UNIVERSITY OF CAMBRIDGE

CEB *Focus*

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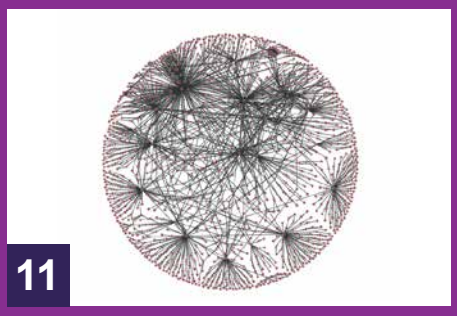
Department of Chemical Engineering and Biotechnology | Easter 2020 | Issue 30

CEB response to COVID-19 in low-income countries



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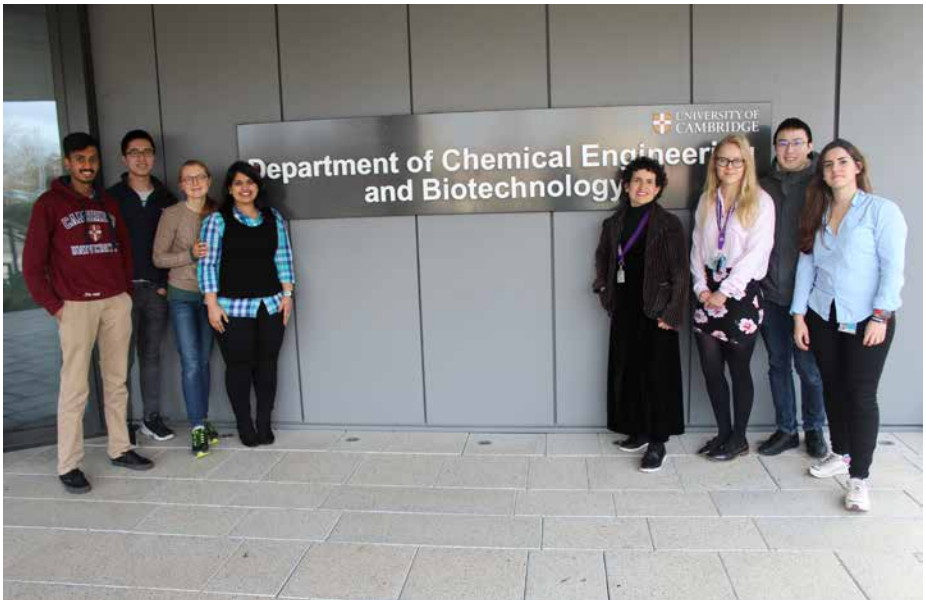


From left to right: Adarsh Arun, Bowen Huang, Sina Schack, Madhuri Manohar, Elena Gonzalez, Sarah Barron, Yong Ren Tan, Cristina Lopez; both Pier Cacciamani and Niki Kotecha (not featured).

Hoping all our global readers are safe and well as we start easing lockdown restrictions brought in as a result of the COVID-19 global pandemic. We bring you a special Easter issue: the end of this academic year not only marks the 10th anniversary of CEB Focus publication in circulation, but also the first issue the Editorial Team puts together completely remotely. Needless to say, a great deal of its content is devoted to the current situation and our response to it. The coronavirus has affected our lives in so far unimaginable ways - from how we interact and communicate with others to how we work in a digital sphere. This has brought us many exciting challenges, which we have faced with great determination. Despite being in different parts of the world, we have continued working on the content for this issue, discussing our edits in Zoom virtual space, and working safely and effectively from the comfort of our own homes.

Our main article is devoted to CEB's response to COVID-19 in low-income countries: from designing and manufacturing an open source ventilator and all its components to making healthcare diagnostics suitable for the challenging conditions in South Africa. 'Research highlights' section features the latest research breakthroughs as well as highlighting the circular chemical economy as a promising solution inspired by cyclic material flows in natural ecosystems.

We also remember the sad passing of our Emeritus Professor John Davidson in 'Alumni Corner' and celebrate several department 'achievements' including: Professor Gladden's appointment as Dame Commander of the Order of the British Empire in January, Dr Gabi Kaminski becoming Senior Fellow of the Higher Education Academy, and Dr Alexander Boy's Human Frontier Science Program Fellowship Award.

We have moved into online teaching and assessment rather swiftly, and in 'Teaching Matters' both our academic staff and students share their insights and experience in this new virtual world, not only how they have overcome initial challenges, but also the benefits gained from the experience. Despite having to work from home, our key activities are ongoing and it is very much 'business as usual'.

Of course, with events being cancelled in a physical form until further notice, we also had to think of new creative ways to continue delivering our outreach activities, and attracting talented staff and students.

Our highlight Open Days have now gone virtual, and I am delighted to report that CEB will be hosting Virtual Open Days on 2 and 3 July. There will be a series of live webinars with a Q&A for our prospect undergraduates to find out more about chemical engineering and biotechnology, the undergraduate course, and life as a student in Cambridge. An overview of our research and applications and the exciting and diverse range of careers available to chemical engineering and biotechnology graduates will also be on offer, including a virtual tour of our building facilities! Check out www.ceb.cam.ac.uk for regular updates.

Please stay safe, stay in touch, and have a wonderful summer!

Elena

Chief Editor

Message from our HoD

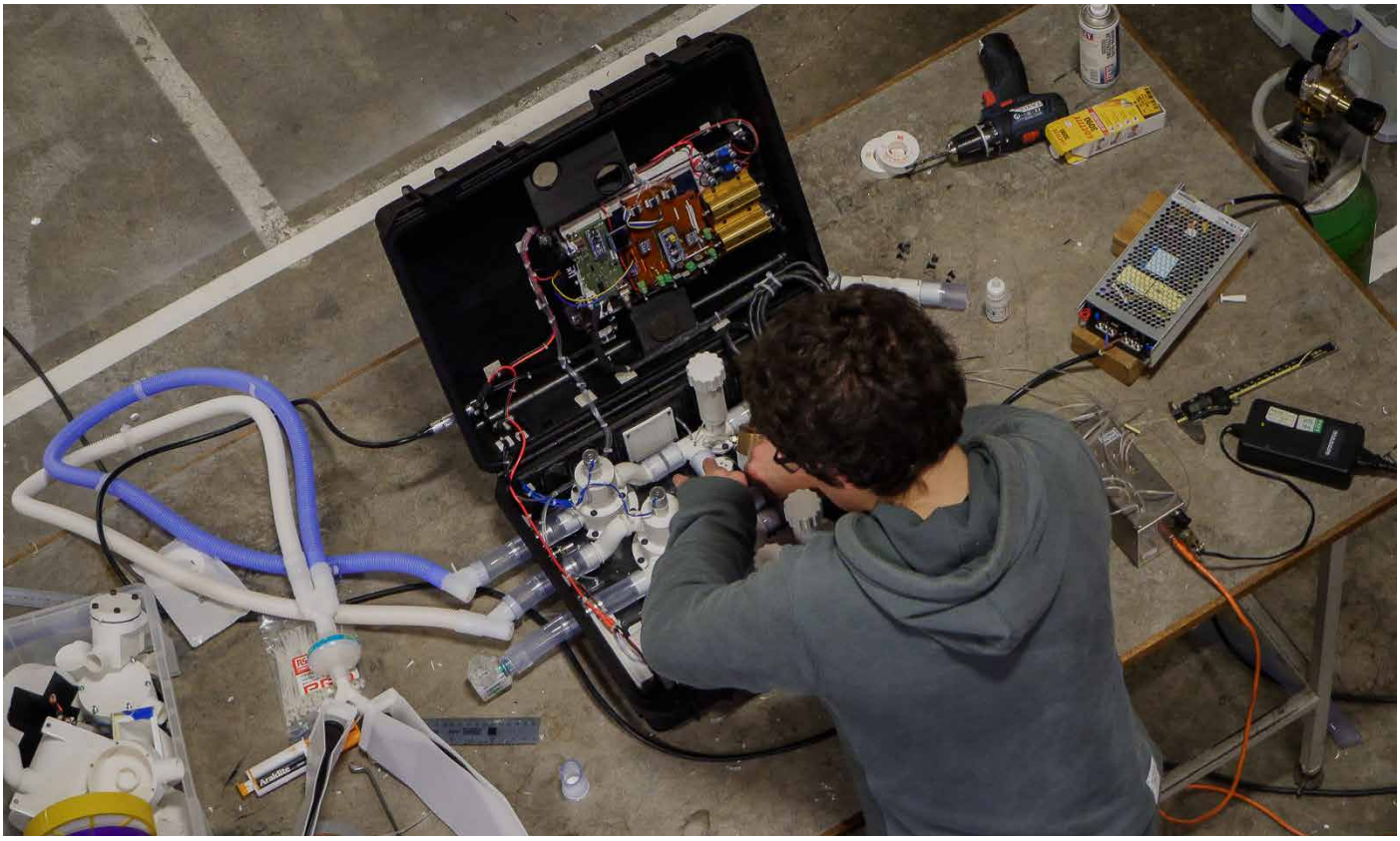
Professor Lisa Hall.

The University and the department have been adapting to new ways of working and to alternative teaching and assessment methods online. The state of lock down, even with the slight easing almost seems to have become a way of life, and most of us continue to work from home. However, we do have a few COVID-19 related activities that we are supporting in CEB, and as we approach the end of academic year, we are now working slowly on a plan to begin to gradually open our lab block. This move will only apply to researchers working in our critical labs and some technical and support staff required to make this happen, although there is no date yet.

The University has categorised its buildings into 1, 2 and 3. Cat 1 will open first. However, we won't be in the first wave. There are also two "tests" that we still have to pass. The first test concerns being able to safely turn the building "back on". The second test concerns the plan for working in the labs with full social distancing. When we get the permission to open the building, we will start a gradual return ensuring the safety and protection of those who will be returning to work.

My very best wishes,

Professor Lisa Hall



Second ventilator prototype being put together at the Whittle lab. Photo credit: Alan Long.

CEB COVID-19 response in low-income countries

Elena Gonzalez, Chief Editor

Basic science, research and innovation are vital to assist efforts to contain and mitigate the rapidly evolving COVID-19 pandemic. There are a number of exciting initiatives emerging from CEB in response to the global pandemic. The coronavirus outbreak has not only presented a number of serious global challenges, especially in low- and middle-income countries (LMICs), but also exciting opportunities to work collaboratively to develop intelligent solutions in this global crisis.

With 10 countries in Africa without any ventilators, it was reported that there are fewer than 2,000 working ventilators across 41 countries in Africa. For example, there are only about 60 ventilators available in the whole of Ghana and the cost per unit is in the order of tens of thousands of pounds. Following a government call for ventilators in the UK in March, a new project was launched to design and build a high quality but affordable, open-source ventilator, specifically designed for the needs in low- and middle-income countries (LMICs) to respond to the pandemic and beyond.

This marked the birth of 'OVSI'[1], a joint effort involving Cambridge University engineers and physicists, the Centre for Global Equality (CGE)[3] and companies in the Cambridge Cluster, in partnership with physicians, engineers and manufacturers in Africa. "It all started on a mailing list at College involving scientists and engineers to get the best out of this crisis," explains Professor Axel Zeitler, Director of Research at CEB who chairs the OVSI project. "We briefly explored what it would take to design such a ventilator and within days a team of engineers from the University and companies around Cambridge got started at the Whittle Laboratory to develop these ideas into a design and a working prototype."

The design went through further iterations and a second prototype of the ventilator[2] was produced within a fortnight. It easily passed the MHRA test specifications for emergency ventilators and was extensively tested at the National Physical Laboratory in Teddington. However, in order for the device to be usable in low-resource hospitals with limited supporting equipment, it needed to pass a set of far more stringent specifications than an emergency ventilator in high-income countries and further design work was needed. A team of 20 engineers at a British motorsport and advanced technology business, Prodrive, has worked on the project seven days a week since early April at the company's headquarters in Banbury, Oxfordshire. The team took the Whittle Laboratory's initial concept and began rapidly evolving the design into parts that could be manufactured from medically appropriate materials in the high production volumes that would be required. In parallel, the second Whittle prototype was shipped to Defy in South Africa to productionise the design, adopt it to local supply chains and design a production line for this unit. The OVSI team is working towards securing regulatory approval for the device prior to volume manufacture, which will be led by two South African companies, domestic appliance manufacturer, Defy, and Denel, a state-owned business.

