her expertise to biological systems – specifically around developing bespoke tools to study tumour and stem cell heterogeneity, which have emerged recently as major clinical challenges. ForCell will provide an unprecedented opportunity to deliver gene-modifying tools in a safer and more economical fashion. The ability to adjust the application of forces on the cell also allows the tools to respond to different cell types and drugs.

"The Enterprise Fellowships are the pinnacle for entrepreneurial engineers," she said. "I am proud to have been selected to be one of the Enterprise Fellows and I can't wait to work with some of the most talented engineers/brilliant minds."

Enterprise Fellowships Programme

The Enterprise Fellowships Programme has been running since 2011, supporting graduates of undergraduate degrees and PhDs, as well as academics at all levels. This accelerator programme consists of 15 days of training, which is complemented by six months of support from a business coach. Alongside this, the entrepreneurs benefit from a full year of one-to-one mentoring from a leading expert in engineering, and tech start-ups and spin-outs. There are 12 graduates and researchers in total each year.

Delivered by the Royal Academy of Engineering's Enterprise Hub, experts in commercialising engineering conduct research into successful, scalable businesses through a unique package of funding and training.

What does the programme offer?

- An equity-free grant of up to £75,000
- 15 days of practitioner-led training
- 1:1 business coaching and mentoring from an unrivalled network of the UK's leading engineers and Royal Academy of Engineering Fellows
- Subsidised access to Culture+, a diversity and inclusion platform designed for engineering start-ups
- Lifetime access to co-working spaces in London, Belfast and Swansea
- Lifelong access to the Hub's network of experts and investors.

Who is eligible?

- Recent graduates
- International PhD students and recent recipients
- UK-based academic researchers at any career stage
- Ireland-based academic researchers at any career stage
- UK Public Sector Research Establishment researchers.

Read the full article at:
www.eng.cam.ac.uk/raeng-enterprise-fellowships24

→ Flooding in southern Iran. Modified Copernicus Sentinel data (2020) processed by the European Space Agency (ESA)

Towards global flood mapping from space: new research unlocks accurate detection in arid regions

The best flood detection tools, such as radar satellites, often struggle in arid regions, where water and dry sand can appear very similar. Because of this, floods in these areas can go undetected—leaving millions of people vulnerable when floods strike.

Thanks to a study published in the journal *Remote Sensing of Environment*, PhD student Shagun Garg has found a way to address this and find better ways to detect floods in some of the world's most overlooked areas.

The image above, captured by the Copernicus Sentinel-2 mission, shows the extent of the flooding in the Sistan and Baluchestan province on 13 January 2020. Flooded areas are visible in brown, while the flooded villages are highlighted by dotted circles. Sediment and mud flows, caused by the heavy rains, can be seen gushing from the Bahu Kalat River, Iran, and Dasht River, Pakistan, into Gwadar Bay.

"When I started this project, I was amazed by how often dry lands were excluded from global flood monitoring studies. Very few studies had focused on this challenge, leaving communities in arid regions at a disadvantage when floods occurred," said Shagun Garg, the lead author and a PhD student at the EPSRC Centre for Doctoral Training in Future Infrastructure and Built Environment: Resilience in a Changing World (FIBE2).

"Floods don't just happen in rainforests or coastal areas; deserts, too, are at risk. Climate change is making floods more frequent, even in dry regions. But here's the problem: because sand and floodwater can look almost the same from space, current flood detection systems often miss these desert floods. As a result, these areas are left out of global flood maps."

The Sentinel-1 Global Backscatter Model is a dataset that describes the Earth's land surface's C-band radar cross section from 2016–2017. Dry arid lands and water both appear dark in radar imagery, creating a challenge in distinguishing between the two. This similarity leads to misclassification, making accurate flood detection in desert regions particularly difficult.

European Space Agency Sentinel-1 satellites use radar to scan the Earth; they can "see" the ground even when it's cloudy or dark. This new research has calculated how to use radar data to tell the difference between dry sand and floodwater more effectively. By combining the amplitude and phase relationship of the radar wave before and after flooding, the authors were able to pinpoint flooded areas that older systems had missed. This approach makes flood detection more accurate by approximately 50%.

The proposed methodology was tested during floods in three different desert areas: Iran, Pakistan and Turkmenistan. In each case, the method successfully mapped the floodwaters where previous methods had failed. For example, after a dam break in Turkmenistan, radar maps revealed the full extent of the flooding. This can help authorities understand the scale of the disaster relief planning and evacuation.

With the growing number of satellites in orbit and continuous improvements in the resolution of satellite images, the Earth's surface can be observed in more detail than ever before. Combined with advancements in computing power, these satellite images can be processed rapidly, providing quicker and more accurate data during disasters.

Over the past decades, satellites have become essential tools in flood risk identification and their potential continues to expand. This research is a crucial step in that direction, offering a more inclusive approach to flood mapping, particularly in regions that were previously left out. By paving the way for global flood monitoring, this work has the potential to greatly improve disaster preparedness and response in vulnerable areas.

