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Professor Frank Kelly
Battcock Chair in
Community Health
and Policy, School
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Your support is a vital resource that helps our students achieve their full potential.



PhD student Aina Roca Barcelo's world has transformed thanks to the generosity of Imperial alumni and friends. An epidemiologist focusing on cardiovascular and respiratory diseases, Aina has been able to leave her home country of Spain to pursue research in the Faculty of Medicine.

After completing a Master's degree, Aina was awestruck to be offered a two-year research assistant contract at Imperial in the Department of Epidemiology and Biostatistics. "I couldn't believe I'd be working at one of the best universities in the world with people I've admired all my life. I was determined to make the most of it."

When applying for her PhD, Aina was committed to staying at Imperial. She received the President's Scholarship, which ensures extraordinary students are free to excel. "The President's Scholarship is the only reason I am in London doing a PhD right now," she says.

No one knows the value of an Imperial education – and of Imperial research – better than the College community, and it is your support that helps to ensure financial barriers do not stand in our students' way.

With your help, we can continue to provide essential aid to disadvantaged and deserving students through the Imperial Bursary, attract the best and brightest applicants with the President's Scholarship, and meet the needs of those facing sudden financial hardship which casts their future at Imperial into doubt.

Your support can transform the life of an individual student.

And because they are Imperial students, many of those you support now will go on to change the world. If you would like to support students like Aina, whether through a gift today or with a gift in your will, please call Anna Wall, Head of Legacy Giving on +44 (0)20 7594 3801 or email a.wall@imperial.ac.uk.

Find out more online at bit.ly/ICL-Magazine-50

“Thank you for giving me this opportunity to turn my dream into reality.”

Aina Roca Barcelo, Department of Epidemiology and Biostatistics PhD.

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Your generosity over fifty editions of Imperial Magazine has raised **£500,000.**

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Imperial/50

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DIGEST

MAGNETOMETER

Solar Orbiter sheds light on the Sun

More than a year after its launch, Imperial's magnetometer instrument aboard the Solar Orbiter spacecraft is helping reveal new insights into the mysteries of the Sun.

The Imperial-designed and built magnetometer (MAG) has taken billions of measurements of the magnetic field coming from the Sun, giving new insights into the solar wind and how it creates 'space weather'.

The Solar Orbiter itself has taken the closest ever images of the Sun, observed its polar regions like never before and unravelled the mysteries of the solar cycle.

MAG Calibration Engineer Virginia Angelini says: "Every morning we receive an email with the principal information about the magnetometer – it is like the instrument is telling us 'Good morning team, I'm OK! The data will arrive soon!' That is a very happy moment. We are literally conversing with an instrument on a probe travelling at several kilometres per second, millions of kilometres away from us, watching the Sun from a privileged position. I believe this is amazing."

Professor Tim Horbury, Principal Investigator for MAG adds: "We're already seeing hundreds of scientists engage with the data – there is huge excitement in the community about Solar Orbiter. It's a decade-long mission, but we've seen so much in just the first year that I can't wait to see what new, totally unexpected results come from exploring space close to the Sun." ♦

Checking in
The team behind Imperial's magnetometer aboard the Solar Orbiter spacecraft receive daily updates on progress.

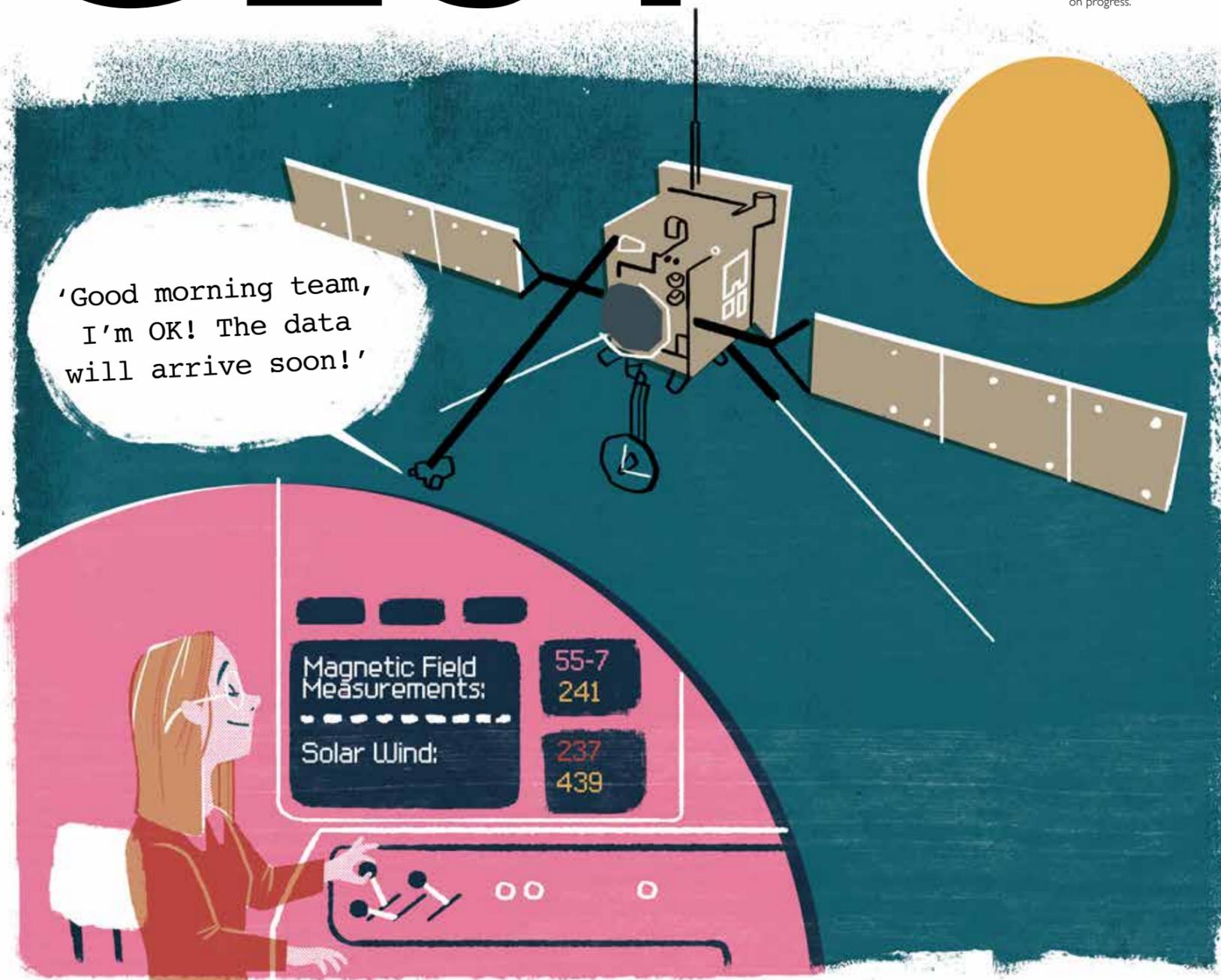


ILLUSTRATION LEFT: ADAM NICKEL, ABOVE RIGHT: MIKE LEMANSKI

Letters

WRITE TO US

Email: imperialmagazine@imperial.ac.uk

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Messages may be edited for length.

Progress on carbon

The route to carbon neutral feature (*Imperial 48*) was fascinating, and I've read much about global warming and climate change, and their effect on the future of our planet and people.

History over the last million years shows temperatures going up and down in waves. Even if global warming were a cyclical phenomenon, and human fossil fuel consumption a side issue in that cycle, as intelligent people we still ought to be developing the technology to reduce the negative effects.

I have been out of engineering for more than 30 years, but I still follow progress in different fields. I have read about a range of initiatives, all good but all of which have their technical and financial challenges.

One area that I have not come across is the breaking down of atmospheric CO₂ to carbon and O₂, thereby avoiding storage issues. Can anyone tell me if there has been progress in this field, or is it just not technically or financially feasible?

René Leclézio
(*Chemical Engineering 1978*)

The impact of methane

Working in the North Wales coalfield in the early 1960s, I was told several times that the thermal energy in the methane in the upcast shaft of a colliery equalled or exceeded the thermal energy of the coal produced.

Because it had a concentration of much less than one per cent, clearly it had no commercial value. However, if the principle is still true in international coal production, this could be making a significant contribution to global warming.

Is there anyone who would like to investigate the impact of methane released from coal production?

L George Stone
(*BSc (Eng) Mining 1960*)

A model article

Thanks for the fascinating article about the dinosaurs and 'Extinction day' (*Imperial 49*) – it's pretty great how modelling can lead to answers.

Harsharan Bains (via LinkedIn)
(*Chemical Engineering 1999*)

Memories of Jezebel

The article about Jezebel (*Imperial 48*) was very interesting. Jezebel is obviously a prized possession, but one that came into our possession earlier than stated. I was at Imperial, studying chemistry, from 1944 until 1950, and Jezebel was an RCS trophy then. Unfortunately, I have no information concerning when it came into our possession, but it must have been before 1944. Perhaps another reader knows more?

Fred Cox
(*Chemistry 1950*)

> Keep up with the latest news from the College as it happens, and share your thoughts and news on our Imperial alumni Facebook page and LinkedIn group.

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FROM THE PRESIDENT / PROFESSOR ALICE GAST

Innovation, public health and blue-sky discoveries: the fuel of post-pandemic momentum

The global pandemic has tested everyone, strained our health systems and compelled us to develop new ways of working, teaching and learning. The past year has presented a seemingly continuous stream of challenges; our students, alumni and staff have met those challenges with determination, creativity and foresight. They dealt with the difficulties of today without losing their focus on the future.