The focus on low middle income countries (LMIC's), which set OVSI apart from other consortia responding to the UK Government's Ventilator Challenge, was influenced by the Centre for Global Equality, which has an Inclusive Innovation Programme embedded in CEB through the Sensor CDT. "The inclusive innovation approach focuses strongly on co-creating solutions with partners in end-user communities in order to ensure that what is produced is genuinely needed, and is context-appropriate," explains Dr Lara Allen, CEO of the Centre for Global Equality. "We are working closely with engineers and medics in Uganda, Kenya and Ethiopia to ensure that what is designed is really fit for purpose in those countries. The way in which the Cambridge Oxygen Concentrator team is working with colleagues at the University of Nairobi is a particularly exciting example of effective co-creation."

One of the key challenges faced in many hospitals in developing countries is the lack of supporting infrastructure for ventilators, particularly oxygen and reliable electricity. This is why OVSI is developing a ventilator system rather than a ventilator on its own. The key part of this system is the oxygen concentrator, which will provide oxygen to the ventilator where pressurised piped or bottled oxygen is unavailable. The concentrator team is being led by Dr David Fairen-Jimenez, head of the Adsorption and Advanced Materials Group, together with Alexei Lapkin, Professor of Sustainable Reaction Engineering.

CEB postdoctoral researcher Dr Prince Bawuah is helping, together with his colleagues from the Africans in STEM network, to educate about our project and start the dialogue with other partners for long-term collaborations going forward and beyond the immediate pandemic, to make the OVSI ventilator available to communities where respiratory diseases and other medical indications cannot

From conceptual design of the ventilator unit to manufacture of injection moulding tools

be met currently. The first pre-production units of the ventilator are currently being built by Defy, a leading southern African manufacturer of domestic appliances and subsidiary of Beko, and Denel, a state-owned company. One of Beko's engineers has been part of the engineering team working at the Whittle Laboratory from the start of the project and made the link to Defy possible.

OVSI has successfully secured funding from the University's COVID-19 response fund to further develop the ventilator. "It's interesting to see how universities and departments have come together," says Professor Zeitler. "It has been an incredible journey seeing the joined efforts of talented and enthusiastic people. So many people have worked incredibly hard, in many cases day and night, throughout this project since it started without any funding involved. Aside from students and staff from a range of departments we have had support from a wide range of engineers, law firms, administrators, scientists and enthusiasts all bringing in their time for free and under the full understanding that this work is going to be made fully open source."

Professor Geoff Moggridge, head of our Structured Materials Group, is also playing a crucial part in this joint effort. His team is working with the team of engineers in the Whittle Lab led by long-term collaborator, Dr James Taylor, to design and manufacture critical parts of the ventilator design for injection moulding. The designs and tools will enable the team in South Africa to manufacture ventilator parts there. However, quality control tests on manufacturing needs to be carried out prior to sending these tools to South Africa to check that the parts are satisfactory before they go to large-scale manufacture. "Up to this point plastic parts have been produced by 3D printing but we now need to produce large scale by injection moulding," says Professor Moggridge. His group recently injection-moulded 52 parts for the ventilator project in his lab at CEB, which marked the first experimental work in the department since the shut-down. The parts involved are flowmeters, two of which are required per ventilator, one for oxygen, the other for air. The aim is to produce a robust and inexpensive device for less developed economies and

"The biggest challenge of all is being able to produce and distribute the ventilators at a low cost there"

"We are looking for an affordable device at a cost that is equivalent to a bowl of rice (or local equivalent), which would help build their local economies and education without needing to rely on foreign aid."

so the pressure drop is used for the measurement. The flow-meters are critical parts of the whole device and precision and reproducibility of manufacture are essential. The flowmeters will be tested and calibrated in the Whittle Lab before being shipped to South Africa.

"The entire injection process for the flow meters, from design to production, was completed in just 10 days: with the conceptual design already done by James Taylor, Marta Serrani produced a full CAD design for the part and the mould required to produce it. James and Ruhi manufactured the mould from aluminium on the 5 axis milling machines in the Whittle lab. 25 kg of polymer was delivered to my doorstep. Injection moulding then commenced, carried out by Joanna Stasiak and Ruhi Patel. Finally, once appropriate processing parameters were established, the 52 parts were actually moulded in two days," says Professor Moggridge.

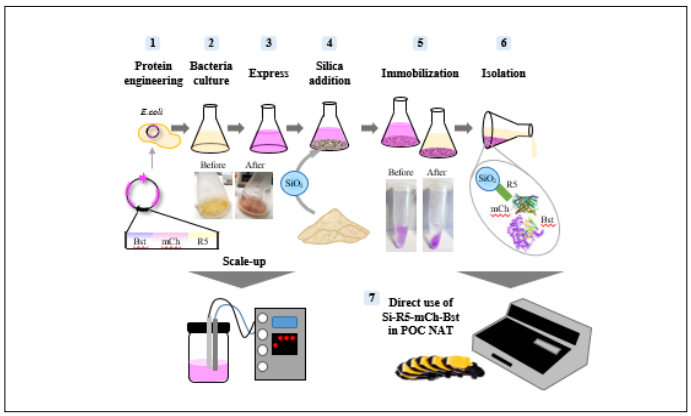
However, working in low-resource settings presents a number of challenges: electronic and mechanical components still need to be found, and long-term quality testing of the parts in Africa needs to follow. Sourcing ventilator components is hard and the environmental conditions for ventilator operation are different in different countries because of different humidity levels. Still, the biggest challenge of all is being able to produce and distribute the ventilators at a low cost in South Africa.

Needless to say, the device design is to be of a good standard, and also meet a number of medical regulations, which may take a long time to get through.

Professor Moggridge, who previously designed and produced a medical prosthetic heart valve, has already had ample experience working with medical devices, finding a route for authorisation by the Food and Drug Administration (FDA) and bringing these to market.

"The ventilators with their oxygen-efficient design have the potential to make a major long-term impact for the communities where they get deployed as they would remain on the ground," says Professor Zeitler. "The aim is to make all this open-source and openly available. The University is going to have all IP assigned to it from this project and our prototype designs will be made available through an open-source license with all the disclaimers and protection of the team members who've given their time to make this a reality." OVSI have also taken the Open COVID Pledge alongside major companies such as Microsoft, IBM, Fujitsu and Amazon that between them hold 260k patents to publicly state their commitment to making their intellectual property available to fight COVID-19. The Pledge is an initiative that was started by a coalition of lawyers and scientists, including CEB's Dr Jenny Molloy and Dr Frank Tietze from the Institute for Manufacturing.

Another enterprise to combat COVID-19 in low, middle-income countries that has sprung up at CEB is being led by our HoD, Professor Lisa Hall, and Dr Jenny Molloy. They have submitted a clinical testing grant application with collaborators at the Technical University of Denmark (DTU) and three Ghanaian research institutions, including two national COVID-19 testing centres, which currently process 1500 tests per day. This will enable initial clinical assessment of a rapid, point-of-care test for viral RNA developed by DTU, while Professor Hall and Dr Molloy develop capacity for manufacturing of the enzymes used in the test



A representation of enzyme production in a lab.

(nucleic acid polymerases) by local labs and companies in Ghana.

The concept of local manufacturing has several advantages over the existing diagnostic supply chain, which requires importation of tests or test reagents at overseas prices that are too expensive in comparison to local purchasing power. Firstly, the costs could be substantially lowered, making them more affordable for use at the huge scale needed to tackle COVID-19. Secondly, local manufacturing builds resilience and autonomy into a supply chain that is challenging and prone to disruption even at the best of times. Many researchers in Africa, Asia and Latin America routinely face long waits for the reagent kits and enzymes they need, from weeks to months, in addition to disruption of the cold chain for reagents delivered on ice and challenges with customs, importation paperwork and public or institutional procurement systems, as evidenced in an interview-based study conducted by Dr Molloy.

That problem is exacerbated during the pandemic when demand is high; normal supply chains are struggling to cope with demand and many countries that manufacture reagents are imposing export controls. A recent commentary in *Nature* by Dr John Nkengasong, Director of the Africa Centres for Disease Control and Prevention (Africa CDC) put it succinctly: "The collapse of global cooperation and a failure of international solidarity have shoved Africa out of the diagnostics market... . African countries have funds to pay for reagents but cannot buy them."

Both Dr Molloy and Professor Hall are building on existing projects to develop low-cost protocols for enzyme manufacturing. Members of the Analytical Biotechnology Lab at CEB have developed a system for producing and purifying enzymes for nucleic acid tests such as PCR and LAMP that attaches the enzymes needed for the assay onto silica particles. The silica can even be cheaply obtained from beach sand. Moreover, the enzymes they make are tagged with a bright-pink coloured protein that offers visual reassurance across all steps of the production and purification process, showing that the enzyme has correctly folded and is in the right place. The whole process has been designed to allow distributed local production without high capital investment and offering convenience and ease of production and quality control with substantial production cost savings.

Members of the Hall Lab including Dushanth Seevaratnam and Dr Cassi Henderson have already undertaken clinical trials in Ghana and Malaysia, using these enzymes in studies using nucleic acid testing to detect species of malaria and the tests are extremely adaptable to many infectious diseases. "The basic test components remain the same but the sequence for different RNA or DNA is targeted for whatever disease you are looking to test for, be that Ebola, malaria, or the SARS-CoV-2 virus that causes COVID-19," says Professor Hall.

"Infectious diseases remain a major cause of morbidity and mortality in low-income countries. As well as COVID-19, these include food and waterborne diseases (bacterial diarrhoea, enteric fever, hepatitis A), vector-borne diseases

EBTi-COVID-19 Testing Team in Ethiopia

(malaria, dengue, chikungunya and Zika), zoonotic diseases (leptospirosis, rabies) respiratory infections (influenza-like illnesses, pneumonia, tuberculosis) and HIV infection. There is a lack of diagnostic tests to distinguish febrile disease like COVID-19, and with patients presenting fever and a wide range of non-specific symptoms, which are difficult to diagnose without specialist laboratory tests, doctors/medical practitioners are having to diagnose on the basis of probability, resulting in empirical treatment, which may be unnecessary, incorrect or potentially even harmful."

The collaboration to develop affordable diagnostics for the entire COVID-19 care pathway also includes Dr Tony Jackson from the Department of Biochemistry, who is looking at a novel single chain antibody for the team to develop an immunoassay. This will allow them to design a test which indicates if people have previously had COVID-19. The antibody technology can be adapted for local distributed production in the same way that the polymerase enzyme is produced for the nucleic acid test, which could be a game-changer in terms of rapid access for the next pandemic.

Dr Molloy has been working with labs in Ghana, Cameroon and Ethiopia for two years to build capacity for enzyme manufacturing; leveraging a collection of 16 off-patent enzymes, which her group are currently synthesising in collaboration

"Both Dr Molloy and Professor Hall are building on existing projects to develop low-cost protocols for enzyme manufacturing."

with US company Ginkgo Bioworks and Stanford University as "ready-to-use" DNA, plus over 100 useful blocks of DNA to build new functions. This will be shipped to a network of labs for research, including those conducting research in diagnostics who will share back the results of their experiments to enable the whole network to move forward quickly to optimised protocols, taking into account the need for quality assurance and validation data to enable early conversations with diagnostics regulators and manufacturing partners. "What is exciting about the Reclone network is the speed at which partnerships have developed between academia, government and the private sector in both Latin America and Africa," says Dr Molloy. "The scientists leading these initiatives have a sense of urgency but are cognisant of the lengthy timelines involved in getting manufacturing efforts off the ground in comparison to the speed of the pandemic. They are committed to a long-term vision for building biotechnology capacity and increasing pandemic preparedness that could have far-reaching impact in their countries and regions".

Professor Hall, whose past work has included the research behind widely used glucose test strips[5] has recently been focussing on breaking the barrier to local manufacturing of diagnostics in LMICs, working with Ghana, Malaysia and the Philippines. She and Dr Molloy's next research steps are now also looking beyond the production of enzymes for research and proof of concept trials and into the barriers and bottlenecks to advancing the manufacture of a regulator-approved diagnostic device in countries currently without all the enabling the infrastructure. "We are looking for an affordable device at a cost that is equivalent to a bowl of rice (or local equivalent), which would help build their local economies and education without needing to rely on foreign aid," explains Professor Hall. This goal requires research and innovation in financing models and partnerships as well as a roadmap and guidance for manufacturers and regulators to ensure high-quality products that meet international guidelines. There are numerous other challenges to overcome in how those tests are then applied in the health system. Overcoming these requires technological innovations, for example, Dr Molloy is working with the Ethiopian Biotechnology Institute[4] to scale up COVID-19 testing using open source robotics hardware, as well as consideration of economic, ethical, legal and social dimensions at a systems level.