Read the full article and zoom in on the flood map at:
www.eng.cam.ac.uk/flood-mapping

Sustainable Offsite Construction project: building the future of civil engineering

The Department of Engineering has launched an innovative project to promote sustainable offsite construction.

This initiative will equip students with crucial project management skills while immersing them in modern digital construction technologies. It also underscores the critical importance of scheduling, teamwork, financial control, health and safety, and the practical aspects of engineering theory.

The Sustainable Offsite Construction project proposed by Laing O'Rourke Associate Professor Dr Brian Sheil on behalf of the Construction Group, involves third-year students building a 13-metre bridge using modular components at an onsite location near the Eddington campus in Cambridge. The first project took place in June 2024 and provided a hands-on construction experience that gave the students the opportunity to put their theoretical knowledge gained on the engineering course thus far into practice.

The bridge that the students constructed is based on Laing O'Rourke's state-of-the-art modular 'Digital Bridges' using reusable precast reinforced concrete, emphasising environmental and financial sustainability.

Onsite, the students all underwent a steep learning curve. They quickly gained experience and confidence, both in manual tasks, as well as in documentation management and presentation skills when presenting their progress and costs at the end of each day. The project also provided a substantial opportunity for the students to develop essential teamwork, management, leadership and communication skills, learning to work together and overcome challenges to achieve a common goal.

> We are thrilled to offer students the opportunity to participate in the Sustainable Offsite Construction project, which promotes sustainable construction practices and fosters industry collaboration and real-world learning.
>
> Dr Brian Sheil

The teaching format involves problem-based learning with mini-lectures, practical demonstration sessions, build sessions and teaching and training delivered by industry partners. Students have the opportunity to work with skilled staff from the contractor (Laing O'Rourke), the consulting engineers (Ramboll), Steel fabricators (Severfield) and technology experts (Trimble) to gain hands-on experience.

The project's coursework and assessment are multimodal and include an interim client interview, where students discuss the construction plan; programme; costing; environmental, health and safety issues; and their roles within the construction team to recognise the importance of communication skills in industry.

The initiative aims to cultivate a new generation of engineers proficient in construction practices and committed to sustainable and innovative solutions. The Sustainable Offsite Construction project marks a significant step towards integrating sustainable engineering practices into the University's curriculum and industry partnerships, while also aligning with the broader goals of the Laing O'Rourke Centre.

> The initiative aims to cultivate a new generation of engineers proficient in construction practices and committed to sustainable and innovative solutions.

View photos of the bridge construction at:

www.eng.cam.ac.uk/student-construction-project

→ Dr Anna-Maria Kypraiou on the lower deck of a crude oil tanker, working on optimising the energy consumption of the vessel

ALUMNI UPDATE

Meet Dr Anna-Maria Kypraiou

Founder of Eyesea Green energy management technologies

Founder and CEO of Eyesea Green Limited, Dr Anna-Maria Kypraiou is at the forefront of developing technologies aimed at reducing carbon emissions while enhancing living standards.

Dr Kypraiou grew up in Athens, Greece. She came to Cambridge in 2012 to study the MPhil in Energy Technologies, followed by a PhD in Engineering working with Professor Mastorakos on the effect of thermoacoustic instabilities on flame dynamics in gas turbine engines. The PhD was part of the University Gas Turbine Partnership between the University of Cambridge and Rolls-Royce plc.

Since 2019, she has been actively involved in a range of initiatives that connect academia, research, industry and student engagement, while overseeing the academic progress of undergraduate Engineering students through her roles as Fellow, College Lecturer and Director of Studies in Engineering at Cambridge Colleges (Murray Edwards, Churchill and Hughes Hall).

Dr Kypraiou's research focuses on: the reduction of pollutants and development of energy optimisation strategies in the maritime industry; development of systems for the use of hydrogen in power generation; technology development for building energy usage optimisation; development of scientific methods to analyse building performance; and the use of new technology methods to evaluate occupant comfort and wellbeing.

As founder and CEO of Eyesea Green Limited, Dr Kypraiou is at the forefront of developing technologies aimed at reducing building energy consumption and carbon emissions while enhancing living standards. Eyesense is the company's first such technology, developed, manufactured and assembled as part of Eyesea Green, in Cambridge. It is an innovative energy management solution designed to prioritise comfort and wellbeing while significantly reducing energy consumption and carbon emissions with its advanced features and intelligent capabilities.

The Eyesense system is a pioneer in distributed energy management, which was initially launched in student accommodation (including Oxbridge Colleges) and offices, but it is currently used in many other applications, including social houses, councils, universities, commercial buildings, schools, churches and care homes.

Eyesense autonomously controls heating, ventilation, lighting and humidity, making real-time adjustments based on temperature, occupancy, CO_2 levels and solar gain, seamlessly integrating with existing building management systems or operating independently. By delivering real-time energy intelligence, characterising buildings' thermal performance, and using AI to assess damp and mould risks as well as enhancing occupant comfort, Eyesense enables estates to make data-driven decisions, ensuring the most effective retrofits while cutting carbon emissions and energy waste.