The restrictions imposed in the UK and elsewhere forced us to rethink how we teach. Our students and staff developed a range of innovative programmes to ensure that Imperial continues to educate future generations of leaders in science, engineering, medicine and business. Multi-mode education, remotely controlled laboratories, travel-free expeditions, 'labs-in-a-box', turning lecture halls into learning studios, and augmented-reality medical examinations are but a few examples of how addressing the challenges of today became the beginning of a blueprint for the future.

We begin to emerge from the worst of the global pandemic with a fresh appreciation of the many contributions the members of the Imperial community make when they apply their talents to a new challenge: our engineers created innovative tests for COVID-19; our scientists and medics studied the disease, the ways it harms people and how to treat it; and our economists advised our government and others. All the while, we had numerous medical students and staff caring for patients on the front lines.

Throughout this year, the world gained an unprecedented understanding of the critical

importance of excellence in public health. In our £100m campaign for the School of Public Health, we define public health as the art and science of preventing disease, prolonging life and improving health. This view should be a holistic one, and we are finding that our School of Public Health has never been more important.

While our epidemiologists in the Jameel Institute led the way in understanding waves of infection, transmission of new variants and impacts of mitigations, as well as vaccination strategies, their colleagues in the School were ensuring that other aspects of the health of the public were not forgotten. You can read about two of these public health matters in this magazine.

The lockdown put more of us and our families into an even deeper relationship with our electronic devices. We should ask: what are the current and future impacts of this on our health and our society? In this issue, you will read about the insightful study led by Professor Mireille

It's a testament to the College that we foster 'wacky ideas' and let academics pursue their passion

Toledano, Director of Imperial's Mohn Centre for Children's Health and Wellbeing, investigating the impact of mobile phones on cognition and wellbeing in young people.

And throughout London and most big cities, an important question we all want to ask is: what are the health effects of the air I'm breathing?



Professor Frank Kelly, the Battcock Chair of Community Health and Policy, and his Environmental Research Group are just the people to ask. From advising policymakers to informing the public, Kelly's group has been at the forefront of air pollution and public health research.

These impressive studies come from years of dedicated research and education of the next generation. Nowhere is a view of future possibilities more evident than in the unfettered blue-sky research that Imperial academics pursue all the time. It's a testament to Imperial that we foster such "wacky ideas" and let academics pursue their passion. Their discoveries came to pass thanks to the freedom to pursue an idea, follow a hunch, develop a dream. These novel projects were made possible by Imperial's Presidential Excellence Funds, philanthropy and government support. As the UK and countries around the world look to recover following the pandemic, they must realise that it's not always the quick solution that is the most powerful or longest-lasting.

We must keep this in mind as we look ahead at the challenges we face, including those we cannot predict. As a society, we too often focus on immediate problems to the exclusion of thinking about the problems that loom over the horizon. If the past year has taught us anything, it should be a clear call for sustainable investment in the research and education that made Britain's impressive scientific response possible. ♦

> *Professor Alice Gast is President of Imperial College London and is an internationally renowned academic leader and researcher.*

ANTARCTIC STUDY

Life under ice

A new study of microbial life in lakes underneath the Antarctic ice sheet could provide insights into similar lakes beneath the surfaces of icy moons orbiting Jupiter and Saturn, and the southern ice cap on Mars.

The findings were the result of a collaboration between researchers from Imperial, the University Claude Bernard Lyon 1 and the British Antarctic Survey, providing insights into how life might adapt and evolve under persistent extreme cold conditions.

Lead researcher Dr Louis Coustou says the study "changes our appreciation of how these habitats work, and how we might sample them when exploration takes place".



TRAUMATIC BRAIN INJURY

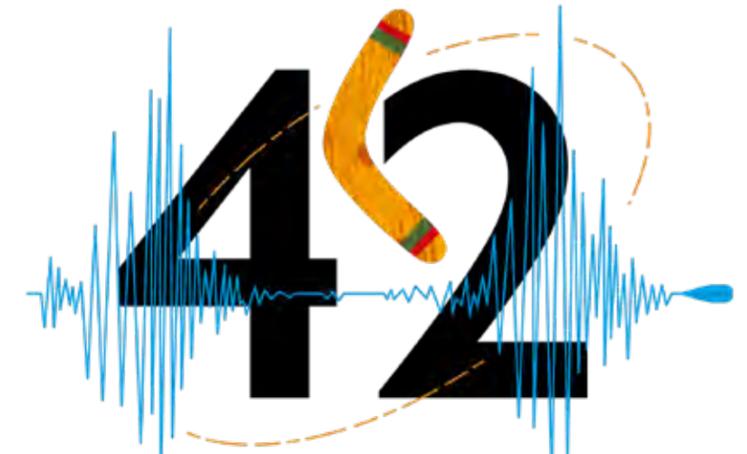
Heading off injury

New research into the severity and long-term effects of traumatic brain injury (TBI) could help design more effective helmets for a range of sports and activities.

The research, from a cross-disciplinary team at Imperial, combined a computational model of brain injury with experimental studies on rat brains. Findings revealed for the first time the link between the mechanical forces that act on the brain during TBI and the resulting long-term changes.

According to Dr Mazdak Ghajari from the Dyson School of Design Engineering: "The initial damage during a TBI takes only milliseconds to occur, but it triggers many changes that result in ongoing effects that can be felt years later. Understanding the link between the two is crucial for predicting who is at risk of long-term damage. With this new model, we can now more accurately predict which injuries will cause severe, long-term damage, and potentially avert it."

The initial damage takes milliseconds, but effects can be felt years later



The Hitchhiker's Guide to the Galaxy says 42 is the answer. But what is the question? For Dr Stephen Hicks it's how to improve earthquake warning systems.

Tectonic plates shift, the ground shakes and a crack moves across the Earth's surface in a single direction: until 2010, scientists thought they knew what happened during an earthquake. Then an eyewitness in Mexico witnessed a quake reverse its course.

Dr Stephen Hicks, Research Associate in the Department of Earth Science and Engineering, says it isn't clear why this happens. "One possibility is that the fault that ruptures is old and weak, allowing this unusual reversal. Or perhaps the earthquake starts going one way but doesn't have room to keep going, so it has to go back the other way to release its energy."

Last year, his team were the first to provide evidence of these 'boomerang' earthquakes (published in the journal *Nature Geoscience*) – although that wasn't their intention. They installed seismometers close to a tectonic plate boundary in the Atlantic sea floor, hoping to learn more about how seismic waves affected the types of rock in the area. They got lucky and recorded a magnitude seven earthquake. "We measured two pulses, which implied that there was a reversing component. When we checked data from monitoring networks around the world, that confirmed it."

Dr Hicks's subsequent analysis suggests that all earthquakes might have some degree of reversing capability – information that has the potential to save lives. "In parts of the world where there's a high seismic hazard, it could influence how buildings are designed and improve early warning systems. If we can let residents know even a few seconds before – it could be in this direction, but it could also be in this direction' – then more people will be covered."

For now, Hicks is focused on the eastern Caribbean – an area that hasn't been studied in detail before – to help build a clearer picture of different tectonic plate settings around the world and how they move. His hope is that, one day, earthquakes will be less unpredictable. "The more we understand about how they happen, the closer we move to the ultimate goal of earthquake forecasting."

> *Dr Stephen Hicks is a Research Associate in the Department of Earth Science and Engineering. His article on the Romanche earthquake in Nature Geoscience can be found at [nature.com/articles/s41561-020-0619-9](https://www.nature.com/articles/s41561-020-0619-9)*

PHOTOGRAPHY THIS PAGE: PETER BUCKTROUT; BRITISH ANTARCTIC SURVEY; ILLUSTRATION: MIKE LEMANSKI; PHOTOGRAPHY OPPOSITE PAGE: IMPERIAL COLLEGE LONDON/THOMAS ANGUS

Passing it on
Paul Atherton is helping the next generation of entrepreneurs identify new opportunities.

IN BRIEF

Women in Science Award

Professor Molly Stevens has won the FEBS/EMBO Women in Science Award in recognition of her innovative bioengineering approach addressing key problems in regenerative medicine and biosensing. bit.ly/imp50-women-science

£4.5m investment for startup

Myricx Pharma, a drugs discovery Imperial startup, has secured a £4.5m investment from venture capital firm Sofinnova Partners to develop drugs that could offer a safer and more effective way to treat certain drug-resistant cancers. bit.ly/imp50-startup-win

Food allergy on the decline

Deaths from anaphylaxis – serious allergic reactions – due to food have declined over the past 20 years, according to analysis of NHS data, conducted by Imperial scientists, aimed at improving the quality of life for people living with food hypersensitivity. bit.ly/imp50-food-allergy

Air quality improving

Life expectancy for children in London will improve by six months as a result of air quality policies, according to a new report by researchers from the School of Public Health's Environmental Research Group. *The Environmental Research Group, led by Professor Frank Kelly, is a collective of 68 researchers working on air quality. Read more from Professor Kelly on p30.*

OVERHEARD ON CAMPUS

SONICOM: Imperial's immersive audio project to help improve 3D sound in alternative reality scenarios.

Green Beads: Award-winning, student-founded startup from Imperial that has developed an algae-based alternative to harmful microplastics.

Range selectivity: A mysterious cellular binding concept that could be used to target diseased cells with high specificity.

Green finance: Imperial will house one of two physical hubs to help commercialise products and services to transform green global finance.



PHOTOGRAPHY: ZUTE LIGHTFOOT

One day we looked at each other and asked: “Why are we doing this for free? We should form a company”

IMPERIAL INNOVATES

Venture mentoring scheme sets a high bar

Paul Atherton (*PhD Physics 1978*) is using what he learned founding and selling fibre optics company Queensgate Instruments to help talented new entrepreneurs thrive.