Dr Sara Serradas Duarte, Programme Coordinator of Cambridge Global Challenges (CGC), the University's Strategic Research Initiative for the UN Sustainable Development Goals, is impressed by what CEB is achieving: "As the pandemic spreads to the poorest parts of the world, inequality is exacerbated, the vulnerabilities of countries that particularly struggle to respond to the pandemic are more visible and their development needs are more urgent. Drawing on previous science-for-development experience, CEB colleagues have made key contributions to the University's response to COVID-19 in low-income countries."

"CEB's work has addressed the most immediate healthcare needs of these countries such as access to ventilators and to COVID-19 testing, as well as their existing longer-term transformational development priorities as further evidenced by the pandemic, including IP frameworks to appropriately mobilise the innovation required for the creation of the ventilator, and supply chains that adequately secure the provision of the reagents necessary for the testing. As highlighted by the United Nations Social and Economic Recovery Framework, and by the recent call for an international response to COVID-19 by the UK and other six European Development Ministers, "thinking long-term from the start" will be essential."

Check out the University's COVID-19 response fund[6], how the Cambridge response to COVID-19 in Official Development Assistance target countries[7] is being coordinated, and how you may be able to contribute and/or advance your ongoing project.

Sources:

[1] www.ovsi.org

[2] See video on www.cam.ac.uk/research/news/open-source-ventilator-designed-by-cambridge-team-for-use-in-low-and-middle-income-countries

[3] www.centreforglobalequality.org

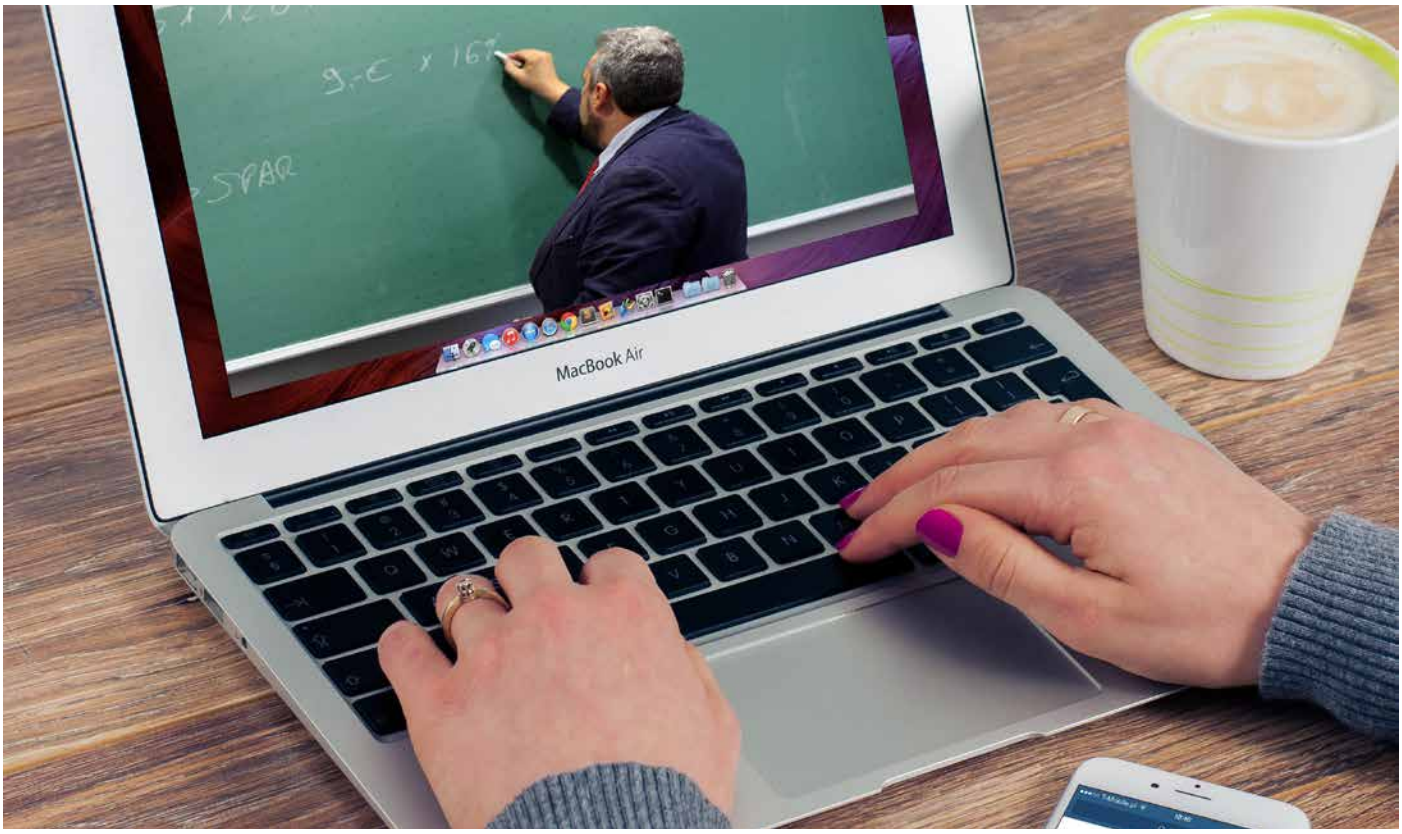
[4] w.openbioeconomy.org/news/alborada-fund-awarded-to-scale-up-covid-19-testing-in-ethiopia/

[5] http://www.cam.ac.uk/research/impact/biosensor-boost-for-diabetics

[6] Uni call 'help us tackle covid-19 www.cam.ac.uk/business-and-enterprise/help-us-tackle-covid-19

[7] Cambridge's response to COVID-19 in Official Development Assistance- target countries www.gci.cam.ac.uk/cambridges-response-covid-19-oda-target-countries

Online teaching: a perspective from staff and students



The new reality of virtual teaching and learning

This term has seen the department, along with the rest of the University, move towards remote teaching with little notice. With the cancellation of face-to-face lectures in the next academic year, this sudden change is likely to persist, setting a new normal for the university. The CEB Focus team reached out to Dr Patrick Barrie, the Director of Education for the School of Technology and Senior Lecturer at CEB, to share some of his perspectives and insights on the lessons learnt so far on remote teaching.

Remote Teaching

Dr Patrick Barrie

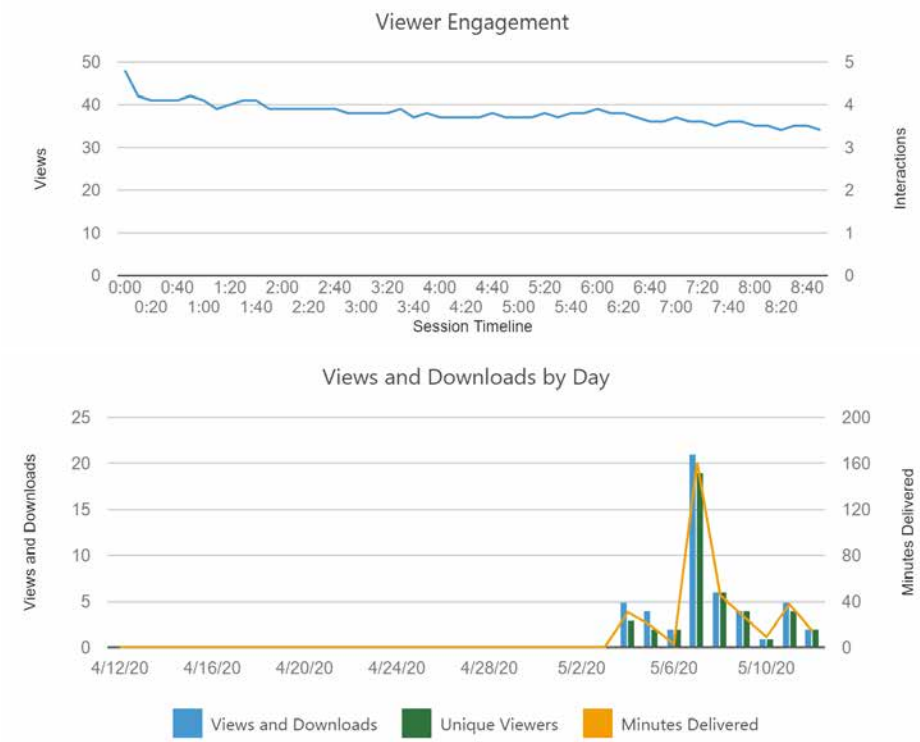
There are two main modes for the delivery of material normally taught by lectures. Delivery may be synchronous (live) or asynchronous (pre-recorded). Each of these has separate advantages and disadvantages, and both have been used by lecturers in the Department this term.

The key advantage of synchronous delivery is that lecturers have the opportunity to interact with the audience – if there is no interaction, then the material should probably be delivered asynchronously. Webinars may be delivered by Teams, Zoom, Adobe Connect, Panopto or other pieces of software. Interaction should be driven by getting listeners to use the chat box regularly in the talk, or by the judicious use of polls. Lecturers should ask questions that solicit chat responses that have very short but open-ended answers. There are various types of questions that may be asked. Preparatory questions get students to input something, almost anything, into the chat box at the start. Other types of questions may ask a student to predict what is coming next, or to check that a concept has been understood. Lecturers should signal a question is coming, ask it, give a short time for responses, and indicate that they have skimmed responses before continuing. Even without prompting, students need to be encouraged to use the chat box to query material that is unclear.

However, it is not always easy to maintain good interaction in webinars because lecturers have to be delivering material and scanning chat responses at the same time. Delivery also usually takes longer than a conventional lecture.

The other mode for delivering lecture material is asynchronously, where the material is pre-recorded and students can watch the video recording(s) whenever they like. It is true that synchronous delivery can be recorded and watched back by students later, but this is not usually as effective as a course that had been planned for asynchronous delivery.

The key advantage of asynchronous delivery is that there is no constraint on timings. Students in different time zones are not at any disadvantage with this mode of teaching. The duration of the video(s) can be chosen to match the content. Students are more likely to watch several 10-minute videos than attempt to concentrate for a 50-minute video. Furthermore, students can watch parts of the video more than once if they want. Another advantage of asynchronous delivery is that there is the opportunity for video editing before uploading. Lecturers may cut any mistakes they make in delivery. They can also top and tail the start and end of a video recording if necessary. Shorter videos can be combined into a longer one if desired. There is also scope for the inclusion of quizzes within pre-recorded videos.



Statistics on student views of an educational video using Panopto software

These may be a simple check on student understanding in the middle of the lecture. Lecturers can even force students to answer questions correctly on a quiz before the next part of the video will play. Depending on the software, a summary of student answers to embedded quizzes may be available.

Videos may be pre-recorded using a variety of software. Educationalists state that those with a "talking head" visible at the corner of slides engage students better than those without. The University currently recommends Panopto Recorder because it is available to all academics within Cambridge and can be downloaded onto personal computers/MacBooks/laptops. However, Zoom and other software can also be used. A PowerPoint presentation with audio recording is a simple alternative, though not technically a video. Videos may be transferred to Panopto Online, no matter what software they were recorded in, rather than uploaded directly to Moodle. Panopto Online is integrated with Moodle so that the video can easily be played from Moodle. This has a number of advantages. First, Panopto allows video editing to be performed as described earlier. Second, Panopto collects statistics on student viewing habits. Lecturers can check how often a video has been viewed, which parts of the video were viewed, and even what time of day they were viewed. It is of interest to see whether significant numbers of students watch only the first 2 minutes of a video, or whether there are any parts that are watched multiple times by a single individual. However, one of the main drawbacks of asynchronous delivery is the lack of interaction with students. In principle, this can be compensated by Moodle Open Forums for students to ask questions about a particular course – both to the lecturer and to each other. These can allow anonymous posts if desired. Thus far, students in the department have not engaged much with this feature, possibly because it is unfamiliar to them, and they can also ask questions through the College supervision system.

College supervisions have also had to be done remotely this term, with Teams and Zoom being the most common software used. Students have been able to scan their answers to problem sheets and email their work as a pdf document to supervisors ahead of the supervision. Supervisors can then highlight mistakes (or good points!) on the pdf document before the supervision, and then share their screen during the supervision. It is often helpful to write out mathematical equations or sketch figures during a supervision. This is feasible if the supervisor has a visualiser, or a tablet with a stylus, but it is challenging otherwise. Several people have used Apps that allow a smartphone camera to behave as a visualiser with some success, but it is not quite as good as they would like. This will need to be explored further given that College supervisions are due to be delivered remotely as well next academic year.

In conclusion, the need to teach remotely poses challenges, but it is still possible to teach well. Indeed, there are opportunities for improved education in this digital age.