Eyesea Green Limited recently won the highly competitive Big Retrofit Challenge co-hosted by the National Home Decarbonisation Group, Innovate UK, The Retrofit Academy and Futurebuild, which recognised the Eyesense technology to be a game-changing innovation in the industry.

Dr Kypraiou is at the forefront of continuous innovation to spearhead pioneering solutions that directly address the challenges outlined in Awaab's Law, ensuring safe and healthy living conditions across the housing sector.

Dr Kypraiou and Eyesea Green Limited lead this groundbreaking solution, working with housing associations, councils and leading built environment stakeholders, and most importantly, collaborating closely with Professor Dongfang Liang on research projects for the development of AI models for the characterisation of thermal performance in buildings. They are also working closely with Professor Stuart Scott and Dr Fiona Smail on research projects that focus on the development of AI algorithms to evaluate damp and mould potential and occupant comfort.

Dr Kypraiou says: "Having completed the MPhil in Energy Technologies 12 years ago, I find it immensely rewarding to now be an industrial supervisor to the students in that very same programme, guiding their research projects as they tackle pressing social and environmental challenges."

→ **Read the full article at:**
www.eng.cam.ac.uk/eyesea
www.eyeseagreen.com

→ Sebastian Lindner-Liaw (left) and Jerrell Ong accept a runner-up award at the Cambridge Climate Challenge. RIGHT: Rendering of a terracotta lattice on the facade of a sustainable data centre design

Credit: [LEFT] Ellie Austin. [RIGHT] Terracotta Cooling

A sustainable solution for cooling energy-hungry data centres in hot climates

Two MPhil in Engineering for Sustainable Development students are on a mission to slash the energy and water consumption of data centres operating in the Global South, with their start-up Terracotta Cooling.

Terracotta Cooling is pitched as an innovative solution to a growing problem of how to keep data centres cool in an efficient and sustainable way.

Data centres are the backbone of the digital world and key to harnessing the transformative powers of AI, cloud computing and the Internet of Things (IoT). However, they also generate lots of heat, with those operating in the equatorial climate of countries like India, and South-East Asia in the Global South, struggling with humidity and temperatures above 40°C (104°F) all year round.

This capital-intensive technology designed for the Global North has, to date, been ill-suited for local contexts in the Global South.

Hoping to change this are MPhil students Jerrell Ong (CEO) and Sebastian Lindner-Liaw (CSO), together with their colleague Eric Tay (CFO), who have taken inspiration for their start-up from local, handcrafted terracotta 'beehive' cooling structures. These structures are typically made up of stacked terracotta cones in a beehive formation, which enable effective cooling by improving the surface area. The students' proposal is for a similar cooling structure made of stacked terracotta cylinders inside of a lattice framework, with recycled water pumped over the terracotta.

Jerrell said: "Our proposed structure is made of stacked terracotta cylinders, sourced and produced in the Global South, ideally in proximity to the site in question. The water flowing down and around these cylinders creates an evaporative effect, cooling the air that flows through it. The water condenses at the top of the lattice to create a circulatory, non-consumptive system. We have used computational fluid dynamic modelling to create new equipment and aisle configurations better suited to the temperature distributions resulting from this system.

"Using a locally inspired terracotta 'beehive' structure and air flow optimisation, our structure has the potential to slash the immense energy costs by 30%, and water usage normally associated with cooling large data centres, particularly in hotter climates in countries like India, reducing emissions and strain on critical resources."

Terracotta Cooling's mission aligns with three of the 17 Sustainable Development Goals (SDGs)[1], as follows:

- Goal 9 (industry, innovation and infrastructure) – designing and building data centres in a more sustainable way, compatible with local contexts and enhancing resilience.

- Goal 6 (clean water and sanitation) – reducing industrial water use to prevent negative impact on surrounding communities who may otherwise not have access to clean water.

- Goal 12 (responsible consumption and adoption) – reducing the material and ecological footprint of data centres and by extension technologies like AI or cloud computing.

The trio secured a runner-up position at the 2024 Cambridge Climate Challenge after pitching Terracotta Cooling to a panel of climate innovation experts.

The Challenge is an eight-week innovation competition for early career researchers, designed to give young academics the skills to scale-up their own climate solutions into successful and impactful businesses.

> Using a locally inspired terracotta 'beehive' structure and air flow optimisation, our structure has the potential to slash the immense energy costs by 30%, and water usage.
>
> Jerrell Ong (CEO)

[1] These SDGs sit at the heart of a shared blueprint adopted in 2015 by all United Nations Member States and are an urgent call for action by all developed and developing countries as part of a global partnership.