Every few years, someone creates a product that sparks my interest as an investor. The latest one is an app called MyDelica. I'm one of the founders but I can't take credit for the idea. It comes from Dr Robin Carhart-Harris's research in the Department of Brain Sciences, and advises on the safest practices for using psychedelic drugs like mushrooms, without promoting their use.

A lot of people are now micro-dosing psychedelics because it can have a beneficial effect on mental health and they're following marijuana in becoming legal in a number of places. The app is just beginning its journey and I'd say it's going to be an interesting one.

I'm also the founding director of the Imperial Venture Mentoring Service. I'm very proud of what we've achieved in the past three years: we have 75 entrepreneur mentors on board and they're astonishingly good. The bar is deliberately set very high because Imperial is a world-class institution.

The people who come to us are students or academics in the very early stages of setting up their companies, working out what to sell, who to sell it to and how to price it. I think I'm in a good position to guide people through that process because I've been an academic, completed an MBA at London Business School and spent 20 years running a business.

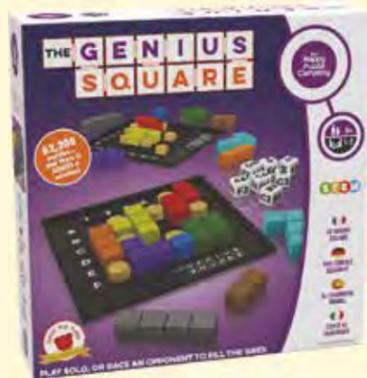
I co-founded Queensgate Instruments in 1978 with Jim Ring, Ken Reay (PhD Physics 1989), Tom Hicks (Physics 1970, PhD 1973) and Martyn Wells (PhD Physics 1977). We were PhD students when we came up with the technology to make optical interferometers for large telescopes, vastly improving their resolution. Imperial is unique in that it encourages students to get involved with industry and has built an entrepreneurial ecosystem that is second to none. One day we looked at each other and asked: “Why are we doing this for free? We should form a company.”

We had no idea how successful it would be. I turned down a professorship in the US after Queensgate got a contract from NASA to use our technology on the Space Shuttle, because I really wanted to be involved in that. We then designed and built some new products, moving away from space to become an optical fibre company.

We didn't know it at the time, but the tuneable optical filter we made would go on to become a key component of the optical internet. We thought that it would be useful, but we didn't know what for, and for 14 years we agonised about spending money on it. Then along came this huge wave of interest in telecommunications, which led to an offer to sell the business that we couldn't turn down. People said: “You were very clever to anticipate all of this,” but the truth is, we were very patient.

Now, a lot of people knock on my door looking for business support, but I don't invest in many companies because I like to have a significant role, and I know that each one might be a ten- or 15-year journey. This is not a ‘get-rich-quick’ game. You can fail quickly, but success takes time. ♦

> Paul is the joint winner of Imperial's Alumni Entrepreneur Award for 2021.



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Debra Sobel, London

Welcome to The Genius Square!

The aim of each of the 62,208 possible puzzles is to complete the square using the nine coloured shapes, once the seven 'blockers' have been positioned. There may be times when it seems impossible, but there will ALWAYS be at least one solution...and that's why it's called The Genius Square!

Each player receives a Genius Square grid (two are included) and a set of the nine coloured shapes, plus seven 'blocker' pieces. Roll all seven of the dice together and place a 'blocker' piece into the squares matching the seven co-ordinates that appear on the dice. Now race your opponent to fill every other space on the grid using the nine shapes.

There are 62,208 possible combinations in which the dice can fall. Using a specially devised computer programme, we have confirmed that all of them have at least one possible solution. Some combinations will be easy to solve, some much harder. It's all in the luck of the roll of the dice.

As soon as somebody finishes first, roll the dice and play again! An example of how to play is shown above. You can also play alone and challenge yourself against the clock!

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EDUCATION: EMILIA DOBB,
EARTH SCIENCE, FOURTH YEAR

Goats, snakes and jetpacks – how new-look field trips result in truly unique experiences



If someone had told me that I would spend time down a Sardinian mine this year, I would have been very surprised. Field trips are a huge part of the identity of a geoscientist, so although I have thoroughly enjoyed my MSci Earth Sciences course, as a wheelchair user, I always felt sad when my classmates set off on trips without me. The experiences you can gain are important for applying what you've learned in the classroom, and to not be able to do them was pretty disheartening.

When the Sardinian field trip was planned, I'd resigned myself to doing a geological report on the area instead of joining my classmates. But when COVID-19 hit, the trip was off and our lecturers really stepped up. As well as keeping us informed and continuing to deliver world class teaching, they also worked ridiculously hard to create virtual field trips via an app using Unity, a game engine that creates virtual and augmented reality games, as well as simulations and other experiences. So, at the end of May, I was able to set off with my classmates to Sardinia – virtually.

The app they created enabled us to explore 3D outcrops using high-resolution photographs, 3D images of rock samples and a virtual microscope.

Because the trip included students in Asian time zones, we had teaching in the morning and then independent mapping in the afternoon.

We had briefings at outcrops via Microsoft Teams, and then we were sent to look around the virtual world. We also had a separate Teams channel where we could take a screenshot and upload a photo, so lecturers and graduate teaching assistants (GTAs) could comment.

In addition to the teaching staff, we had a virtual GTA, known as GeeDee (Geology Demonstrator). You could ask her specific questions, but she had quite an attitude, telling us to get our own answers and making jokes about the Royal School of Mines. She'd also make us follow her and criticise our walking speed. It was great fun.

Everything on the virtual field trip was as realistic as possible: Dr Matthew Genge and Dr Mark Sutton, who developed the app, built in things like goats that we had to chase off, bushes with snakes that could bite you and cliffs that we could fall off (and I did, more than once). Apart from the odd moment – such as the Jaws theme that played if you hit the ocean, or the jetpack to fly you back – most things were true to the real thing. And there were obvious advantages, too: no weather problems, no injuries, and we could also go to places we would never have been able to access for health

and safety reasons, such as mines and outcrops by the side of the road. I now feel if I was dropped into a geological outcrop, I'd know what I was doing.

The camaraderie was good, too. On another virtual mapping trip to Scotland, we walked (a virtual) five square kilometres and finished up in a virtual pub. We were assigned groups and the lecturers were able to move between the groups.

No weather problems, no injuries, and we got to visit places that are normally off limits for health and safety reasons

The benefits of virtual field trips are amazing. For those with greater mobility but lower energy levels, they're great. And for those with mental health problems, they can be easier to manage, as field trips can be quite intense, mentally and physically. It's been incredible to have an alternative, and I hope this will set a precedent for years to come. ♦

> *Emilia Dobb is an undergraduate in Earth Science and Engineering.*

ADVENTURES IN ... IMPERIAL ARTWORKS

Putting Imperial’s art collection in the frame

Professor Sian Harding is leading a project that will help to ensure the College’s extensive art collection reflects its diversity.

Words: Sarah Woodward / Photography: Angela Moore

With a central glass chandelier and heavy, draped curtains framing Victorian paned windows, the Council Room at 170 Queen’s Gate is a magnificent setting for a meeting. Those lucky enough to visit often will see a series of portraits that adorn the walls – those of the past Presidents and Rectors of Imperial, dating all the way back to 1845. But Professor Sian Harding is keen to expand Imperial’s artistic horizons to also include what’s current and relevant now. “Today everyone should be able to see themselves reflected in the art on our walls and in our public spaces,” she says.

Harding chairs the recently established Artworks Group, commissioned by the President and Provost to consider how, through its art, the College can better reflect Imperial’s diverse community. “Our aim is to revive and reinvigorate our artistic spaces, reflecting the community both as it is now and also how we would like it to be, especially from the point of view of racial diversity.”

Now Professor of Cardiac Pharmacology, Harding grew up in a creative household. “The Provost, Ian Walmsley, knew I was especially interested in the bridge between art and science. When he asked me to take on this new challenge, I couldn’t have been more excited.”

A longtime supporter of the Chisenhale Gallery in London’s East End, as well as Imperial’s own Blyth Gallery, Harding is keen to introduce a breadth of artistic media. “I would love to see plasma screens lighting up some of our dreary, dark corridors. We have a huge and growing photographic asset library, but could do more to make use of these images in displays that better represent our diverse community.”

With this in mind, Harding is working on an audit with archivist Ann Barrett to work out how best to highlight these diverse images and find other figures from Imperial’s past who could be celebrated through College art. “There are some obvious examples. Take one of our Nobel Prize winners in Physics, Abdus Salam, whom the BBC recently

described as ‘the Muslim science genius forgotten by history’. He has not been forgotten at Imperial, but I’d like to see more made of him.”

The Artworks Group is working alongside the History Group, which is tasked with examining the College’s legacy with a focus on colonialism and Empire, but Harding is just as focused on creating a space for new works of art. “Together with the Royal College of Art, we are planning a competition, Portraiture (in the wider sense), that will have a particular focus on works that depict members of Imperial’s Black, Asian and Minority Ethnic (BAME) community by artists that identify as BAME. And we hope to attract sponsors for individual portraits among the staff, students and alumni that will reflect our diverse community.”

The project’s focus is not just about whose portrait hangs where. “There are incredible images from the Constructionarium, our radical design course which allows students to manage and build real engineering projects. I’d like to see images on our walls that reflect more of daily life at the College.”

The group wants to create a space where everyone can feel at home, and that starts with engagement. “For the refurbishment of the Reynolds Building at the Charing Cross Campus, for example, a student focus group was set up to think about how the new space could be decorated,” says Harding. They came up with a series of shields from the different medical schools. The results were wonderful, if a bit gory – there were plenty of organs on display!