Student perspectives

The CEB Focus team also reached out to students to hear their side of the story regarding remote teaching and learning. Notably, several Part I students highlighted concerns that the lecturer may not receive immediate feedback from the students when a concept isn't properly understood, and it may take a significant amount of time for lecturers to get back to students via email especially if lectures are not delivered live (asynchronously). Others noted a drop in productivity that comes from working in a place of relaxation, although ameliorated to certain extent by the convenience that comes with not physically traveling to the department each day. Regardless, there was an understanding that although learning will be disrupted in some form, the department, professors and lecturers will try their best to achieve learning outcomes and get back to students promptly.

GRSoc, CEB's Graduate Student Committee, has also undertaken efforts to support graduate students especially with regards to collaborative online learning. Jana Weber and Yunhui Zhuang, Graduate Student-staff Consultative Committee representatives, noted that "the lockdown has led to many students working more on the computational side of their projects. Some of them are learning new programming skills, finishing up data analysis and discovering online courses". To facilitate collaborative learning, the Committee has initiated skills development channels on Teams delving into cutting edge topics ranging from Python and Machine Learning to Image Analysis and Graph Theory.

"With the CEB skills development channels we aim to provide a platform to share our knowledge, which makes the start into new topics much easier and much more enjoyable", Jana and Yunhui noted. "We've already noticed the first few entries in the channels and even offers to give online tutorials. Our vision is an interactive forum, connecting experts, beginners, and everyone in between, and allowing us to learn with each other. If the first few channels are received well, we are happy to provide a broader range of topics!"

It is heartening to see that a concerted effort is being made by staff, academics, students, and committees to ensure that learning is not significantly disrupted during these uncertain and troubling times. As the Easter term unfolds, transparent communication between all parties will continue to refine online teaching and learning methods and ultimately arrive at the optimal approach.

More information on the University's remote teaching plans can be found at www.cctl.cam.ac.uk/teaching-remotely.

CEB students pitch their beer designs

Representatives that attended the microbrewery visit along with CET I Students

CEB academics Dr Katherine Smart, Lecturer in Brewing and Dr Róisín Owens, organised a visit to Jesus College microbrewery in early February for students to learn how beer is made in preparation for a beer design pitch session.

CEB CET I Biotechnology students attended the microbrewery trip along with Sonia Ganatra and Jessica Simmons, representatives from Briggs of Burton, Andrew Patterson from Lallemand and Nigel Davies from Muntons.

Briggs of Burton is a process engineering company providing design, engineering, and specialist equipment to the brewing, distilling, food, pharma, and biotechnology industries. With over 285 years of experience, Briggs of Burton are one of the pioneers of process engineering in the world.

Students also learnt about the huge number of beer styles, which can be produced using malt, hops, yeast, water and the effective use of the brewing process. The styles are then classified according to their appearance (colour, clarity and foam) and sensory characteristics. Various methods are deployed to assess beer colour, clarity and foam. Sensory characteristics are assessed using aroma and taste and are typically conducted in specialised laboratories within a brewery. There are 90 aroma and flavour characteristics associated with beer. These are collectively displayed on a 'Beer Flavour Wheel' used by the industry to assess beer style, the sensory profile of a brand and quality attributes. The method of sensory analysis was also demonstrated.

Dr Smart also gave a talk on 'Brewing: Industrial applications of Biotechnology' in Jesus College. All students also had the opportunity to test the aroma and taste of beers whilst working behind the scenes on designing and marketing their own beer brand.

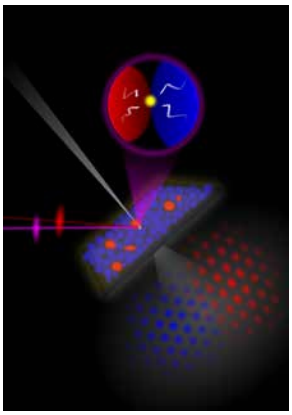
On 21 February the students pitched the beers that they had designed to a great audience. Each gave a two-minute presentation and there were about 45 presentations in total. There was a panel of judges including Georgia Goddard from Thirsty, Nigel Davies from Muntons malt and Mark Burton, the Master Brewer at Jesus college who evaluated all the pitches. The pitches were an exercise to get students to apply what they learnt on the visit to designing and making their own beer.

There was no prize, but the students were graded on their exercise, which counts to their final marks.

"All students also had the opportunity to test the aroma and taste of beers whilst working behind the scenes on designing and marketing their own beer brand."

After the pitching, students and staff held a small social gathering with an optional tasting of some leftover beer. Overall, it was a valuable experience for students, who have since shared positive feedback about the microbrewery visit and the beer design pitching event. Therefore, there are plans for these educational events to continue in the future once COVID-19 is under control.

Shedding light on dark traps



A visual representation of a charge carrier trapped at a particular site within the perovskite structure

In the last decade, perovskites – a diverse range of materials with a specific crystal structure – have emerged as promising alternatives to silicon solar cells, as they are cheaper and greener to manufacture, while achieving a comparable level of efficiency.

However, perovskites still show significant performance losses and instabilities. More specifically, defects or minor blemishes in the material result in a 'dark trap', where energised charge carriers can get stuck and recombine, losing their energy to heat, rather than converting it into useful electricity or light. Most research to date has focused on ways to remove these losses, but the actual physical causes of dark traps remain unknown.

Now, researchers from Dr Sam Stranks's group at Cambridge University's Department of Chemical Engineering and Biotechnology and Cavendish Laboratory, and Professor Keshav Dani's Femtosecond Spectroscopy Unit at OIST in Japan, have identified the source of the problem.

The team employed scanning electron diffraction to create detailed images of the perovskite crystal structure and Photo-Emission Electron Microscopy (PEEM) to visualise the charge carrier trapping process. "In perovskites, we have regular mosaic grains of material and most of the grains are nice and pristine – the structure we would expect," explains Stranks. "But every now and again, you get a grain that's slightly distorted and the chemistry of that grain is inhomogeneous. What was really interesting, and which initially confused us, was that it's not the distorted grain that's the trap but where that grain meets a pristine grain; it's at that junction that the traps cluster."

With this exciting development, there is understanding now that the key to improving the performance of perovskites lies in targeting these inhomogeneous phases or getting rid of the junctions in some way.

"Most of the progress in device performance has been trial and error and so far, this has been quite an inefficient process," affirms Stranks. "To date, it really hasn't been driven by knowing a specific cause and systematically targeting that. This is one of the first breakthroughs that will help us to use the fundamental science to engineer more efficient devices."

References:

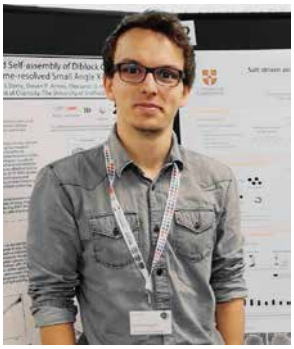
www.ceb.cam.ac.uk/shedding-light-dark-traps

D. W. DeQuilettes et al., "Impact of microstructure on local carrier lifetime in perovskite solar cells," Science (80-.)., 2015.

'Green' production of magnetic silica beads

David Brossault's poster focusing on a green method to produce metal doped silica composite materials, and their potential for both biological and environmental applications, was assessed by a panel of three academics from the Texas A&M University, University of Strathclyde and Indiana University, and ranked first among the 88 posters in the competition's nanoscience category.

Magnetic silica beads are interesting composite materials. These systems, usually composed of an iron oxide core coated with a silica layer, have attracted a lot of interest in the last few years due to their magnetic properties combined to their non-toxic and easily functionalisable surface



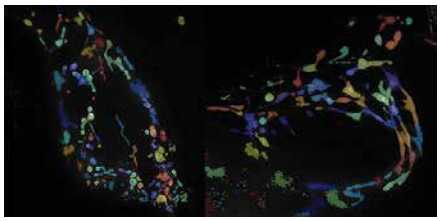
David Brossault, PhD Student in our Colloidal Dispersions Group

"The conference itself was a great experience. During those 24 hours, I had the opportunity to read about so many interesting research topics from researchers from all over the world. It also gave me the opportunity to debate on my own research and promote my 1st paper to people I would have never met in normal conditions. The use of such a powerful social network is a great opportunity to promote your research and reach way more people than in a physical conference. Furthermore, you don't have to pay expensive fees and the cherry on the cake is you can do all of it from the comfort of your own room. So, if I have one tip to give, attend the RSC poster Twitter conference 2021,!" said Brossault.

References:

www.ceb.cam.ac.uk/news/green-production-magnetic-silica-beads-wins-twitter-poster-prize-and-our-highlighted-paper

Design of a functionalised metal-organic framework system for enhanced targeted delivery to mitochondria



Shape analysis of cancer cell mitchondria using Cell Profiler software

Mitochondria, powerhouses that provide the energy needed for our cells to function, are structurally and functionally different in cancer cells relative to healthy cells. Given that they also play a role in triggering programmed cell death, they have been an attractive target for anti-cancer strategies. The anti-cancer drug dichloroacetate (DCA), in particular, has already been shown to change the activity of cancer cell mitochondria and trigger cell death, but the drug can't easily cross cell membranes.

This is where MOFs come in. MOFs are porous, self-assembling, 3D nanoparticles are made of metal and organic building blocks and can act as drug delivery systems, carrying DCA through cell membranes and increasing its efficacy. Due to their porosity, MOFs can also carry large amounts of the drug, and additional molecules can be added to the MOF structure so that it specifically travels to mitochondria, ensuring almost all of the DCA reaches its intended target site within the cell.

Leveraging all these features, Dr Sam Haddad, a former PhD student in our Adsorption and Advanced Materials group, led by Dr David Fairén-Jiménez, has developed a non-toxic and highly porous zirconium-based MOF nanoparticle, modified to target cancer cell mitochondria, which could deliver DCA to its intended site. Due to the high specificity and selectivity of the MOF, the required dose could be reduced to 1 % of the original concentration. Furthermore, working with super-resolution microscopy and bio-imaging experts from our Laser Analytics and Molecular Neuroscience groups, the team was able to see the potent effect of their system in stunning detail.

"The work that went into finding an optimal system was long and tedious, but finally paid off, and we were very pleased with

the results. MOFs have only recently started being explored for therapeutic purposes and we have demonstrated that they are worthy candidates," Dr Haddad added.

The work so far has focused on cancer cells outside of a living system. The challenge for the team now is to further investigate how their system might function in a more complex environment.

References:

www.ceb.cam.ac.uk/shedding-light-dark-traps

Performance-limiting nanoscale trap clusters at grain junctions in halide perovskites

Doherty, T.A.S., Winchester, A.J., Macpherson, S. et al. Nature 580, 360–366 (2020)

Supercharging decarbonisation through intelligent technologies

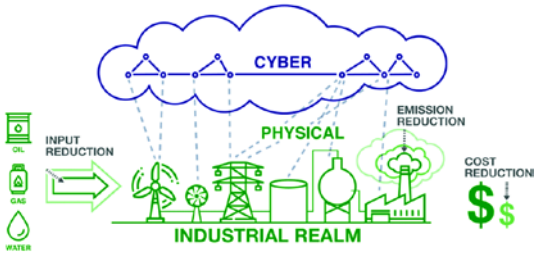


Illustration of an intelligent cyber-physical system

A new review from our researchers in the Cambridge Centre for Advanced Research and Education in Singapore (CARES) has shown how integrating digital tools into the world's energy systems could drastically reduce carbon emissions. The review re-assesses the famous marginal abatement cost curve (MACC) popularised by McKinsey, which illustrates both the cost and potential of various carbon dioxide reduction strategies and are used by policy makers to assess which paths to pursue. The digitalisation of energy systems completely alters the MACC, thanks to the creation of novel pathways for the transition to low-carbon energy.

While existing digital technologies such as big data, machine learning, the Internet of Things (IoT) and artificial intelligence (AI) have numerous and effective applications when considered individually, the potential reduction of carbon emissions is multiplied when they are combined. Such combinations are called cyber-physical systems – interacting networks of physical infrastructure and computers that allow for smarter analysis, decision-making and optimisation of energy systems. If cyber-physical systems are integrated into our energy systems, carbon abatement potential can be expected to increase by 20 per cent, rising to 30 per cent when AI is included. Enhanced forecasting of renewable energy sources such as wind and solar, and improving the energy efficiency of large power plants are just two examples of many where intelligent cyber-physical systems could add value.

Ultimately, the addition of cyber-physical systems is a substantial update to the MACC and further establishes it as an indispensable tool for those working on decarbonisation, and smoothly transitioning the world towards sustainable energy while maintaining economic stability.

"This review is an in-depth study of the impact that digitalisation could have on our energy systems," says Professor Markus Kraft, Director of CARES. "Digital technologies, if applied wisely, could increase the efficiency of energy provision and industrial production to the point where our current path towards climate breakdown is shifted substantially. Integrating artificial intelligence into these technologies will have an even greater positive impact. It is my hope that policy makers, researchers and those working in industry will find our review useful in their quest to decarbonise our world."