G7 representatives meet in Cambridge to discuss semiconductors

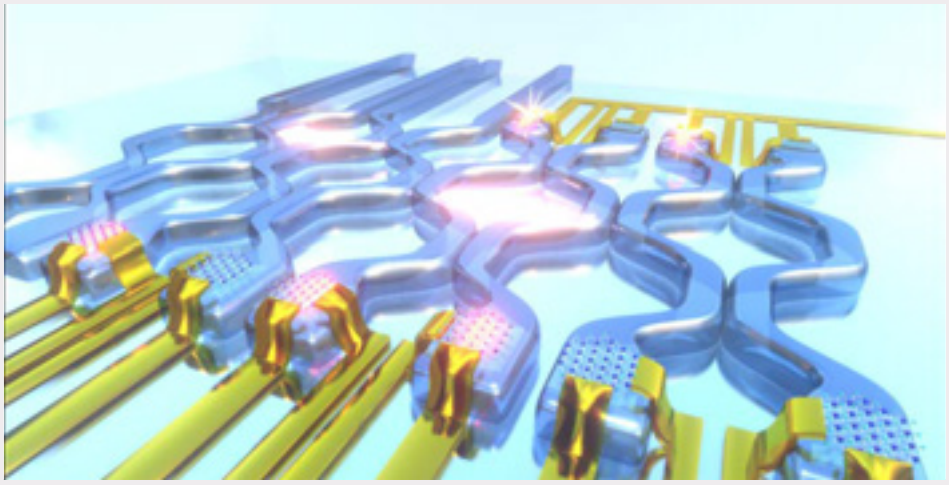
Representatives of the Semiconductors Point of Contact (PoC) Group from the G7 group of nations met in Cambridge to discuss the main priorities for the future development of semiconductors and their impact on the global economy.

The meeting was held at ARM, which designs over 95% of the processors in the world. Representatives from the University of Cambridge, as well as representatives from local semiconductor companies, participated in the events.

Semiconductors underpin nearly every electrical, optical and quantum device, from mobile phones and medical equipment to electric vehicles. They are of global strategic significance due to the integral role they play in net zero, AI and quantum technology.

The G7 Semiconductor PoC Group is dedicated to facilitating information exchange and sharing best practices among G7 members. The Group plans to exchange information on issues impacting the semiconductor industry, including pre-competitive industrial research and development priorities, sustainable manufacturing, the effect of non-market policies and practices, and crisis coordination channels.

A 2023 report found that the University of Cambridge contributes nearly £30 billion to the UK economy annually and supports more than 86,000 jobs across the UK, including 52,000 in the East of England.



For every £1 the University spends, it creates £11.70 of economic impact, and for every £1 million of publicly-funded research income it receives, it generates £12.65 million in economic impact across the UK.

Speaking at the time, Science Minister Lord Vallance said: “Semiconductors are an unseen but vital component in so many of the technologies we rely on in our lives and backing UK innovators offers a real opportunity to grow these firms into industry leaders, strengthening our £10 billion sector and ensuring it drives economic growth. Hosting the G7 semiconductors Points of Contact group is also a chance to showcase the UK’s competitive and growing sector and make clear our commitment to keeping the UK at the forefront of advancing technology.”

Written by Hilary Fletcher

Read the full article at:
www.eng.cam.ac.uk/G7-semiconductors

Joining forces to fast-track radical new technologies to revolutionise brain health

A major consortium from across the Cambridge life sciences, technology and business worlds has announced a multi-million-pound, three-year collaboration with the Advanced Research and Invention Agency (ARIA), the UK Government’s new research funding agency.

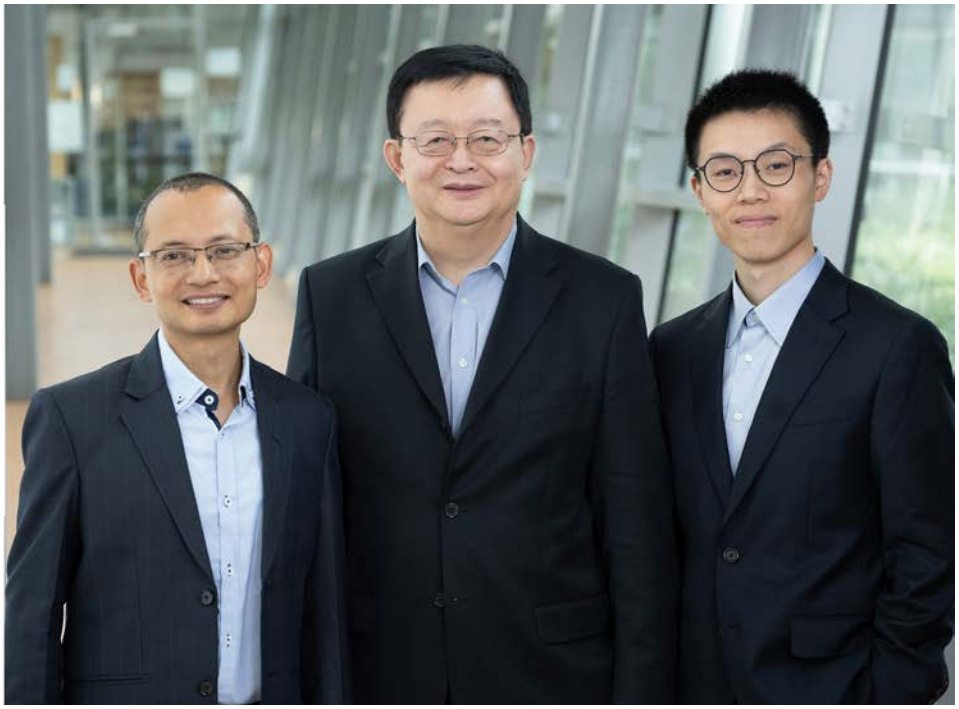
As one of ARIA’s new Activation Partners in the agency’s *Scalable Neural Interfaces* opportunity space, this collaboration aims to rocket-boost progress on a new generation of neurotechnologies designed to treat conditions such as depression, dementia, chronic pain, epilepsy and injuries to the nervous system.