“We have so much material to choose from, so many ongoing projects to include and so many spaces to fill, including the blank canvas of the new sites. We will be presenting a smörgåsbord of concepts and approaches. And that is just as it should be, as we set out to reflect the truly diverse nature of our community through art. The work is already there – but we must make sure it is put more prominently on display.” ♦



Left: Professor Sian Harding and *The Circle of Life* sculpture by Sarah Tombs, at the main entrance to Hammersmith Hospital, London. “I love the grace of this sculpture, and the metaphor of the supporting hand. I’m intrigued by the small symbols carved into the sculpture at various points and wish I knew their significance.”

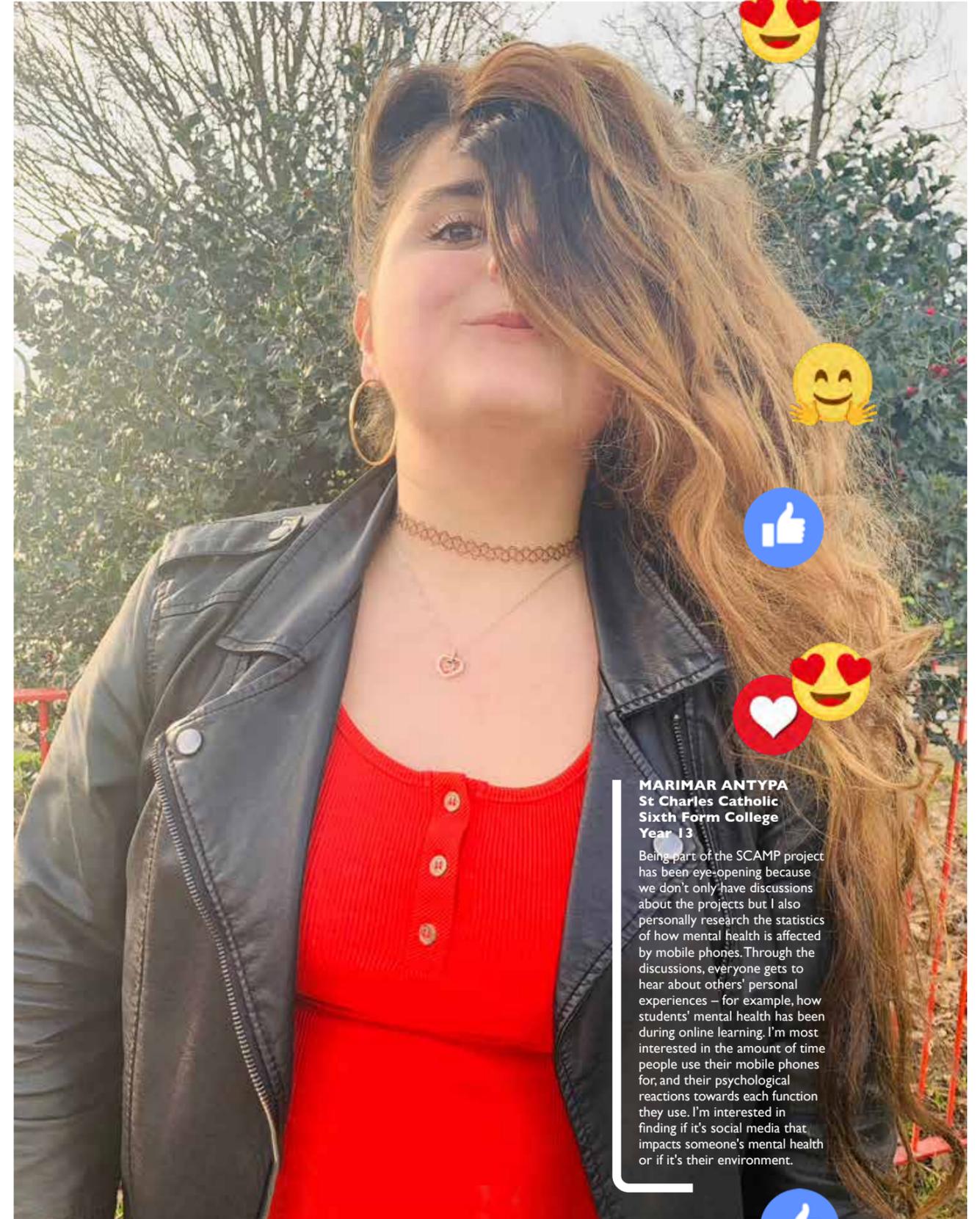
HOW MANY LIKES DID YOU GET?

COMBINE A HOT BUTTON ISSUE WITH 7,000 TEENAGERS AND WHAT DO YOU GET? THE BIGGEST STUDY OF ITS KIND INTO THE IMPACT OF MOBILE TECH ON YOUNG LIVES.

Words: Victoria James
Photos: These images were taken by students' friends and family on their phones.

MOBILE TECHNOLOGY is transforming our lives, but is it always for the better? While many of us would like to reduce our device dependency, the way children and teenagers use new and emerging technology poses even more of a quandary, and serious questions are being asked about potential effects on their mental health and wellbeing. Could mobile devices shorten attention spans, dull critical thinking and reduce physical activity? Or are they a window into a wider world that broadens young people's horizons and boosts their social connections and mental wellbeing?

Now, an ambitious longitudinal study by Imperial's Department of Epidemiology and Biostatistics at its School of Public Health, headed up by Professor Mireille Toledano, Mohn Chair in Population Child Health and Director of the Mohn Centre for Children's Health and Wellbeing, is beginning to provide answers. ▶



MARIMAR ANTYPA
St Charles Catholic
Sixth Form College
Year 13

Being part of the SCAMP project has been eye-opening because we don't only have discussions about the projects but I also personally research the statistics of how mental health is affected by mobile phones. Through the discussions, everyone gets to hear about others' personal experiences – for example, how students' mental health has been during online learning. I'm most interested in the amount of time people use their mobile phones for, and their psychological reactions towards each function they use. I'm interested in finding if it's social media that impacts someone's mental health or if it's their environment.

The Study of Cognition, Adolescents and Mobile Phones (SCAMP) was launched in 2014, funded principally by the Department of Health and Social Care. It will deliver an in-depth understanding of how mobile technology is impacting the lives of young people, with the potential to transform child and adolescent health globally.

“The use of devices by children, and how much restriction should be placed on that use, is a massive concern for parents,” says Toledano. “When we launched the study, the main concern was whether radio frequency fields were harmful to developing brains.” But as the technology has evolved, so has the study: its focus now is mobile usage and how that affects the lives of children and young adults in a multitude of ways.

It’s not an unexamined relationship. “There are thousands of studies looking at social media and self-esteem, from whether phone use worsens children’s wellbeing to whether it might make them more depressed, for instance,” says Toledano, “but most are cross-sectional and explore only short-term effects.” By contrast, the ground-breaking SCAMP has been designed to follow children over the long term – up to ten years – capturing hundreds of different data points along the way.

“The holistic approach is key,” Toledano explains. “Cognitive development and how children think affects how they process emotions, which affects their mental health.”

Girls are affected more than boys; and there are cultural differences

All these elements are also going to influence educational achievement, but most existing studies only look at single aspects of that. Our study recognises that the brain functions in a cohesive, complex way, where everything works in synergy. So, when we look at outcomes, we look at all these things together.”

The study recruited 7,000 Year 7 (age 11 to 12) children from 39 schools in and around London; those children are now in Year 12 or 13 and aged around 17, preparing to exit secondary education. “We’ve been able to look at them during the COVID-19 pandemic,” says Toledano, “and we’ll be following them through their first steps out of school and into higher education or the world of work.”

SCAMP is a prospective cohort study and will only fully yield answers once the data collection is complete and available for interrogation, prompting questions that might not even have been imaginable at the study’s inception. But SCAMP is already offering researchers “very nuanced” insights. There are striking differences by gender and ethnicity in terms of how children are impacted by social media. “Girls are affected more than boys,” says Toledano. “And we’re picking up cultural differences in what determines acceptable social media use in different communities, whether that’s peer relationships or parental decisions.”

SOME FINDINGS ARE SO CLEAR they should already be heeded. “We’ve seen very strong evidence on night-time use,” says Toledano. “Those who used a mobile phone in a dark room one hour before going to sleep were about 150 per cent more likely to get a night of insufficient sleep than those who did not use it.” Other observations may challenge established assumptions. “There have been reports that videogaming improves focus and reaction time,” says Toledano. “But those look at piecemeal elements such as reaction times. Our analysis will take in the bigger picture, which is what’s relevant in the wider world.”

And then there are the pandemic findings. “The number of young people who have hit the clinical threshold of anxiety and depression has gone from 13 and ▶



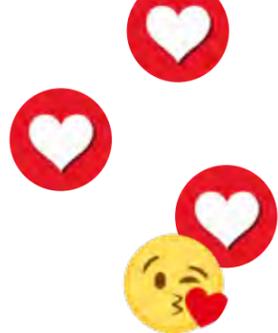
ORLANDO ALEXANDER
Berkhamsted
Sixth Form Year 1

It has been very interesting to be part of the study and get a ‘behind the scenes’ insight into the world of research. I am a SCAMP Ambassador at my school, which has been very rewarding; for example, last term I lead an assembly on the SCAMP study, where I explained to those in my year how they could get involved with SCAMP’s online research surveys. Personally, I am really interested in finding out more about their findings into the potential adverse effects caused by EMF radiation from mobile phones.



ESTHER FORLORUNSHO
London Academy
of Excellence
Year 13

It’s exciting that I got to speak to so many young people and explore my views and those of others. The SCAMP project has provided me with a great introduction to the world of research. I’m interested to find out more about the long-term effects of frequent usage of phones on the teenage brain. This is because I’m fascinated by neurology, due to the complex yet delicate nature of the brain.