References:

www.ceb.cam.ac.uk/news/supercharging-decarbonisation-through-intelligent-technologies

O. Inderwildi, C. Zhang, X. Wang and M. Kraft, Energy Environ. Sci., 2020, Advance Article , DOI: 10.1039/C9EE01919G - Reproduced by permission of The Royal Society of Chemistry

Filling the gaps in biologics data: bioscience engineering paper wins 'Paper of the Year' award

Data science

Research led by Duygu Dikicioglu, Nishanthi Gangadharan and Jeanet Mante from our Bioscience Engineering group, headed by Professor Nigel Slater, have been awarded the 'Paper of the Year' for 2019 by Springer journal Bioprocess and Biosystems Engineering.

In their paper, "A heuristic approach to handling missing data in biologics manufacturing databases", the researchers explore how to deal with gaps in bioprocess data sets, in order to use them for machine learning models that could improve efficiency in the biotechnology industry.

Industrial and academic research into bioprocesses – such as the production of antibodies, enzymes or proteins – generates huge datasets, as researchers seek the optimum conditions across a myriad of variables for a particular process.

Leverhulme Early Career Fellow Duygu Dikicioglu saw the potential to use these vast datasets in her group's development of mathematical modelling algorithms designed to predict the outcomes of different reactions and conditions. The models could cut down the amount of trial and error in bioprocess research.

"The award was completely unexpected; I think all the authors were really happy. When we started working on it, everybody had a feeling that this was an important thing, but at the same time, not a lot of people are working on it. So we're really happy that our work has been taken well by the community."

"I was very happily surprised by the award," says Jeanet. "I think it is a reflection of the wonderful mentor Duygu is, and the collaboration she fostered between Nisha and myself. Nigel and Duygu gave me the opportunity to build confidence in my research aptitude, which in turn gave me the confidence to pursue a PhD. Seeing work that meant a lot to me personally gaining recognition is especially meaningful."

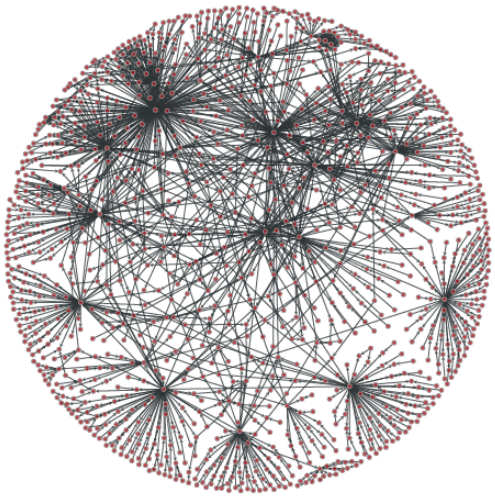
Jeanet Mante is now a PhD student at the University of Utah, Nisha Gangadharan is a PhD student in our department and Duygu Dikicioglu has taken up a position as Associate Professor of Digital Bioprocess Engineering at University College London in April this year.

Reference:

www.ceb.cam.ac.uk/news/filling-gaps-biologics-data-bioscience-engineering-paper-wins-paper-year-award

Navigating chemical space to realise a circular chemical economy

Jana Weber, PhD student in the Sustainable Reaction Engineering Group



A complex reaction network

It is estimated that by 2030, the chemical industry will become the main driver for global oil consumption.

We extract natural resources, we process them, we utilise the products, and we dispose waste; this is called a linear industrial chain. Linear supply chains are associated with problems at both ends: the depletion of natural resources as well as the generation of huge amounts of waste. One promising solution to this global challenge is a circular economy, which is inspired by cyclical material flows in ecosystems in nature. Thus, waste should be ideally treated as a valuable resource. Promising materials are for instance seafood shell waste where chitin is of interest, wood waste, from which especially lignin provides useful chemical structures, and crude sulphate turpentine, which is a by-product from the paper industry and contains valuable terpene hydrocarbons, suitable for processing in industries such as flavour and fragrance industries. These feedstocks can contribute to the transition towards a carbon neutral economy.

To integrate waste streams into the chemical supply chain, a system approach is needed. We use data mining from one of the largest electronic reaction databases and explore the chemical space as a network. Each molecule is represented by a node in the network and possible chemical transformations are shown by links between the molecules. With access to Reaxys, these networks can easily be of the size of millions of molecules and cover large areas of chemical transformations. From the network structure, we discern strategic molecules that lie at strategic locations in the overall system, e.g. having a high connectivity or connecting different branches of products. These strategic molecules play an important role in the development of future sustainable supply chains because they have the potential to become future “platform chemicals” in a circular economy. Producing strategic molecules from renewable sources through sustainable processes should be a focus of academic investigations as well as of industrial applications, as these have a large effect on the overall supply chain.

To find such sustainable processes we look at a large set of possible reaction pathways from the network and optimise material flows. We can for example find short reaction pathways, most reproducible reactions, and reactions that fulfil certain green metrics. One may visualise that as a Google maps navigating through chemical space.

In my PhD, I am working on the automation of process route evaluations to enable a fast and easy customisable screening in large reaction spaces. I see the work most useful for the transition towards sustainable chemical supply chains, as only highly efficient sustainable process routes will be competitive enough to be implemented in the real world. This makes large scale screening a prerequisite if we want to identify the most promising process alternatives.

My work is part of the Sustainable Reaction Engineering (SRE) group led by Professor Alexei Lapkin. The group is interested in finding better manufacturing processes for a sustainable society. We work on problems at multiple levels, starting from the selection of appropriate catalysts or solvents for a specific reaction and reaching to the big data analysis of chemical or enzymatic networks.

My PhD so far has been challenging, but mostly very inspiring! I have very much enjoyed learning about network science. Networks are used to model our brains, epidemic spread of diseases, the diffusion of political opinions and technological innovation, ecosystems, the electricity grid and many more. I believe that the complex system approach has led me to a much better understanding of sustainability and its complexities not only within chemical engineering but also in general.

Reference:

J. M. Weber, P. Lió, and A. A. Lapkin, “Identification of strategic molecules for future circular supply chains using large reaction networks,” React. Chem. Eng., vol. 4, no. 11, pp. 1969–1981, 2019

Star(ch) power

Dr Ljiljana Fruk, Lecturer and Bionano Engineering Group PI

The molecular composition of starch. Credit Ljiljana Fruk and Philip Mair

I have just had pizza and this has instantaneously transformed me from a grumpy Ljiljana into a cheerful article-writing ball of energy. This is the power of comfort food. Chocolate cake, pizza, pasta, ice-cream, halva; we all have our own "miracle-makers", and at their core are starches and sugars, which promote the release of the "feel-good" neurotransmitter serotonin. Studies have shown that the level of amino acid tryptophan in blood increases after we consume starchy food. Tryptophan is a precursor to serotonin. More tryptophan in plasma means that more can get through the brain-blood barrier and be converted to serotonin in the brain, making an instant impact on our mood. It is not surprising then that, when we are stressed, feeling down, or find ourselves in a month-long quarantine, we crave starchy food like pizza, fries and pasta.

However, if you have too much starch on a regular basis, your weight will go up, and, as enzymes will be working overtime, your heart will suffer, and your blood sugar levels will go through the roof. The key to healthy eating involves the balance of various nutrients. As happy as they may make us, starch and sugar taken in high amounts over longer periods can stimulate the release of cytokine molecules, which will trigger inflammation and, ultimately, lead to depressive moods.

Refined starch has high glycemic index, meaning that it can be digested and metabolised rapidly. Such fast-metabolic rate causes the fluctuation in the blood sugar level, and overall that is not good. What we need to ingest is starch that can act slowly, that from tubers such as sweet potato, or weakly processed, or plain seeds and grains.

Humans started eating starch early in their development, and even our hunter-gatherer ancestors suffered from dental problems and cardiovascular diseases caused by starch-rich diet some 13 000 years ago 1. Despite these recent findings, it is believed that consumption of a food rich in starch gave humans an evolutionary advantage over other animals, as they could get more energy faster, and plenty of sugar to sustain enhanced brain activity.

But what makes starch so special? It is a large molecule, which consists of many glucose units grouped into two distinct structural units, helical amylose and branched amylopectin. Glucose, involved in energy-producing metabolic cycle, is released with the help of enzymes. For example, some people might have up to 20 copies for gene coding for the enzyme amylase, which kick-starts the digestion of starch in the mouth. Such a large number of copies highlights the significance of starch digestion.

We can digest starch efficiently, but we cannot make it, we get it from plants. It is produced in most green plants, although the higher content is found in tubers, roots and seeds. In animals, an equivalent to starch would be glycogen, employed to store energy.

Pure starch is not particularly exciting to look at. It is white powder, insoluble in cold water or alcohols, and if you put it in the mouth, the chances are that it will not taste like anything. First starchy compounds were probably obtained from wheat, and nowadays, corn and potato starch are the most prevalent. Although it is important for the food industry, starch is also one of the most versatile compounds. In fact, as far as 4000 years ago, it was used as an adhesive to glue together papyrus in old Egypt. Arabic pharmacologist Abu Masur (853-944 AD) used starch mixed with saliva to make artificial honey to successfully treat wounds and kill bacteria. The word "starch" originates from "Stärke" in German (meaning strong, stiff, strengthen) and it was used as a stiffening agent for various textiles. Leave it to the appearance-conscious Romans, who used starch in cosmetic and hair products, and the studious, ancient Chinese, who used it to make high-quality rice paper.

In the 19th century chemists started experimenting with sugars, and making them from starch by hydrolysis, and an explosion in a Dublin textile mill in 1821 led to starch being converted to British gum or dextrin, which transformed the pharmaceutical, textile and paper industry, and it is still used in applications requiring strong adhesives. The 21st century is seeing starch nanoparticles being used in food technology, and it seems the future of starch is bright.

Due to bad press and its links to obesity and diabetes, it is easy to forget that, it was the need for starch that pushed us into farming and bought us more time (and energy!) for thinking and creating. Starch helped us survive harsh winters, and now, a long quarantine. It has also transformed the way we make food, paper, clothing and medicine. In the "molecules hall of fame" it is not the shiniest of them all, but definitely the most versatile, and consistently present at turning points in human development.

Reference:

[1]Humphrey, L. T et al, PNAS 2014, 111 (3), 954-959

AstraZeneca support of CEB research

To nurture development of future talent at CEB, AstraZeneca (AZ) is collaborating with the EPSRC Sensor CDT to fund PhD projects. To date, over 9 projects have been funded that use cutting-edge technologies to tackle fundamental questions regarding bio-processing, large molecule and protein-based therapeutics. Combining expertise from the drug development and academic research setting is hugely valuable for both parties and in creating innovative solutions to global health problems. CEB Focus team got in touch with some students and industrial scientists to gather their personal insights on this programme.

For more information visit: www.youtube.com/watch?v=YBiS7bFXM8Y&feature=youtu.be and www.cdt.sensors.cam.ac.uk/

What have been the positive aspects of this collaborative project and how has this benefited your research?

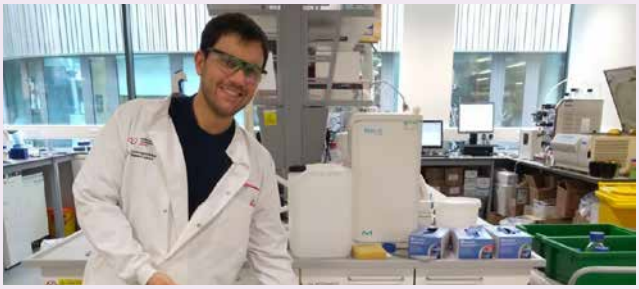
Viv Lindo - "The partnership has been beneficial in allowing AZ to research areas related to better therapeutic product design, but areas that are not directly aligned with the current drug development processes. In a fast-moving industry, the need to remain "cutting-edge" is important and fundamental research is the means to allow this to continue. Students on the programme help to address many questions that would otherwise take much longer to find solutions."

Dr Róisín M Owens - "The partnership has hugely benefited both the funded student and more broadly my research group. We have been exposed to the way research is carried out in industry and have learnt about some cutting-edge cell biology techniques carried out in pharmaceutical R&D laboratories. The other major advantage is the potential for translation of our technologies for real world application. This closes the loop in terms of us working on sensor technologies that are really useful in the pharma industry."

AstraZeneca research scientist, Viv Lindo's area of research includes understanding the nature and causes of peptide instability in therapeutic formulation.

Róisín M Owens, Co-director of the Sensor CDT and leader of the Bioelectronics Systems Technology group.