Cambridge’s partnership with ARIA will create a home for original thinkers who are struggling to find the funding, space and mentoring needed to stress-test their radical ideas.

It will scour the UK for innovators, from any background, with a highly ambitious concept for a technology that could transform brain health. The very best will be offered the resources to test and then scale up their idea at pace, so it can be brought to patients across the world quickly and affordably.

The vision is to unlock more treatments with fewer side effects, creating a world where personalised brain healthcare is available to everyone.

Read the full article at:
www.eng.cam.ac.uk/aria



Department spin-out lands $5.3 million for next-gen VR lens technology

↑ From left, Dr Pawan Shrestha, Professor Daping Chu, and Dr Xin Chang

A start-up pioneering nanophotonic lens technology for images that are always in focus – recreating human vision for the ultimate virtual reality (VR) experience – has secured $5.3 million to bring the technology to market. AllFocal Optics is co-founded by Professor Daping Chu (CSO) and alumni Dr Pawan Shrestha (CEO) and Dr Xin Chang (CTO).

Spun-out of the Department of Engineering, AllFocal Optics' technology is built on 10 years of research and development in the Centre for Photonic Devices and Sensors led by Professor Chu and Dr Shrestha – former Royal Academy of Engineering enterprise fellow.

Led by SpeedInvest and Innovate UK grants, this investment comes on the back of successful trials with Jaguar Land Rover, along with the addition of tech veteran Dr Ash Saulsbury (Microsoft's former VP of Technology and the leader of Meta's AR team) as Chair of AllFocal Optics.

"This means AllFocal Optics is on track to become the first in the world to deliver ultra-thin lenses that recreate human vision for a better and more comfortable virtual experience," said Professor Chu, Nanjing Chair of Technology and Innovation. "Our cutting-edge thin nanophotonic lenses allow users to visually access virtual information in the real world without the nausea and discomfort typically associated with virtual, augmented and mixed reality."

He added: "It marks a significant step in overcoming a critical obstacle to the mass adoption of Extended Reality (XR) hardware and applications, redefining the XR experience for anyone (even if they wear glasses)."

AllFocal's advanced nanotech devices can be built into car head-up displays, projecting sat-nav directions directly onto windscreens. The first trials of AllFocal Optics in car settings will take place early next year in partnership with Jaguar Land Rover. The company anticipates its lenses will be in AR glasses and VR headsets within the next two years.

Dr Shrestha said: "Critical to XR's mass adoption is enabling users to interact with virtual images for as long as they like, without feeling nauseous, and to seamlessly shift focus between physical and virtual environments. Our technology, compatible with LCD, OLED, or any type of display, makes that possible.

"By projecting a digital image onto a user's retina, it keeps the image in focus regardless of how the eyes adjust to the surrounding world, completely eliminating any discomfort.

"After more than a decade of research, we're now ready to take our technology to market, unleashing possibilities across automotive, medical, engineering industries and more."

> "Our cutting-edge thin nanophotonic lenses allow users to visually access virtual information in the real world without the nausea and discomfort typically associated with virtual, augmented and mixed reality."
>
> Professor Daping Chu

www.cpds.eng.cam.ac.uk

Credit: Pandora Designs – stock.adobe.com

Machining the future: the AI advantage

↑ Computer Numerical Control (CNC) machining

The manufacturing industry could transform significantly as artificial intelligence (AI) is adopted across applications, including production, decision-making and operational efficiency.

In this article, Sebastian Pattinson, Associate Professor in Manufacturing Processes, Systems and Organisations, at the Institute for Manufacturing (IfM), delves into how AI could improve processes.

The field of AI is advancing rapidly, with ongoing improvements in AI models and sensors presenting exciting prospects for enhancing manufacturing and design processes. This expansion of AI has the potential to greatly improve how we approach conception, creation and building, resulting in innovative and efficient developments in these areas. As AI techniques mature and become more accessible and widespread, its impact is likely to grow.

Traditional methods of controlling processes typically rely on predetermined models and rules that are often based on historical data and human expertise. However, these methods have limitations, particularly when it comes to dealing with the increasing complexity, variability and unpredictability of modern manufacturing processes and the world they operate in. Also, these methods generally do not make the most of the enormous amounts of data that can be generated by modern sensors and systems in real time.

This is where AI comes in. To clarify what we are talking about here, AI is (broadly) the ability of machines to do things that we ordinarily think of as requiring human intelligence. AI boils down to mathematical relationships between variables, so we usually describe specific instances of AI programs or algorithms as 'AI models'.