14 per cent before the pandemic, up to 29 to 35 per cent respectively, during the first lockdown,” says Toledano. “When schools were closed, that’s when worrying mental health issues really rocketed. They need the face-to-face contact.”

The long-term goal of SCAMP is to provide an evidence base that gives not just policymakers, but also children and their parents, the knowledge to make an informed choice about their use of mobile phones. But more specifically, it hopes to provide insight into a huge global challenge: the onset of poor mental health. It’s estimated that a billion people worldwide suffer from some kind of mental disorder. Half of all adult mental health problems manifest by the age of 14; by 24, that figure has risen to 75 per cent. “Something is happening in the teenage years that we need to capture and understand,” says Toledano. Accomplishing this will be one of SCAMP’s most significant achievements. “Devices are important, but what else is going on with teenagers that means some end up with significant mental health issues?” asks Toledano. That ‘what else?’ spans a vast range of factors, from puberty and genetics to physical activity and environmental interactions. So the SCAMP team is gathering data from multiple angles, such as diet, exercise, sleep, BMI, device use, time in school, time spent with friends and family, time outdoors in green spaces, who’s in their household, and what kind of home that household lives in. “By collecting this very large-scale data for children over many years we can unravel the patterns that send children down different mental health trajectories,” Toledano explains. “We will start picking up early warning signs well before clinical diagnosis, and then we can examine what factors might have predicted that.”

IT’S NOT ONLY ABOUT getting upstream of emerging problems for some young people, it’s also about evaluating what builds resilience in their more fortunate peers. “You’ve got three groups,” Toledano says. “One has mental health problems, another is resilient, and a third is currently on a pathway towards mental health problems but currently below a clinical threshold. So, what are the things that make a difference between those groups: is it genetics and biomarkers, or time outdoors, or sports, or time with friends? Using artificial intelligence, we can identify things we’re seeing over and over. And then we can test that model against the people in the middle.”

Such knowledge should bring the power to intervene. Personalised healthcare is a cutting-edge concept that’s gradually becoming a reality thanks to researchers across a vast range of disciplines. The SCAMP team has a prototype app that Toledano describes as “an early intervention and prevention tool for young people. They record things like what they’re doing, where they’re going and their mood. Then, in time, the AI is able to make recommendations, such as ‘your mood seems low – go for a walk’. There are plenty of apps a bit like this, but they’re not data-based and individualised, and that’s what really makes the difference. For one person, the recommendation might be taking a walk, while for another talking to a friend might be more effective or, for another, taking a relaxing bath.

“If we can pin down that detail, we’re creating a tool that is incredibly personalised and much more effective,” says Toledano. “So, we’re working with Aldo Faisal’s group in the departments of Computing and Bioengineering, and with Dasha Nicholls in Brain Sciences on this. We’re doing what we at Imperial call the future of science, which is cross-disciplinary collaboration – we’re working with ecologists and cultural and social scientists as well.”

At the heart of Toledano’s investigation is the welfare of the young people who are sharing so much of their lives with her team. The study has a young people’s advisory group, who feed in their own opinions on what they want to know to improve their quality of life, and the kind of tools they would readily use. The Mohn Centre for Children’s Health and Wellbeing’s mission is to improve physical and mental health for children, particularly in urban areas, reaching



LAGSIKA KUGATHAS
The Cardinal Wiseman Catholic School
Sixth Form Final year

I’ve had the chance to consider various factors that may influence our psychological and intellectual state in lockdown. Factors such as a lack of exercise and the inability to regularly communicate how we may feel reminds me that I must take this action myself and encourage those around me to do so too. I hope to understand better the factors which affect our mental health and our ability to memorise and work efficiently in our day to day life, and I’m curious to know whether this has any long-term consequences.



LUCY-MAE BLY
Tring Park School for the Performing Arts
Year 13

It gives me the opportunity to develop my inquisitive passion for psychology, child development and what makes us human in the twenty-first century. I love the interactive meetings and sharing my thoughts and opinions on elements of SCAMP’s forward-thinking work, such as the development of their app. I also get to listen and connect with others of similar interest and age from all walks of life. I am most interested in finding out about how technology affects mental health. I am curious as to how we can adapt ways of harnessing technology within its vital and ever-evolving landscape, in order to protect our mental health.

Be part of Imperial's future by leaving a gift in your will.

After starting her career as a secretary, Dr Gloria Borley (Geology 1960, PhD 1962) joined Imperial as a student in 1957, having decided with her husband James that they would both pursue higher education. Upon completing her undergraduate degree in Geology and PhD in Geochemistry, Dr Borley went on to become one of the first female lecturers at Imperial's Royal School of Mines.

Gloria remained at Imperial, overseeing Mineralogy and Petrology, until her retirement. Dr Borley passed away in 2016, leaving a generous legacy gift to support neurological research at Imperial. She made her pledge in memory of her husband, James, who she lost to Alzheimer's disease.

Dr Borley described the impact of her husband's condition as 'catastrophic', and their experience left her determined to support neurological research at Imperial. "Imperial constantly pushes the boundaries of progress in science," she said. "My decision to set up this scholarship fund was extremely cathartic – it gave me a sense of relief that something positive could emerge from such a sad experience. My legacy will enable gifted young students to continue making important progress in neurological research."



Dr Gloria Borley, also pictured top right, part of Imperial's past and future



The chance to transform lives

Legacy gifts have a far-reaching impact at Imperial, allowing us to invest in exciting research and cutting-edge facilities, and to support the best and brightest students from all walks of life. A gift in your will can help us to advance the forefront of research and education, help us to plan for the future with confidence and ensure we always remain a home for great minds.

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If you would like to discuss how you can leave a gift to Imperial in your will, please call Anna Wall, Head of Legacy Giving on +44 (0)20 7594 3801 or email a.wall@imperial.ac.uk.

We will start picking up early warning signs well before clinical diagnosis



THADY FOX
Cardinal Vaughan Memorial School
Year 12

SCAMP has provided a refreshing jump to the cutting edge, the forefront of academia: something equally exciting and empowering. It has provided vivid insight, development of various practical skills and a deep, satisfying sense of productivity, of being a part of something. I look forward to seeing how SCAMP impacts the world. Will it spark further research? Will it encourage and catalyse change in education? Will it shape the life of my peers in any way? I'm privileged to know that I played a part.

those "who don't have access to green space and clean air – where there is deprivation, within minority communities. SCAMP will really help us to help them." With several years still to run, the SCAMP study will comprehensively remedy the historical under-researching of young people's lives. "Children and adults are often studied," says Toledano, "and interest in the elderly is rising because of the ageing population. But adolescents? People think they're uncontrollable, that you can't understand them. But they need more of our attention. Their developing minds are so fascinating." ♦



MILLY REES
Godolphin and Latymer
Year 13

I have taken part in SCAMP since Year 7 and am now part of the young people's advisory group, which I have enjoyed contributing to. It has allowed me to be able to express my opinions, and to feel like we, as young people, have a voice. I look forward to finding out more about the impact that mobile phones, or isolation, has had on the mental health of young people during lockdown. I want us to be able to learn from the study and make positive changes to support people in the future.

Into the blue

Over the past year, the critical role of Imperial science has been in the spotlight like never before. But like so much research, much of the work which is now so critical began as a leap of faith. A hunch. Or sometimes, just sheer curiosity. So what does tomorrow hold? We asked the next generation of blue sky thinkers what they are working on.

Words: Lucy Jolin
Photography: Nato Welton
Styling: Rebecca De Boehmler

Using AI to handle maths proofs at scale

Dr Kevin Buzzard

It all started with a nagging worry. Every day, links to around 20 new maths proofs would arrive in Dr Kevin Buzzard's inbox: all hugely long and complex, and often referencing each other. There were more than any one individual or team could read, let alone work through and check. The reality, as Buzzard discovered, was even more worrying: not only was it difficult for anyone to check – was anyone even trying? His idea? To teach computers maths and let the machines check the proofs. “And it turned out that no mathematicians had really taken that idea seriously before,” he says.