3rd year PhD student, Carolina Orozco's research involves looking at the physical stability of therapeutic antibodies.



2nd year PhD student, Luca Mascheroni's research involves using optical microscopy to understand the molecular mechanisms of flu vaccines.

What opportunities have you benefited from?

Carolina Orozco- "I think collaboration between academia and industry is very fruitful. I have been working between the University and AstraZeneca since the beginning of my PhD, and I have learned so much from both environments. I was trained in the biophysical theory and techniques by my academic supervisor, and mass spectrometry and monoclonal antibody (mAb) expression, by my team in AstraZeneca. It is also very formative to be exposed to the internal expertise in antibodies, and to the dynamics within a pharmaceutical company."

Luca Mascheroni - "I have benefitted from this collaborative project in several ways. First, I can visit and work in AstraZeneca: it is great to see how scientific research is done on an industrial site! Second, the collaboration with AZ made my project more 'practical': I think several PhD projects are academically very intriguing but do not have a real application in everyday life, but my project has the potential to really benefit society! Finally, organising my work between two institutions was good for building up a 'network' of connections that could be useful in my job hunting process after I finish my PhD."

Johnson Matthey's response to tackling COVID-19

Johnson Matthey is a global leader in science and sustainable technologies. From their headquarters in Royston (UK), they are doing their bit to support their people, customers and local communities in the fight against COVID-19.

Johnson Matthey is an important part of the supply chains that are providing vital products and services to the healthcare industry. They are a major manufacturer of products involved with treating chronic pain for the majority of patients in the UK, and are also involved in maintaining food and energy supplies during COVID-19. The company's efforts in tackling the virus within their local area include:

- Manufacturing goggles and visors at sites for community medical staff and care organisations.
- Donating PPE equipment to medical and care organisations.
- Pledging to match all donations made by our employees to fund local projects supporting communities adversely impacted by COVID-19.

"We know that science will help provide the solution in winning the fight against COVID-19 long term, as well as many other major health and climate related challenges that we will face over the years to come. However, the impact of COVID-19 is likely to further increase the barriers to studying science for children and young people. To tackle this, we're committing £1 million as a special fund towards improving access to a quality science education to enable a cleaner and healthier world," concludes Robert MacLeod, Chief Executive of Johnson Matthey.

A member of the Johnson Matthey team working in the laboratory and contributing efforts to help towards tackling the COVID-19 crisis

Resources:

www.matthey.com/en/news/2020/responding-to-covid-19

INEOS prioritises manufacturing of hand sanitiser over other industrial products

In response to Government requests for assistance during the global COVID-19 outbreak, INEOS identified the manufacture of hand sanitisers as a way to address the significant shortages being experienced across Europe and the USA.

This latest project combines INEOS's know-how in engineering, chemical production and safety, with their logistical expertise. INEOS produces more than 300 different products essential in producing drugs, testing kits, ventilators and protective clothing in the fight against COVID-19, and is Europe's largest producer of two of the core ingredients for hospital grade hand sanitiser, ethanol and iso-propyl alcohol (IPA). The company planned to redirect the production of ethanol and IPA away from industrial products and into medical use. It then designed new blending and bottling lines and began the installation of necessary equipment for the manufacture, packaging and distribution of essential hand sanitisers to hospitals and front-line medical staff. It is hoped that these new plants – to be built in record time – will help meet the shortfall.

Since March, INEOS has built six plants across the world, located in Newton Aycliffe in the UK, Herne in Germany, Etain and Lavera in France, Jacksonville, Arkansas and Neville Island, Pennsylvania in the US. Each plant was successfully constructed in under ten days and each will be producing one million bottles a month. The first deliveries were made to hospitals in Warrington in the UK, Metz and Verdun in France, Antwerp in Belgium, during April and Little Rock in the US in May.

INEOS hand sanitisers

INEOS was also able to enlist the logistics expertise of the TEAM INEOS cycling team and Sir Dave Brailsford to help plan the delivery of the new hand sanitisers to hospitals in key COVID 19 hot-spot areas across Europe. This initiative has now seen the equivalent of over 2.7 million pocket sized hand gels donated completely free of charge to front-line hospitals in France, Germany, UK, Belgium and the USA.

See more information on INEOS hand gel on www.ineoshandgel.com

Dr Alexander Boys awarded the Human Frontier Science Program Fellowship

Dr Alexander Boys

Dr Alexander Boys, a Postdoctoral Research Associate working in the Bioelectronic Systems Technology Group with Dr Róisín Owens, was recently awarded a 3-year Cross-Disciplinary Fellowship from the Human Frontier Science Program (HFSP). He will be working with Dr Owens and Professor George Malliaras of the Department of Engineering on developing tissue-engineered implants for mapping the neural pathways of the nervous system of the gut.

The HFSP Cross-Disciplinary Fellowships support 15 young scientists to embark on research at the interface of biology and neighbouring disciplines, and Dr Boys was one of the selected few to receive the award. His study focuses on the development of a tissue-engineered, bioelectronic neural probe for mapping the neural architecture of the gut in live animals, specifically targeting the influence of gut bacteria on the brain.

This project involves an international collaboration in life science research covering a variety of fields including biomedical engineering, electrical engineering, neuroscience, and gastroenterology. As such, the team for this work includes multiple researchers from around the world. The team at Cambridge will also be collaborating with Dr Niall Hyland at University College Cork and Professor Nicholas Melosh at Stanford University.

Source:

www.ceb.cam.ac.uk/news/dr-alexander-boys-awarded-human-frontier-science-program-fellowship

Dr Gabi Kaminski Schierle becomes Senior Fellow of the Higher Education Academy

Dr Kaminski Schierle

Dr Kaminski Schierle has achieved the status of Senior Fellow 'in recognition of attainment against the UK Professional Standards Framework for teaching and learning support in higher education' by the Higher Education Academy. The Higher Education Academy is an independent non-profit organisation committed to world-class teaching in higher education. They work in partnership with institutions and individuals in higher education supporting student success, bringing the sector together to collaborate, and share teaching strategies and practice.

In achieving Senior Fellow, Dr Kaminski's experience was assessed against the following criteria:

1. Demonstrate impact and influence through, for example, responsibility for leading, managing or organising programmes, subjects and/or disciplinary areas.

2. Experienced subject mentors and staff who support those new to teaching.

3. Experienced staff with departmental and/or wider teaching and learning to support advisory responsibilities within an institution.

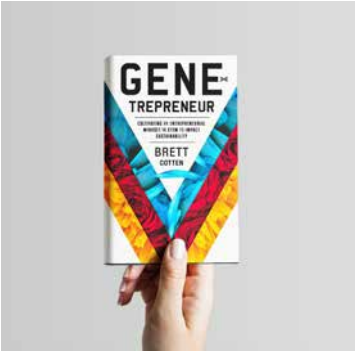
Dr Kaminski Schierle is currently the Programme Director for our MPhil in Biotechnology course, which supports students with skills and experience in the physical sciences transition to apply their knowledge in biotech and pharmaceutical fields. She also leads the Molecular Neuroscience Group in our department, investigating the molecular mechanisms that can cause neurodegenerative diseases, such as Parkinson's disease, Alzheimer's disease, and Huntington's disease.

We would like to congratulate Dr Kaminski Schierle on her appointment and thank her for the continued dedication to teaching excellence in our department.

Source:

www.ceb.cam.ac.uk/news/dr-gabi-kaminski-schierle-becomes-senior-fellow-higher-education-academy

CEB's Gene-trepreneur



Brett Cotton's new book 'Gene-trepreneur'

Gene-trepreneur is a new book written by one of our Bioscience Enterprise postgraduate student Brett Cotten, to catalyse university peers and young professionals in STEM fields to become Gene-trepreneurs in their unique ways. There are many tough problems to solve in the world, so how can one align the causes that he/she cares about with his/her burgeoning career? How can one's pain point turn into a purpose? Gene-trepreneur aims to answer this through interviews with successful entrepreneurs doing just that while also including many fun movie references along the way.

First off, what even is a "Gene-trepreneur"? Cotten defines a Gene-trepreneur as anyone who uses biotech and the entrepreneurial mindset to achieve impacts in animal well-being, environmental sustainability and human health. He interviewed entrepreneurs operating in food innovation, materials science, microbial fermentation and species conservation to highlight opportunities where STEM students while engaging the right mindset, can also make their positive impacts.

The overarching idea is: wouldn't it be great if you could use Gene-trepreneur as a starting point for building your impactful bioscience endeavour, or perhaps even altering your course to join one? Everyone can be a part of creating a healthier, bio-based future. Now is truly the best time to turn your pain points into purposes.

If you would like to get in touch about the book or otherwise, you can reach out to Brett on LinkedIn or contact him via email at brett.a.cotten@gmail.com.

You can get Brett's book on Amazon www.amazon.com/Gene-trepreneur-Cultivating-Entrepreneurial-Mindset-Sustainability-ebook/dp/B07ZY75Z7N

Dr Achilleas Savva

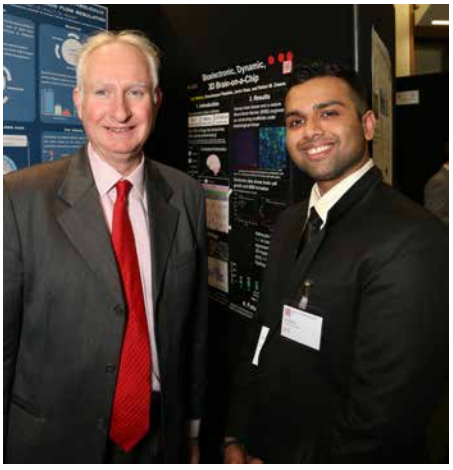
Dr Achilleas Savva awarded Marie Skłodowska-Curie Actions Individual Fellowship

Congratulations to Dr Achilleas Savva, a postdoctoral researcher from the Bioelectronic Systems Technology (BEST) group, on his new Marie Skłodowska-Curie Actions (MSCA) fellowship!

The MSCA Individual Fellowships are funded by the European Commission and allow experienced researchers the opportunity to boost their career by working abroad. With the fellowship, Dr Savva aims to develop a multifunctional 3D polymer scaffold as a platform for stem cell growth and differentiation control. The scaffold that he is developing will be composed of biocompatible polymers blends which are electrically and optically active. By introducing electrical or optical stimuli through the scaffold, it is then aimed to be able to control the functions of the stem cells. Consequently, these highly biomimetic platforms and the fundamental knowledge produced in this project will be an invaluable tool to further progress with stem cell research towards therapeutic goals.

The outcomes of this project can, in the short term, benefit the research field of bioelectronics by providing the fundamental knowledge and a novel platform for a facile control of cell function and, in the long term, can impact the global need for better treatment of diseases.

''I feel very pleased that the project will take place in Dr Róisín Owens' group and such a diverse department like CEB. The research itself is highly multidisciplinary spanning from materials science, electrochemistry, engineering, biomaterials, cell culture and biology. Therefore, I look forward to starting working closely with my colleagues within CEB, towards exciting research and loads of fun!," Dr Savva commented on his latest award.



Yash Mishra with Cambridge MP Daniel Zeichner at STEM for Britain 2020

Yash Mishra presents brain-on-a-chip research in Parliament at STEM for Britain

Back in March, shortly before the beginning of the UK lockdown, PhD student Yash Mishra presented his research at the UK Parliament for an event called STEM for Britain.

STEM for Britain is defined as a platform "for presenting and discussing ground-breaking and frontier UK research and R&D to Members of both Houses of Parliament at Westminster." Yash Mishra, a PhD student in our Bioelectronic Systems Technology group, was one of those selected out of over 500 entrants to present a poster on his research to MPs from across the country. Along with many other MPs, Yash met Cambridge's own Daniel Zeichner.

Mishra presented his work developing artificial organs - a so-called brain-on-a-chip - to enable easier and more accurate testing of treatments for neurological diseases such as dementia and Alzheimer's. His research is aimed at helping create alternative methodologies to animal testing that can help shape the future of medical research.

His participation in the event has shown how multidisciplinary engineering can address some of the current healthcare challenges. The event also provided him with a platform to discuss how policy and governance can help pave the way for new technology to progress.

Source: www.ceb.cam.ac.uk/news/yash-mishra-presents-brain-on-a-chip-research-parliament-stem-britain

Professor Lynn Faith Gladden.

Professor Gladden appointed Dame Commander of the Order of the British Empire

Professor Dame Lynn Faith Gladden, Executive Chair of Engineering and Physical Sciences Research Council, Shell Professor of Chemical Engineering, and former Head of the Department of Chemical Engineering and Biotechnology, was named Dame Commander of the British Empire (DBE) in the 2020 Queen's Birthday Honours list for her services to Academic and Industrial Research in Chemical Engineering. The DBE award follows her Officer of the British Empire (OBE) award given in 2001 for her services to Chemistry, and the Commander of the British Empire (CBE) award in 2014 for her services to Chemical Engineering.