In the past decade, a branch of AI called machine learning, where models learn to improve their performance from data rather than explicit programming, has become very prominent. More recently, this has been augmented by the rise of foundation models and generative AI. Foundation models are large models that have been trained on very large data sets, which can be adapted to a variety of tasks. Generative models learn how to create new content, such as text or images, based on the existing data that they are given. The confluence of these trends in the form of ChatGPT and similar models has propelled AI into the mainstream in ways not seen before.

Potential benefits of AI

- **Improving productivity**
  Often, manufacturers have more data than they know what to do with, and data fuels AI. By analysing vast amounts of data, hidden patterns, anomalies and insights can be discovered. The discovered relationships may then be used to enable a better understanding of processes to make more informed decisions. This can optimise process performance and reduce downtime.

- **Enhancing quality, resilience and sustainability**
  AI can help manufacturers to monitor and maintain the quality of their raw materials, products and equipment by detecting and responding to defects, anomalies and errors in real time. With increasing data and sophistication, this can allow you to use new materials more quickly should supplies be interrupted and to effectively use natural or recycled materials, which can feature variable properties.

- **Increasing innovation and competitiveness**
  AI techniques can help to design better products, services and business models. This can include better product designs, for example, driven by rapid and efficient data-driven simulations and more rapid reconfiguration driven by supply and demand. In the future AI could even help to break down siloed knowledge across design, manufacturing and supply chains, leading to a step change in capabilities.

- **Reducing waste**
  AI techniques can reduce waste related to materials, energy, time and space. This can take several forms, from coupling in-process monitoring with anomaly detection to repair defects or discontinuing work on a failed part, to using AI to operate processes in ways that minimise energy or material use.

- **Empowering humans**
  AI systems can augment workers' knowledge by making the most relevant expert insights readily available. AI could also aid communication and coordination with customers and suppliers, for instance, using chatbots.

Read the full article at:
www.eng.cam.ac.uk/ai-advantage

Quicker, cheaper quality control of safety-critical metal components

By studying how light reflects from the surface of metals, engineers can now tell if manufactured parts meet quality control standards. This time- and cost-effective technology opens new avenues for quality control of safety-critical metal components, such as those used in aerospace.

Typically, metals comprise a myriad of tiny crystal grains, which differ in size, shape and crystal lattice orientation, namely how the atoms within the grain are packed and arranged in space. The ensemble of these features is usually referred to as the metal's 'microstructure', which can vary significantly depending on the manufacturing processes used to make the metal part (like casting or forging). Because the properties of metals are invariably linked to their microstructure, it is paramount to assess this information as parts are produced and even as they are used in engineering applications. This then allows quality control engineers to certify metal components or make informed decisions on whether they have reached end of life and should be replaced.

The challenge, however, is that assessing the microstructure of metals requires high-end equipment and tedious procedures. The current gold standard, for instance, is a scanning electron microscopy technique which is based on electron diffraction. Besides the high cost of the equipment required to run these measurements, this technique prevents the direct analysis of entire parts because of the small size of the vacuum chamber. This limits microstructure analysis to small-sized, flat samples that must be extracted from the metal parts produced. Because of the high cost and low scalability of these measurements, the industry must rely on conservative microstructure estimates to minimise safety concerns around the use of different metal components.

The alternative, innovative technique proposed by researchers at the University of Cambridge is well poised to change this paradigm forever. Using just visible light, the method, called directional reflectance microscopy (DRM), offers the same microstructural information in ambient environment, at a fraction of the cost, and over entire metal components. The results are reported in the journal *npj Computational Materials*, where the research team showcases these capabilities on an entire turbine blade, the 'heart' of jet engines in modern aviation.

"We believe that DRM could open a completely new quality control process flow, whereby metal parts can be analysed in real time during manufacturing," says Dr Matteo Seita from Cambridge's Department of Engineering, who led the research. "This approach is perfectly aligned with the idea of digital manufacturing, where each part produced has a 'digital passport' that includes information about part microstructure."

Dr Seita and his team have spent years making DRM as low-cost and accessible as possible, while ensuring that the microstructural information acquired is precise and reliable. DRM requires a simple optical camera and a rotating source of white light, which illuminates the surface of metal parts from different directions. After etching the metal surface using chemical reagents, the reflected light intensity measured by the optical camera is fed to special image analysis algorithms, which allow inferences of the underlying crystal orientation of the grains composing the material. This information is then used to reconstruct the microstructure of the metal part.

The most impressive feature of the new study published by Dr Seita's team is that DRM can provide microstructural information directly from the complex, non-flat surface of life-size metal components. "This is a game-changer in the field of non-destructive analysis," says Dr Seita. "There is no need to dissect metal components into small, flat specimens so that they can fit into the electron microscope. The material's microstructure can be imaged directly onto the curved surface of the metal part."

Read the full article at:
www.eng.cam.ac.uk/quality-control-metal-components

Credit: Gerd Altmann from Pixabay

Building a more sustainable world

Arup is a global engineering and sustainable development firm with designers, consultants and experts working across 140 countries. Arup and Cambridge have been working together since the 1960s. Today, the partnership is focused on harnessing new digital technologies to build a more sustainable world.