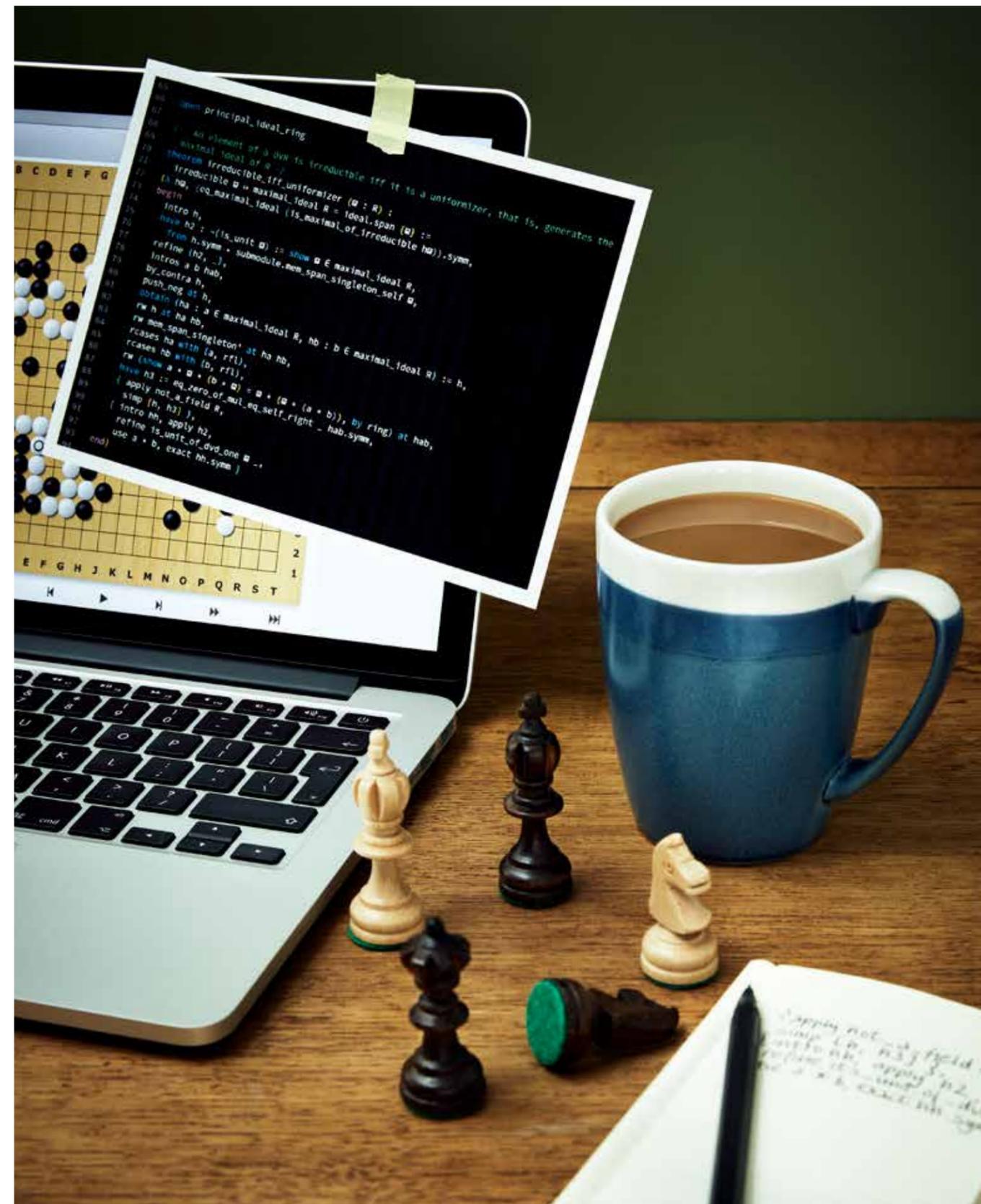
Pure maths and computer science are two very different disciplines, but Buzzard says that Imperial was enthusiastic about his ‘wacky’ ideas. He began by teaching a computer basic maths. Next, he encouraged his undergraduates to get involved through a taught course and a club – which resulted in his collaborating on a published paper with four of them.

“Imperial likes innovative ideas because they know they could turn into something,” he says. “I’d make funding applications and other people would say: ‘It’s too weird’ – but not Imperial.” The team moved on to harder concepts: MSc-level maths and highly complex concepts such as perfectoid spaces, invented by Fields Medal winner Peter Scholze.

Today, Buzzard's idea has grown into a programme to get mathematics undergraduates trained to formalise maths on computers – the Xena Project. Buzzard has won funding for a post-doc to support the project, is building a database of theories, and is starting to bring an official group together. Scholze himself got in touch in 2020, challenging Buzzard's community to check one of his proofs: work on this has already started. And industry is extremely interested.

“There is a huge amount of momentum right now,” says Buzzard. “I believe that machines like these are going to change the way mathematics is done over the next five years. The revolution will come once young people start using this software. Look ahead, and computers will be competing with mathematicians, in the same way that they were taught to play chess and Go better than humans. Maths is a game with a finite number of rules, like chess and Go. The difference is that maths has an infinite board.” ▶

Right:
Dr Kevin Buzzard's inspiration for the Xena Project came from the challenge of checking long and complex maths proofs.



Developing 3D-based alternative growing systems

Dr Giovanni Sena

It might sound like some kind of science-fiction concept coined by the Victorians, but electrotropism offers a potential solution to two of the biggest challenges faced by the modern world – climate change and population growth.

Dr Giovanni Sena and Dr Connor Myant, and their collaborators, Dr Gunnar Pruessner and Professor Chris Braddock, have imagined a world in which plants can be cultivated everywhere: skyscraper walls, farms in the sky, spaceships orbiting the Earth or journeying to far-off planets.

And that matters, Sena points out, because current alternative growing systems are not yet efficient enough. Hydroponics has great potential to improve production but the existing solutions – vertical farming and vertical gardens – present serious technical challenges. He works on root development and the interaction between roots and electric fields, and Myant is an expert in 3D printing and manufacturing design. Together, they have come up with a revolutionary idea: a plant growth module that marries cutting-edge 3D technology with root electrotropism, the phenomenon where plant roots grow towards negative electric charges.

The team is now working on the development of a 3D-printable, bio-compatible hydrogel, spiked with micronutrients, and patterned with cavities, designed to optimise the gas diffusion and oxygenation which are crucial for efficient growth. To enhance the plant's natural ability to grow in unusual spatial configurations, it will also incorporate electrically conducting elements. These will generate local electric fields designed to guide root growth in any desired direction, allowing the grower to control and programme the root system.

The potential is vast. The ability to modify the platform's characteristics could make the module perfect for controlled, lab-based research. Electrotropism could be used to simulate gravity, allowing plants to grow in orbital free-fall, or outside strong gravitational fields. It could benefit our built environment, too, enabling green wall systems that are far easier to maintain. As a possible by-product, 3D-printing bioreceptive and biocompatible hydrogel structures will enable new advances in medical applications, smart wearables and soft electronics.

"And the actual integration between the 3D-printed hydrogel and living plants will also be a first of its kind and will inspire further developments and applications," says Sena. "Often the best applications of new technologies are the hardest to predict. Deep down, you hope it will surprise you."

Bioimaging to support the removal of cancerous cells

Dr Fang Xie

In the world of tumour surgery, precision is everything. Removing every last trace is notoriously tricky, even for the most skilled surgeons; indeed, around 40 per cent of patients still show evidence of residual tumours after surgery. Which is why Dr Fang Xie thinks we need to radically improve what those surgeons can see.

"Currently, surgeons inject dyes that indicate the boundary between healthy and cancerous areas, but only to a certain depth, limiting the imaging penetration potential," she says. "The surgeon still has to rely on their experience to select tissue for removal."

Which is why Xie is examining how nanoprobe working at an awe-inspiringly tiny scale could be used during treatment, and is developing

THE BEST APPLICATIONS OF NEW TECHNOLOGIES ARE THE HARDEST TO PREDICT

nanoprobes-based Metal Enhanced Fluorescence (MEF). "Among all forms of imaging, fluorescence imaging inherently has many advantages: it is non-invasive, has high sensitivity, high spatiotemporal resolution and does not use harmful radiation."

Her team have created nanoprobe comprising tiny gold stars bonded to dye molecules, with much greater brightness and unrivalled penetration imaging depth, which have the potential to revolutionise the field of bioimaging and how it is used in precision tumour resection. When injected into patients, these nanoprobe make it possible for surgeons to see tumours in real-time, and with far greater clarity. "The combined micrometre resolution and high penetration depth achieved by engineering these frontier nanomaterial probes will enhance clinical treatment and prognosis of cancer patients," she says.

It's a highly challenging concept with many obstacles: not least the potential challenges that could arise from injecting a patient with a hard substance like gold. But if these obstacles can be overcome, this project will be just the first step. In the future, nanoprobe could be used not just to identify tumours but also to help cure them. "For example, they could be targeted towards biomarkers for cancer in a particular site in the body, amplifying their signal and enabling drugs to be delivered to that very specific place," says Xie. "This would mean treatment doesn't affect other areas in the body, reducing side effects from chemotherapy and enabling the patient to have a much better quality of life. At the moment, we are still working on proof of concept: this is very much blue sky. But we are very ambitious!" ▶

Right:
Dr Giovanni Sena's revolutionary work on electrotropism imagines a world in which plants can be cultivated anywhere.





Left:
Dr Pavani Cherukupally was inspired by her upbringing in India, along the River Musi in Hyderabad and in her father's incense stick factory.

Using sponges to treat contaminated water

Dr Pavani Cherukupally

Growing up in Hyderabad, India, Dr Pavani Cherukupally saw the stark effects of water pollution first hand. "As well as the fact that we had virtually no rain for ten years, I would walk around the city's River Musi on my way home from school each day and see how extremely contaminated it was, spreading water-borne diseases."

Later, as a mechanical engineer, Cherukupally was asked by Professors Chul Park and Professor Amy Bilton at the University of Toronto to design a system to clean up after oil spills. She realised that low-cost materials are key when it comes to effective water technologies for the developing world, and thanks to another childhood memory, developed a system using a surface-engineered sponge (SEnS). "My father owned a factory manufacturing incense sticks," she remembers. "I worked in that factory, and I remember how we would coat the stick with fragrance molecules. With surface coatings, you can do anything!"

The latest prototype, the antimicrobial sponge, developed in collaboration with Professor Daryl Williams and Professor Huw Williams at Imperial's Department of Chemical Engineering and Life Sciences respectively, has demonstrated 95-99 per cent efficacy. It works on the same principle as a magnet and was developed with oil spills and cleaning up wastewater in mind, using a coating of nanoparticles that attract the surface charges of molecules such as bacteria or crude oil, pulling them out of the water and onto the surface of the sponge and leaving behind clean water.

Cherukupally is currently working on proof of concept and hopes to soon start connecting with industry and manufacturers. "For example, it could be used to treat water at a domestic level, because even when it is treated, water can become contaminated with bacteria in the pipes," she says. "Or it could be large-scale and coupled with other technologies – it would still bring the cost down. To work on a project like this, which could have such a big impact, is a real privilege. It's a great gift."