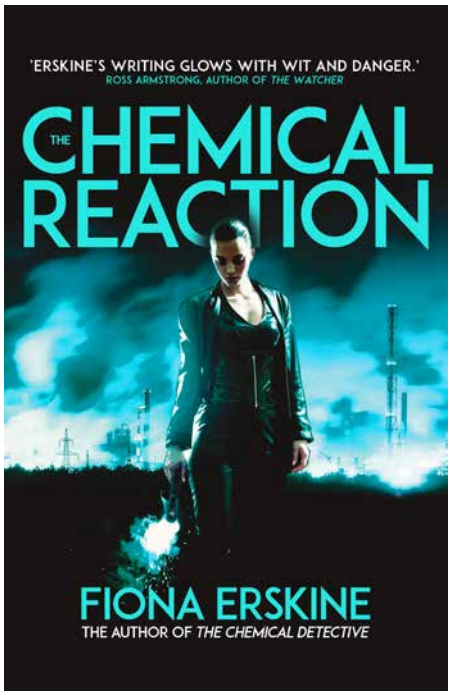
Dame Lynn, also the Director of Research of Magnetic Resonance Research Centre at CEB, is internationally recognised for her work on magnetic resonance imaging (MRI) techniques, and modifying and applying well-established medical techniques, to advance the scientific understanding of the inner workings of fluid flows and chemical reactions. A key aim of a large part of her 'green' work is to increase the energy efficiency of chemical processes and produce products with better 'in-use' properties ranging from controlled-release pharmaceutical materials to optimised catalysts to perform catalytic conversions to produce 'clean' fuels.

"This is a great surprise and honour. It also provides a great opportunity to thank senior colleagues in my research group, and all the students and post-doctoral workers who have worked with me over the past 30 years. I must also thank the University of Cambridge, Trinity College and, in particular, my first 'boss' Professor John Davidson, who has been so supportive over the years," Dame Lynn commented on her latest achievement.

Source: www.ceb.cam.ac.uk/news/professor-gladden-appointed-dame-commander-order-british-empire
www.ceb.cam.ac.uk/news/professor-john-davidson-founding-father-fluidisation-passes-away

Fiona Erskine publishes second book

Alumna Fiona Erksine undertook her Chemical Engineering degree (Selwyn College) from 1979 to 1983. After graduation, she worked with ICI and several different chemical companies, with a special interest in process safety. Her first book 'The Chemical Detective' was published in 2019, with her second book 'The Chemical Reaction' published earlier this year. Research for these thrillers, part of the Jaq Silver series, included a visit to the site of the Chernobyl nuclear accident!



Chemical Reaction by Fiona Erskine

Fiona shared her personal insight on her latest book with the team

"In my new book, Chemical Engineer Jaq Silver is tricked into making a short trip to China, a country I know well. The factory she was sent to visit vanishes overnight. When a former student sends a message in code, she takes a road trip from the Shaolin Temple, home of Kung Fu, to the Banqiao hydroelectric dam, scene of the worst structural failure of the 20th century, ending up in the rare earth mines of Jiangxi. Jaq forms an uneasy alliance with a troupe of western male strippers who are daylighting as art thieves. She outwits corrupt police, duplicitous industrialists, only to come face to face with a knife wielding serial killer, a modern practitioner of Lingchi, administering slow slicing or death by a thousand cuts".

"One of the themes of the book is green energy, and our reliance on rare earth metals from China in particular. The environmental damage and risk to human life can be catastrophic if not handled correctly, which is why we need clever and diligent engineers to keep us safe".

"One of the themes of the book is green energy, and our reliance on rare earth metals from China in particular."

"I have long been fascinated with the worst structural failure of the 20th century, the failure of a dam on a hydroelectric power project which led to deaths of hundreds of thousands of people. While working in China, I visited the Banqiao reservoir, in Henan province, China and the reconstructed dam. Just as Chernobyl played a part in bringing down the iron curtain, the terrible death toll in Banqiao in August 1975 is credited with helping to end Mao's Cultural Revolution".

Check out Fiona's blog post on visiting Banqiao at thechemicaldetective.blog/visit-to-banqiao/

The passing of 'the Founding Father of Fluidisation'

We kicked off 2020 with the sad news that Professor John Davidson, 'The Father of Fluidisation', had passed away over Christmas leaving behind an incredible legacy.

John Davidson joined the Department of Chemical Engineering, University of Cambridge, in 1952 as a University Demonstrator. He became Professor of Chemical Engineering (Shell Professor from 1978) and Head of Department from 1975 through to his retirement in 1993. He was also a much-loved Senior Fellow of Trinity College, which he joined in 1949 and was elected in 1957.

In 1999, he was awarded a Royal Medal in recognition of his distinguished work over many years in Chemical Engineering, including fluid flow, process dynamics, gas absorption and fluidisation technology. He had been a Fellow of the Royal Society since 1974. He was President of the Institution of Chemical Engineers from 1970 to 1971 and Vice-President of the Royal Society from 1988 to 1989.

Although retired many years ago, he remained a very active member of the department and continued supervising research students for a while. He was extremely fond of CEB and its people.

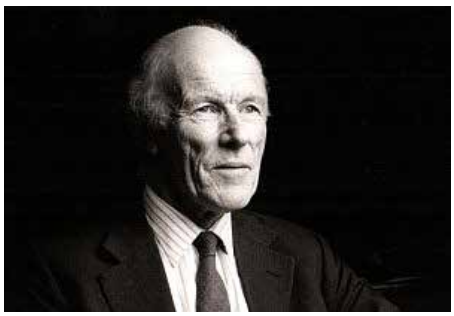
IChemE also launched the "Davidson Medal" in his honour in 2016 describing him 'not only as a Founding Father of Fluidisation in chemical engineering, but also as a mentor who has supported and influenced the careers of several generations of chemical engineers'.

"John was a much loved, much respected and very current member of the department. We will greatly miss seeing him and his always vibrant and insightful contribution to any scientific discussion," noted Professor Lisa Hall, CEB's HoD.

We are hoping to have a remembrance event in CEB in due course to celebrate John and his long career of achievements, contribution to the department, and the chemical engineering discipline.

See more on www.ceb.cam.ac.uk/news/professor-john-davidson-founding-father-fluidisation-passes-away

An obituary was featured by The Chemical Engineer (TCE) magazine www.thechemicalengineer.com/features/john-davidson-1926-2019/



Emeritus Professor John Davidson (1926–2019)

Yunus Yasin launches STEM programmes for young scientists and teachers

After graduating from the University of Cambridge, Dr Yunus Yasin has gone on to achieve multiple feats in the entrepreneurial world, both within STEM teaching and public outreach including founding the Malaysian Science Fair for Young Children (SFYC), the Association of Science and Technology (ASTI) and becoming the STEM advisor to the Malaysian Minister of Education.

Yunus Yasin completed his PhD in Chemical Engineering and Biotechnology at the University of Cambridge in 2002. During his PhD, Yunus took part in the Biotechnology Young Entrepreneurs Scheme (YES), making it into the finals in London, where his team was awarded the 'Best consideration of IP strategy'.

Yunus's team won the University of Cambridge Entrepreneur Society inaugural 1K competition and was also shortlisted at the British Bioscience Entrepreneurship Competition. After graduating, Yunus remained somewhat in the entrepreneurial world, contributing to the start-up of over 13 companies, as well as being heavily involved in STEM outreach. He is especially well known in Malaysia, where he has set up science clubs in low-income primary schools and helped launch the nation-wide Science Fair for Young Children (SFYC). These programmes led to the birth of The Association of Science and Technology (ASTI), a non-profit, non-governmental organisation with the objectives of empowering young children through science-based and skill-development projects. As well as empowering children, Yunus is also passionate about empowering teachers. In 2016, he added a teacher training programme to ASTI and in 2019 became the advisor on STEM to the Malaysian minister of education. "I see STEM outreach as my life purpose. It is 100 percent on a volunteer basis. I still do engineering consultancy work and I am the co-owner of a sustainable resource consultancy company called 2E solutions (www.2esolutions.com). I am also not married, and I am very cheap - so my bills are negligible,!" added Yunus.

Given Yunus's highly successful career and STEM programmes, we asked him for some personal insights.

How has your degree in chemical engineering helped you with STEM outreach?

"I owe a debt of gratitude to my supervisors Dr Bill Paterson and Dr David Scott who always emphasised the understanding of the fundamentals as a means to understand nature and natural phenomena. Also to Professor Chris Lowe from the Institute of Biotechnology who had encouraged us to participate in the Young Entrepreneurship Scheme, which gave me a different way of looking at things, as an entrepreneur and not a job seeker. Finally, the entire experience of being present at the University of Cambridge has given me a "Dead Poet Society" experience - the single most important film that had influenced my life journey".

If you could give one piece of advice to young researchers in the department, what would it be?

"Follow your dreams and have the confidence and resilience to keep on the path(s) you have chosen".

Sources:

www.yescompetitions.co.uk/cases/yunus-yasin.aspx

www.asti.org.my

Top - Yunus, helping to engage and inspire young children at the nation-wide Malaysian Science Fair for Young Children (SFYC). Middle - Yunus, presenting the winning awards at the Young Inventors challenge 2019, a programme organised through ASTI. Bottom - Yunus became the STEM advisor to the Malaysian Minister of Education in 2019.

Bake sale to raise the profile of eating disorders at CEB

Sarah Barron

Sarah Barron (left) and Chiara Barberio (right) raising awareness of eating disorders

Beat was founded in 1989 and is the first national UK eating disorder charity and aims to raise awareness, access to resources and provide online support for those suffering from eating disorders (EDs). There are over 6 categories of Eating Disorders (EDs), many of which are hugely misunderstood and stigmatised. EDs have the highest mortality rate among psychiatric disorders, with around 1.25-3.2 million people in the UK suffering from these disorders. There is an especially high and wide-spread prevalence of EDs across universities and student populations as, along with academic, financial and social pressure, the most common age for developing EDs is 16-20 years old. Despite this, awareness, understanding and funding for EDs are still very limited. Sarah Barron, a PhD student at CEB, got involved and raised awareness and funds for Beat after having personal experience of friends and relatives with EDs.

"In such a highly pressured and competitive academic setting such as University (especially at Cambridge), it probably doesn't surprise you to learn that the majority of students sadly struggle with mental health and eating disorders," says Sarah. She continues "Although many eating disorders are not visible, I have seen many friends, colleagues and acquaintances struggling with their relationship with food but not knowing how or where to ask for help. EDs are still hugely stigmatised and not often spoken about, so I wanted to do something to try and raise awareness, get people talking about the topic in everyday conversation and raise the profile and resources offered by Beat. Together with a bake sale at CEB and a sponsored fitness session with my sports team, I managed to raise over £100 for charity and hope to do bigger and better things for them in the future!"

Sources:

twitter.com/cebcambridge/status/1235863775007236097

www.priorygroup.com/eating-disorders/eating-disorder-statistics

www.beateatingdisorders.org.uk/

Chemical Engineering and Biotechnology Virtual Open Days for Year 12/13, 2 and 3 July 2020

This year's Open Days are virtual with webinars and presentations available on the subject of chemical engineering and how is taught at Cambridge.

For the first time the annual highlight University Open Days have gone virtual and CEB is organising a programme of online webinars for prospect undergraduates during 2 and 3 July 2020 . The aim is to give prospect undergraduates an opportunity to get a taste of what chemical engineering and biotechnology studies are like and an overview of our ground-breaking work and the range of exciting careers chemical engineers can embark on.

There will be presentations and live webinars to give prospect students information about the course, including the admissions system, and how to apply to Cambridge including student life. They will also have a chance to have their questions answered by our academic experts in these disciplines at Q&A sessions.

For any course admissions related queries contact admissions@ceb.cam.ac.uk or outreach@ceb.cam.ac.uk for questions regarding our virtual Open Days or other future outreach events.

Sources:

www.ceb.cam.ac.uk/events/virtual-open-days-year-1213-sixth-form-students

www.ceb.cam.ac.uk/undergraduates/prospectivestudents

"Chemical engineers have a crucial role in solving the world's biggest challenges in energy, sustainability and healthcare and making a positive global impact."

Virtual Homeworking

COVID-19 has changed everything in a blink, including research and work at CEB. Isolation and working from home have challenged us all in many different ways. In light of the lockdown, we asked a Principle Investigator, a member of staff, a Postdoctoral researcher and a PhD student how they are juggling family, work and hobbies at home.