Together we have:

- Worked on 30+ research collaborations in engineering, architecture, geography, land economy, earth sciences and maths
- Co-authored 60+ academic papers
- Changed the way professionals are taught
- Developed new technologies that make our world safer and more sustainable.

Some of this work has been supported by the Ove Arup Foundation, a charity dedicated to promoting its founder's philosophy of 'total design'.

Arup and Cambridge have been working together for more than 60 years and the relationship between Cambridge and the Ove Arup Foundation goes back to the early 1990s.

Talk to anyone involved and it quickly becomes clear why these partnerships have proved so fruitful and enduring.

Both Arup and Cambridge attract what Engineering alumna Dame Jo da Silva, Arup's Global Director of Sustainable Development, describes as "incredibly smart people", all of whom are intent on bringing about positive change across the sector through new technologies and a better understanding of how they can be applied.

Collaboration and a multidisciplinary approach underpin everything the partners undertake, whether it's solving research problems or transforming how professionals are taught - in a way that has been hugely influential around the world.

Making infrastructure smarter

In 2010, Professor Lord Robert Mair, founder of Cambridge's Centre for Smart Infrastructure and Construction (CSIC), saw an opportunity to use the latest ideas in sensing technologies and apply them to infrastructure.

"At the time, sensors were being widely used in sectors such as aerospace, so that engineers knew how every bit of their assets were performing at all times.

"However, the same could not be said of the world of infrastructure. Kenichi Soga (now a professor at University of California, Berkeley) and I could see that these sensing technologies would allow us to understand how vital assets are performing - and if remedial action needs to be taken."

In 2011, CSIC was established in Cambridge with funding from Innovate UK, EPSRC and 28 industry partners, including prime mover and supporter, Arup.

From it emerged new methods and techniques to use distributed fibre optic sensing (DFOS) for monitoring civil infrastructure. DFOS transformed the way changes in strain and temperature are measured, making it possible to assess the engineering performance of structures such as foundation piles, tunnels, retaining walls, pipelines and bridges.

The development of DFOS was a key pillar of the new Centre's activities, and one in which Arup had a key role. Mair said: "As a leader in the field, Arup has always been wedded to the importance of measurement and they have been hugely instrumental in both the development and deployment of the DFOS technology."

Jennifer Schooling, former Director of CSIC (now at Anglia Ruskin University), explained why working with Arup was so instrumental in the development of DFOS.

"Doing good science is one thing, but we needed help to turn it into something that's usable by industry," she said. "That's where Arup came in, helping us to codify how DFOS should be used in practice and working with their clients to show them its benefits. The intellectual 'oomph' was very much a joint effort between Arup and Cambridge."

Read the full article at:
www.eng.cam.ac.uk/arup-collaboration

Honours, awards and prizes

BioMedEng24 Innovation Prize

Professor Shery Huang, whose research has had a significant impact on the fields of biofabrication and sustainable electronic textiles (e-textiles), has been awarded the BioMedEng24 Innovation Prize.

Professor Huang leads the Biointerface Research Group. She has been honoured by the BioMedEng Association for her "creative and pioneering" work, which advances sustainable and ethical biomedical technologies.

Professor Huang's noteworthy contributions include publications in the journals *Nature Electronics* (2024), *Nature Materials* (2023) and *Nature Communications* (2021).

RAEng Fellows 2024

Professors Colm Durkan FREng (pictured), Gopal Madabhushi FREng, and Campbell Middleton FREng have been announced as Fellows of the Royal Academy of Engineering (RAEng) in recognition of their outstanding and continuing contributions to the profession.

"Our new Fellows represent some of the most talented people in the world of engineering and are taken from the ranks of those who are aiming to address some of our most critical problems," said Dr John Lazar CBE FREng, President of the RAEng.

Innovation in computing

A research paper co-authored by Professor Mark Girolami and colleagues from the Institute for Manufacturing (IfM) and The Alan Turing Institute, among others, has won the Hojjat Adeli Award for Innovation in Computing.

The open access paper titled *Hierarchical Bayesian modeling for knowledge transfer across engineering fleets via multitask learning* was chosen by the publishers Wiley-Blackwell as the most innovative computing paper published in the previous volume or year.

The paper was a collaborative effort involving Professor Girolami, Dr Maharshi Dhada (IfM) and Professor Ajith Parlikad (IfM), along with teams from The Alan Turing Institute, University of Glasgow, Imperial College London, Stockholm University and Scania, an industry partner.

In this work, the researchers show that analysing similarities between how natural ecosystems behave and react to their environment can offer insights that can also be used in engineering.

IEEE Control Systems Award

Professor Malcolm Smith is the recipient of the 2025 IEEE Control Systems Award for contributions to robust control, network synthesis and applications to mechanical systems.

His contributions to the control systems field range from the foundations of robust control and systems theory to the synthesis of passive networks.

His most high-profile achievement is his invention of 'the inerter' concept and device, which arose from a fundamental study of performance limits in passive suspension systems.

A collaboration between the University and McLaren Racing led to the inerter's first use in Formula 1 at the Spanish Grand Prix, in 2005, with McLaren achieving its first of 10 victories in the season.