Researching ways to improve control of the immune system

Dr Doryen Bubeck

It's tempting to regard the immune system as a weapon: send a pathogen over the top and watch as it's mown down. But there is so much about it that we still don't understand, says Dr Doryen Bubeck.

"If you get a bacterial infection, the pathogen in your blood will be detected by your innate immune system," Bubeck explains. "One of your body's primary defence mechanisms is the complement response. This involves the formation of the membrane attack complex (MAC) – a large protein-based pore that punches holes in the bacterial pathogen until it has so many holes it has to die. But the MAC doesn't have a specific receptor."

THE MORE WE UNDERSTAND OUR IMMUNE SYSTEM, THE CLOSER WE GET TO BEING ABLE TO CONTROL IT

It can go into any cell membrane around. So our bodies create special receptors to stop the MAC doing that. I want to know how that happens, and how our cells protect themselves."

Bubeck's current research builds on the work she carried out for her Career Establishment Award, funded by Cancer Research UK, which examined how cancer cells evade the complement response during antibody-based immunotherapy treatments and become resistant. She is now examining another aspect of the immune system: the role of plasma chaperones, which bind to excess proteins created by the complement response.

"They are notoriously challenging to study because they are so flexible, and they adopt lots of different shapes depending upon the cargo that they're binding. We've been able to understand some of the cellular functions by almost trapping them as they bind."

The more we understand what's going on in our immune system, says Bubeck, the closer we get to being able to control it – which has huge implications for all kinds of diseases and treatments. "The effects of the immune system are far more subtle than we realise." ♦

> Dr Kevin Buzzard, Dr Fang Xie and Dr Giovanni Sena are all recipients of The President's Excellence Fund for Frontier Research. If you would like to find out more about the scheme that supports research ideas with breakthrough potential, visit bit.ly/frontier-research

It takes two

Teachers teach and students learn, right? Not quite: at Imperial, students are partnering academics to help decide how their courses are designed and delivered.

Words: Hazel Davis / Illustration: Andrew MacGregor

When students and teachers work together to develop and deliver courses, the results can be truly transformative. The Student Shapers scheme, which began two and a half years ago, provides staff and students with a framework they can use to work together and produce insightful outcomes.

The scheme acknowledges the equal value of staff and student expertise and fosters a culture in which both partners can critique and challenge practices and approaches, as well as suggesting novel or innovative ways of working.

“You can ask students what they think, and listen but not necessarily hear,” says Student Shapers director Mike Streule. “This allows staff and students to work in a deeply connected way, actually impacting outcomes rather than going through the often very fuzzy filter of being informed and not acted on.”

Imperial currently has ten Student Shapers projects on the go, with up to 40 usually taking place across the academic year, in areas such as curriculum development, educational research, translation of research into teaching, space design, IExplore and partnership pedagogies. As Streule says, “it’s not surprising there’s huge appetite among the student body for this, with exciting results from subjects as diverse as chemical engineering, aeronautics and primary care in medicine.”



From left: **Anthea MacIntosh-LaRocque** (Physics undergraduate) and **Dr Yasmin Andrew** (Department of Physics student liaison officer).

Space: a new frontier

The student-led redesign of the Department of Physics has involved a full refurbishment of two key areas to improve the social and study experience.

Reimagining two large spaces within the Blackett Building – which houses the Department of Physics in South Kensington – was the challenge taken up by Physics student Anthea MacIntosh-LaRocque and Dr Yasmin Andrew, Department of Physics student liaison officer.

Along with two other Student Shapers – postgraduate Josie McGarrigle and final year undergraduate Max Hart – the team was asked to reimagine foyer areas and a small, largely unused side corridor, and essentially given free rein over what to do with the spaces. “We weren’t even told to limit our thinking to a particular budget,” says MacIntosh-LaRocque.

The students came up with a survey, sent out to the undergraduate and postgraduate cohorts in late June last year, asking for ways in which the space might invoke a better sense of belonging, including how students would choose to divide it up between social and study areas. The trio then came up with initial designs using online design software, FloorPlanner, getting further feedback from students to form a final proposal.

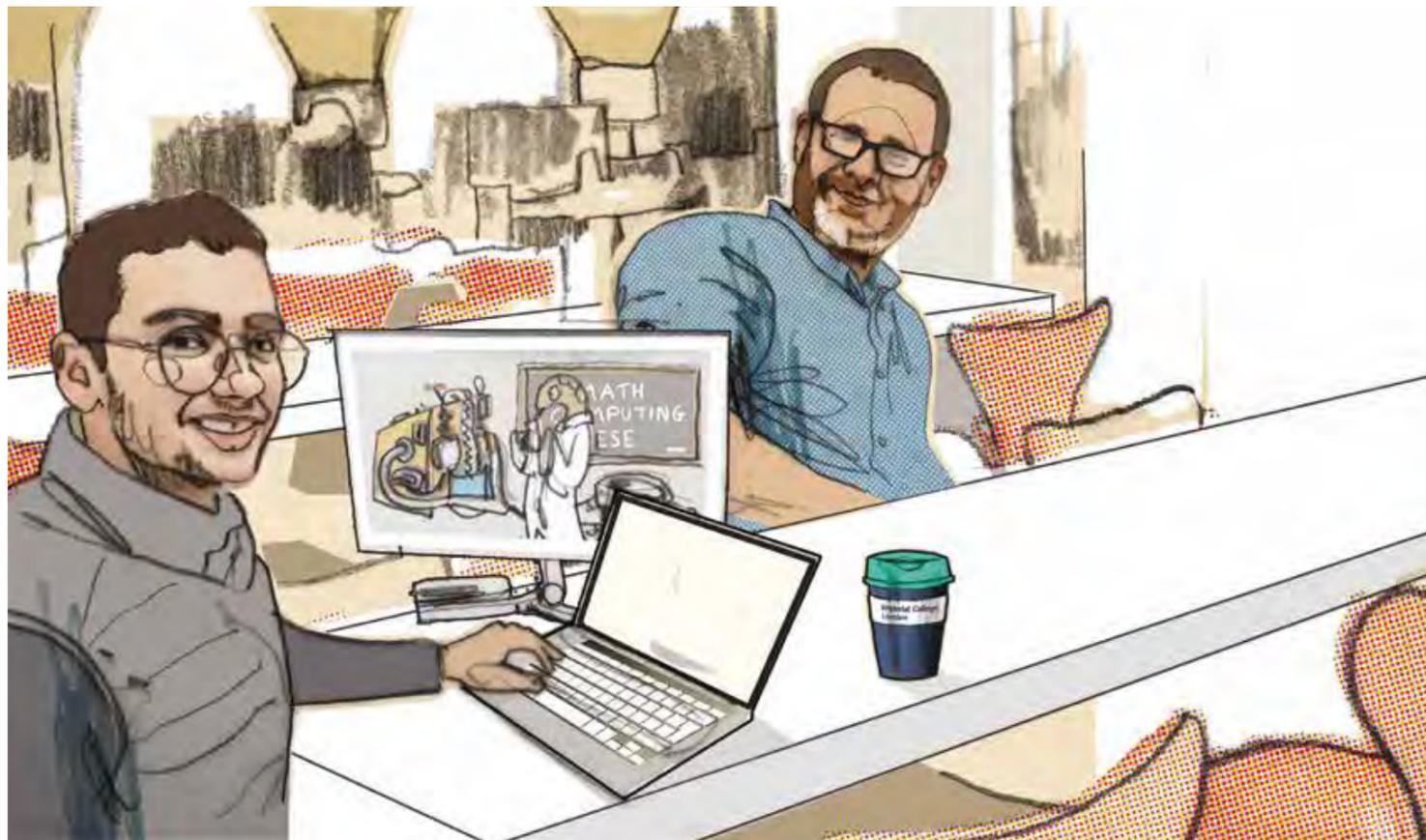
The resulting refurbishment will be a modern, safe and multifunctional space with a new sense of departmental identity. Plans also include the installation of traditional blackboards, student artwork, photos of the physics community and interactive display cabinets.

Working under COVID-19 restrictions made the process more difficult: students couldn’t be in the space but, says MacIntosh-LaRocque: “We perhaps had more conversations about the particulars of the space than we would have had otherwise: ‘Is that wall painted? Do we have a bench there at the moment?’” The group also had ongoing calls with students working on a similar project taking place next door in the Huxley Building.

As a science student, MacIntosh-LaRocque is used to black-and-white numerical data, so she says: “This project really taught me how to collate and deal with data in the social sciences, something I never would have encountered during my degree. I’m really grateful to have had the opportunity to learn that skill on my feet.”

She adds that the scheme “gives students a sense of agency over changes made within their department and beyond. It minimises the dilution of student feedback and I think the College really benefits.”

Below from left:
Raul Adriaensen (Earth
 Science and Engineering
 taught postgraduate)
 and **Matthew Piggott**
 (Professor of Computational
 Geoscience and Engineering).



Cracking the code

Matthew Piggott, Professor of Computational Geoscience and Engineering, has worked with undergraduate students to develop teaching material that supports their exposure to the Python programming language.

“Coding has become a very important part of the scientific world and can open many doors for students,” says Raul Adriaensen, one of Piggott’s Student Shapers. “Many modules, because of their focus, structure and time limitations, can really only describe the theory of how something works, whereas this resource allows students to go a step beyond and understand how this theory can be implemented by playing with models and data themselves.”

To help with this, Adriaensen has created a series of notebooks, including one on the Google Earth engine API that helps “undergraduate as well as postgraduate students use satellite data, and others that provide extra learning tools for lecturers”.