Dr Róisín M. Owens

CEB Lecturer and Bioelectronic Systems Technology PI

Clockwise from top left: Facepainting in the garden (Alex, 8 years old, and Gregory, 12 years old); egg dying for Easter Sourdough; hot cross buns; day 8 of the lego 30-day challenge (on the set of a star wars movie).

Working from home with two kids is an exercise in how not to lose your mind! One of the biggest issues with having two lively boys is finding a quiet place to concentrate. I manage by migrating around the house with my "office" in a tote bag – my Moleskine notebook, a wireless mouse, my water bottle and my to-do list. The to-do list is a blurred lines mixture of: 1. review that paper, 2. bake hot cross buns (last week), 3. write a reference, 4. order from Ocado, 5. update the website … . And of course, my laptop goes with me everywhere. I feel attached to it as if it had an umbilical cord.

We are lucky to have a garden, so I have even done some Zoom sessions outside – the birds chirping in the background does help get me back to some semblance of a ground state.

Today my biggest accomplishment was managing to get a Zoom piano lesson working so that the teacher could see the music, and the musician's hands and not have the iPad fall over. A long bike ride this afternoon with the boys means that I somehow don't mind settling back in to answer the emails that somehow accumulated while I was out. I'll finish the day by updating the to-do list for tomorrow.

Stuart Fordham

CEB Stores Assistant

Stuart enjoying the sunshine with his family.

Lockdown has meant that most of my work isn't possible from home apart from answering emails and placing a few orders. I'm spending lots of time playing and exploring with my daughter Ellie who turned 2 a few weeks ago.

I live with her and my wife in a village called Cambourne. We are very lucky to live here as there are lots of beautiful walks around the many lakes and nature areas. I've found it helpful to appreciate my surroundings look at all the things that you can still do and not get bogged down thinking about what you can't do.

I try to focus on positive things. Such as getting to spend every day with my wife and daughter, enjoying the sunshine in the garden and having beans (and sausages) on toast for lunch pretty much every day. I hope you all stay safe and well. Like old queenie said... we will meet again!

Dr Rocio Bueno Perez

Postdoctoral researcher at the CEB's Adsorption & Advanced Materials group

Dr Rocio Bueno Perez in her home office surrounded by beautiful artwork

I am staying in Cambridge during the lockdown, in a big house with a garden, and three wonderful housemates. As a computational scientist, I keep working from home but I also try to take care and support other people in my group. At first, adapting to homeworking was difficult, but I started changing the lights in my room to create different spaces, and I moved my timetable to match my natural rhythm. To treat myself I am training in karate online with my old karate club, and I bought a graphic tablet to edit pictures. Lockdown has forced us to spend time with ourselves, to enjoy our virtues, come to terms with our defects, and relativise priorities. I think that we have to be careful not to forget all the lessons we are learning now when and if everything goes back to normal.

Joseph El-Kadi

PhD student at CEB's Catalysis and Process Integration group and Social officer of CEB Graduate Researchers' Society (GRSoc)

Joseph playing the lute

I am currently in Abu Dhabi (United Arab Emirates), where my parents live and where I grew up most of my life. My younger brother is also here and I'm grateful to be with family, but I do miss the green open spaces in Cambridge and Grantchester Meadows.

In working from home, I find that chunks of 25 minutes of work followed by a 5-minute break works well for me. It's been tricky maintaining a routine, but sometimes I start my morning with yoga, meditation or reading a book. In the evenings, I usually play my Middle Eastern lute, do a workout on the Nike Training Club app or go for a walk.

I also find that online social activities - be it open-mics, photo competitions or poetry exchanges - have helped me connect with others and remind me that we're all going through difficult times together.

Girls in STEM – the Cambridge graduate women dedicated to promoting gender equity

June Park, Cambridge University Girls in STEM Executive Director

Young girls participating in hand-on experiments organised by the Girls in STEM society.

Curiosity starts at a young age. These two girls are enjoying themselves at the Cambridge East STEM Day.

Since the 1940's when Cambridge first began granting degrees for women, the number of women studying science, technology, engineering, and mathematics (STEM) at Cambridge has steadily grown. Female scientists at Cambridge have changed history with their groundbreaking research, such as Rosalind Franklin with the discovery of the DNA double helix and Dorothy Crowfoot Hodgkin with her works on protein crystallography. Today, gender disparities in some science subjects are improving but significant improvement still needs to be made in Computer Science, Engineering, and Mathematics, where female students respectively made up 22.6%, 25.8%, and 15% of the incoming class for Michaelmas 2019.

"It is empowering to see underrepresented demographics in the STEM fields at science outreach events, and young attendees take note of that."

Gender equity within and beyond the University of Cambridge is what inspired a group of Cambridge graduate women to start Girls in STEM. GiS is a society with the mission to inspire young women and non-binary students to pursue studies and careers in the STEM fields. Started in 2016, GiS works with local organisations to bring engaging hands-on science experiments and encourage young girls to explore studies and careers in STEM fields. June Park, the executive director of GiS, explains "What sets GiS apart from other science outreach organisations is our dedication to promoting gender equity. It is empowering to see underrepresented demographics in the STEM fields at science outreach events, and young attendees take note of that."

"Without the Society of Women Engineers and the community it fostered, I probably would have dropped out of an engineering degree," says Gabrielle Mills, a promotional officer for Girls in STEM and PhD student at CEB. "It is hard to be a female in a predominantly male field, so having a community which supports and furthers you as a female engineer is absolutely imperative."

Girls in STEM went through organizational changes in 2019 to include three codirectors and eleven executive members. GiS just held its main event of the year, Cambridge East STEM Day, in collaboration with the Girl Guides. This event was supported by the Cambridge Stem Cell Institute's Public Engagement Seed Fund and Gates Cambridge Scholar Support Fund. Over 800 young girls attended to participate in numerous hands-on experiments and listen to inspiring stories and scientific talks by Cambridge graduate students.

"Without the Society of Women Engineers and the community it fostered, I probably would have dropped out of an engineering degree."

While the recent COVID-19 crisis has disrupted many of the upcoming volunteering events planned for the next term, the GiS team still plans to organise do-it-at-home science experiments for young students and their parents staying home during these difficult times. Additional events planned for next term include a Zoom Women in STEM networking event. To learn more about the work GiS does, or if you would like to contribute, please get in touch at girlsinstem.cambridge@gmail.com or visit our Facebook Page (www.facebook.com/cu.girlsinstem).

Each for Equal – CEB women share their thoughts

Dr Ljiljana Fruk, CEB lecturer and Bionano Engineering PI

Dr Ljiljana Fruk

"There is something magic about take a glimpse into the nature of things and the laws that govern our part of the universe. Science is not only for the curious, and those who want to understand, but also for those who can persevere, and enjoy the small steps as much as the giant leaps.

I studied chemistry because I wanted to know why the leaves turn brown in the autumn, how can my dad turn sweet grape juice into wine (it was not my dad, it turns out, but rather the microorganism that drives the fermentation!), and how the international space station can stay in the orbit of the Earth and not fall down.

And I learned all of this, and so much more…and the learning never stops.

I'd like to be part of something that has the power to transform the way we live, the way we see the world, and something that teaches us to appreciate that same world a bit more. For me, that was chemistry, for somebody else it might be marine biology, mineralogy or particle physics."

Peace Adesina, PhD student, Sustainable Reaction Engineering Group

Peace Adesina

"I have honed my adaptability and versatility having studied in four different countries. Although there is a changing dynamic with the increasing number of women in the male-dominated field globally, there is still work to be done in the area of mentorship. This includes instilling in young women the confidence and resilience to make ground-breaking research or even spin-off companies in a competitive environment, regardless of ethnicity.

To those considering STEM as a career path, everything you need to succeed is within you amidst the hurdles. There are no limits to how far you can reach.

You just have to be willing to work hard, to bring unique perspectives to the table, remain tenacious and self-driven, and unapologetically walk through new paths, for they often lead to new discoveries, not only for yourself, but the world at large."

Dr Ioanna Mela, Research Associate, Laser Analytics Group

Dr Ioanna Mela

"I took seven months off when I had my little girl, and while I enjoyed having the time with her when she was tiny, it was a big break out of research. The nature of our job is such that it cannot stay static – projects run, students need to finish their PhDs, and publications need to keep moving. Keeping on top of that was an interesting exercise, and while I felt supported both within my family and in my workplace, it does take a toll on your output as a researcher. I found that it is things such as keeping collaborations active and maintaining your presence in your field the most challenging.

It was also challenging coming back to work, and the main reason was the sudden lack of flexibility. Being a researcher usually comes with some flexibility in working hours. This is completely taken away when you have to work within nursery times. If an experiment overruns a little bit, an extra 15 minutes to finish it might seem like nothing, but it becomes a big deal if it is 15 minutes past the nursery closing time! It was a shock initially, but you do learn to plan better and work more efficiently.

I did share the parental leave with my husband, which was very helpful, both for me as a professional and for us as a family. I feel that there is still a lot of room for improvement both within the University and at a national level, but I would like to focus on a scheme within the University that is indeed very supportive. This is the Returning Carers Scheme, which provides small amounts of funding for people coming back from having taken a break for caring responsibilities of any sort."

"There are no limits to how far you can reach."

Source: www.ceb.cam.ac.uk/each-equal

The chemis-TEA of the British cuppa

What's not better to do during lockdown than sipping a cuppa and have a good read

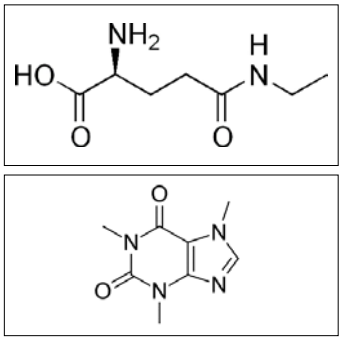
International Tea Day was on 21 May 2020.

During these uncertain times, we wish for certainty, and something certain for centuries has been our love for the British cuppa. It is, evident from our daily 100 million cups of tea consumption. In the UK, over 60% of us drink more than three cups of tea per day with the most widely drunken tea being black tea. However, how many secrets do you know about the taste and smell of tea? In short, the science behind the 'tea-making process' is both complex and fascinating!

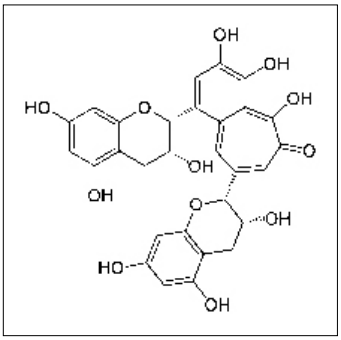
When you infuse the tea leaves in hot water to make your perfect cuppa, chemicals in the tea leaves are gradually released. These chemicals can be grouped into three categories based on the time they take to dissolve. Aromatics that give the tea smell and flavour dissolve almost instantaneously. Lighter polyphenols, caffeine and compounds related to mouthfeel and texture take slightly longer. The heaviest compounds (heavier polyphenols, flavanols and tannins) take the longest time to dissolve which contributes to the colour and richness of the flavour, giving the 'tea body' and bitterness.

L-theanine and caffeine – Tea has a unique amino acid called L-theanine, which, on its own, contributes to the relaxing properties of tea. Coupled with caffeine, it can improve speed, performance and accuracy in cognitively demanding tasks.

Theaflavin – One of the polyphenols in black tea which contributes towards the orange-red colouration of tea, as well as to the taste.



Chemical structure of L theanine (top) & caffeine (bottom).



Chemical structure of theaflavin.

The perfect brew tips from the editors

Soft water. It will have a cleaner, brighter finish and free from minerals that can result in a scummy layer on the tea.

Temperature. Never straight out of a boiling kettle. For black tea, it will ideally be 90 - 98°C.

Time. We recommend 3 to 4 minutes to reach tea brewing peak- the point at which the tea is at its best and before it becomes bitter and unpleasant. If you prefer a stronger tea, we recommend you to add more leaves to enhance the flavour rather than brewing it for a longer period.

And add a splash of FRESH WHOLE milk! (NEVER use powdered/UHT milk)

Sources:

Statista Survey Food and Hot Drinks in the UK in 2019. www.statista.com/statistics/681635/tea-consumption-daily-amount-united-kingdom-uk/#statisticContainer

The chemistry of tea. www.compoundchem.com/2014/02/01/polyphenols-antioxidants-the-chemistry-of-tea/

The science of tea. www.sciencefocus.com/science/science-of-tea/

UK Tea & Infusions Associations. www.tea.co.uk/make-a-perfect-brew

CEB Teaching Consortium of companies

For more information on the CEB Teaching Consortium

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