Google PhD Fellowship

Isaac Reid, whose research explores the interplay of structure and randomness in machine learning, has received a 2024 Google PhD Fellowship.

Google PhD Fellowships directly support outstanding graduate students as they pursue their PhD, as well as connect them to a Google Research Mentor.

"Cambridge and Google have enjoyed a rich history of academic collaboration, sharing ideas and driving progress in AI," says Isaac. "I'm delighted to be a part of that. The Fellowship will help me pursue an ambitious research agenda, and I'm very excited to see where it goes."

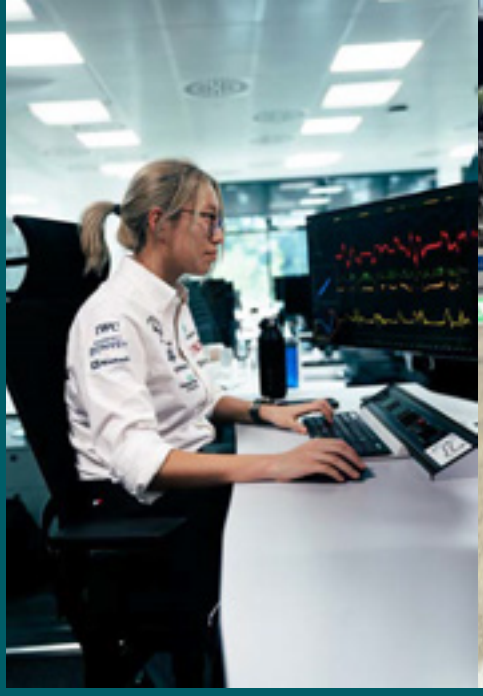
2024 Helios Prize winner

James Lazenby, a PhD student in the Energy, Fluids and Turbomachinery Division, is the winner of the Department's 2024 Helios Prize – awarded for research on sustainable energy and/or energy efficiency.

The Helios Prize was launched in 2019 and is made possible thanks to a generous donation from Cambridge alumnus John Firth.

James is co-author of a research paper, which proposes a method to integrate thermal energy storage with the steam cycle of a nuclear plant (retrofit or new build). This allows the electrical power output of the plant to be flexed up and down whilst maintaining constant reactor power, thereby providing the equivalent of a large-scale electricity storage system.

→ LEFT: Kat working in the race support room back at base in Brackley. RIGHT: Kat's first race working trackside



Credit: [LEFT] Mercedes

How undergrad Kat Tse secured her first job in race engineering

"I think it's fair to say that it's not just one thing or person that has inspired me to take on a career in motorsport; I enjoy a competitive environment – there's nothing more tangible than where you cross the finish line every weekend," says Engineering undergraduate Katrina Tse.

Kat Tse, who is in the fourth year of her Master of Engineering (MEng) degree, is an incoming Graduate Performance Engineer at the Mercedes-AMG PETRONAS Formula 1 Team.

Kat recently completed a 13-month industrial placement in the race engineering team. This involved supporting all races and track running tests either at the factory or trackside, as well as collaborating with other departments such as vehicle dynamics to analyse and improve car performance, whilst also contributing to analytical software capabilities that are bespoke for race engineering.

"There are not many industries in the world where you chase every last millisecond, but Formula 1 is one of them and it's very special – you are always pushing the limits of what is possible," said Kat.

"Working within race engineering, our department is focused around optimising the available package and setups as well as working with the drivers to maximise the number of points we bring back in the championship every race weekend.

"The vast majority of what we do is pre- and post-event work and analysis, as well as developing tools that will aid our weekend work. Of course, we also work all races and tests, whether at the track or back in the race support room at base in Brackley.

"Working at the pinnacle of motorsport is certainly not your normal nine-to-five job, especially working within race engineering, but it is rewarding in its own way. You really do ride the highs and lows with the team, and being at the forefront of the action adds to the excitement."

Just the beginning

"As I look back on my placement year, I often make the comment that while there were lots of memorable moments like working my first race, my first time at the track, my first win with the team etc., nothing quite tops the fact that I know this isn't it, and that the placement year is just the beginning.

"Working with some of the best engineers in the world was super-special. From my first day in the office getting to know everyone to the last day of my placement, where I really felt like part of the team, the one thing that was most surprising for me was the amount of responsibility I was entrusted with from day one. For me, that was key. I was able to ask questions and learn about absolutely everything, and gain a true insight and feeling into working in this industry."

Kat (Trinity College) is currently specialising in aerothermal/aeronautical and mechanical engineering at Cambridge.

"The basics of engineering that I have been taught at Cambridge have proven very helpful for understanding the more complex engineering I faced every day on my industrial placement, for example, load transfer, vibrations, as well as analytic techniques that we apply on signals to perform further analysis."

"However, the softer skills proved to be even more helpful," she added. "For example, being able to approach everything with an open mind and look at things from different angles really helped."

Kat has taken an active interest in motorsport throughout her degree, rising to the rank of team leader of student society Full Blue Racing, the University's Formula Student team, who design, build and race single-seater internal combustion cars.

→ **Read the full article at:**
www.eng.cam.ac.uk/kat-tse

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