The longer-term goal is to embed computing as an adaptive tool that can be used throughout the geoscience curriculum. “The undergraduate students are the ones at the coalface: they recognise the problem, but

are also immediately familiar with the undergraduate programme,” says Piggott. “That means they know where the opportunities to add programming exposure are.”

According to Adriaensen: “This project puts the necessary tools in students’ hands to practise their programming beyond the syllabus requirements and open their options further.” He also hopes it will create a robust archive of knowledge that the curriculum can explore in its modules, research projects and individual learning opportunities. “Nothing in the project is set in stone, and that’s a new experience for me.”

“The communication between staff and students means the project can adapt and provide the most useful output possible for everyone. Everyone’s voice is heard equally, and your ideas can really have an impact on where the project goes.”

Nothing in the project is set in stone, and that’s a new experience for me

Rethinking primary care

Community action projects offer students the opportunity to engage in local communities (typically with poor health outcomes) to better understand their role as future medical professionals within them.

Working in partnership with local communities during the first pandemic-related lockdown was a new experience for Imperial students, but one that ultimately resulted in innovative new ways of approaching and solving problems.

The work of Bethany Golding, Community Collaborations Lead for the Medical Education Innovation and Research Centre (MEDIC) and Undergraduate Primary Care Education, and medical student Korede Salami, focused on the development of third-year students’ COVID-19 community action projects. It identified opportunities for medical students to work in partnership with communities on local health and wellbeing priorities, the key focus of tackling health and societal inequity.

Among other things, Salami worked on creating a needs analysis document, as many people in the voluntary sector, as well as GP tutors and medical students, wanted a quick summary of the needs of a borough to help identify where initiatives should be targeted. She also helped plan sessions for the Medicine in the Community Apprenticeship and supported students with their community action projects, acting as a liaison between students, Community Champions and staff. Their work also supported students participating in the work of the Health Inequality Coalition.

Implementing the project has required flexibility and thoughtfulness, as Golding explains. “Our students hadn’t worked in partnership with local communities in this way before,” she says, “and the course timelines didn’t give much space for community partners and students to get to know each other, so we’ve had to adapt.”

With limited time, the pair decided to focus on a few deliverable goals. “We put our efforts into co-creating resources and materials which could be multipurpose,” explains Golding. “We started by working on an analysis of a borough’s needs and assets which formed part of the evidence base that secured the project funding. These were then adapted into a learning resource for students to help prepare them to work with communities – and also informed the work of regional and national partners, including the North West London NHS Clinical Commissioning Groups.”

Salami says she was initially a little nervous about working with staff members who she’d usually see in a much more formal setting. But, she says, “the staff were very welcoming and encouraging. The remote working experience also prepared me well for my BSc and I gained other skills such as learning how to effectively read academic literature and find the most important information.”

Golding adds: “Having Student Shapers challenge my assumptions about course design helped me to see that co-designing education with our students plays just as vital a role as co-designing NHS services with the people using them.” She adds: “I have learned new ways of thinking that would never have occurred to me otherwise.” ♦



Above facing from left:
Bethany Golding
 (Community Collaborations
 Lead for the MEDIC)
 and **Korede Salami**
 (Medicine undergraduate).

take you breath Every

A

s one of the main forces behind the introduction of London's Congestion Charge, Professor Frank Kelly doesn't always get a warm welcome. But his battle against the world's second biggest cause of early death – poor air quality – has had life-changing outcomes on a global scale.

“An enormous number of people have their lives cut short by the quality of the air they breathe,” says Kelly, the inaugural Battcock Chair of Community Health and Policy at Imperial's School of Public Health. Indeed, the World Health Organization (WHO) estimates poor air quality is responsible for the premature deaths of between 28,000 and 36,000 people every year in the UK – and 7.2 million worldwide. “The only factor responsible for more early deaths is tobacco smoking,” Kelly points out. “That means air quality is the second most important health challenge we face. And on top of all these early deaths are many conditions and diseases that are influenced by air quality, either in their development or their progression.” ▶

PROFESSOR FRANK KELLY

SETS OUT HIS LIFE-SAVING VISION FOR A POLLUTION-FREE FUTURE.

Words: Becky Allen / Portrait photography: David Vintiner



The depth of that challenge was highlighted recently, with the landmark finding that ten-year-old Ella Kissi-Debrah's death in 2013 was caused by acute respiratory failure, severe asthma and air pollution exposure. The judge said that she was exposed to nitrogen dioxide and particulate matter pollution in excess of WHO guidelines, the principal source of which were traffic emissions. "The best-case scenario is that the proposed Ella's Law introduces air quality guidelines to the UK in the new Environment Bill," says Kelly. "If that's not achieved, then her mother is just one of many environmental crusaders who have been shouting from the rooftops for a number of years that we need to do something about this issue."

As head of the London Air Quality Network (LAQN), as well as the Atmospheric Emissions Inventory for London, Kelly and his research team are the front line. Set up in 1993, the LAQN takes hourly measurements of carbon monoxide, sulphur dioxide, ozone, nitrogen dioxide and particulate matter at more than 200 sites in and around London. Under Kelly's stewardship, it has grown into the largest regulatory network in the world.

The network provides a goldmine of data, enabling Kelly and his team to conduct health studies, develop mathematical models and design interventions to help improve air quality in the capital. And for politicians, policymakers and the public, the LAQN provides rich, reliable information on London's air quality.

This breadth of work – from measuring and modelling to health effects and policy options – has enabled Kelly and his team to directly impact London's traffic and air quality. Over the past 20 years, their science has shaped not



only the Congestion Charge, but also the Low Emission Zone, and the Ultra Low Emission Zone (ULEZ). All these initiatives have had a significant impact on pollution levels in the capital, so much so that other European cities, including Manchester, Paris and Madrid, have introduced traffic control schemes built on their work.

But we must go further, Kelly says. "It's not just air quality, it's also about congestion and efficiency of movement. Busy cities are noisy, ugly, unpleasant places. We could do much better," he says. "When you see how cities like Copenhagen, Utrecht and Barcelona have changed, you realise what life could be like."

It was time spent abroad that fed Kelly's enthusiasm for what could be achieved. A physiologist by training, Kelly has studied the lungs since the start of his career, and was determined to discover how pollutants like ozone, nitrogen dioxide and particulate matter damaged them. To gather his data, he had to travel to the University of Umeå, 250 miles from the Arctic Circle, to use its human exposure chamber.

"We didn't have anything like that in the UK 20 years ago. In fact, we still don't, really. Thanks to Umeå's clinical expertise and its medical students, who were our volunteers, we were able to expose people to precise concentrations of these pollutants and use bronchoscopy – a procedure that lets you examine the airways – to investigate what was going on in the lungs," he explains.

This seminal study revealed that the respiratory tract lining fluid (the thin film of fluid covering the surface of the lungs) contained a range of different antioxidants. Wondering why these protective molecules should be present in such large quantities, Kelly looked at the reactivity of the pollutants.

"We discovered that ozone, nitrogen dioxide and particulates all caused oxidative reactions, and the antioxidants at the surface of the lungs protect against those reactions," he says. "When we looked at different people and different diseases, we found large variations in antioxidants, depending on what people ate and the air they breathed. Understanding how high concentrations of pollutants can overcome our defences and cause damage was one of our major scientific achievements."

Returning to London and the LAQN, Kelly followed up with another ingenious study using Europe's busiest shopping street as a real-world laboratory. "We were investigating diesel emissions and it suddenly struck me that Oxford Street – with its procession of red buses and black cabs – was a diesel exposure chamber." He invited a team of volunteers for a 'shopping trip' along Oxford Street. But instead of shopping bags, the volunteers carried backpacks containing equipment that monitored their lung function and the levels of air pollution. "The results revealed for the first time what real-world scenarios were doing to our lungs and other organs."

As well as contributing to respiratory diseases such as asthma, chronic obstructive pulmonary disease and lung cancer, air pollution also plays a role in cardiovascular disease – the biggest killer in most high-income countries – and neurodegenerative

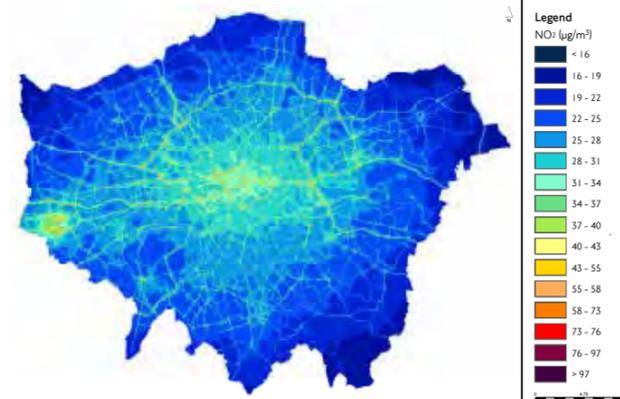
There are few chronic diseases that aren't linked to air quality



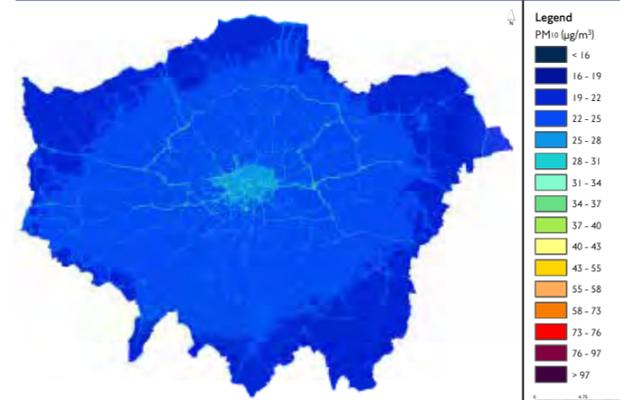
PHOTOGRAPHY: IMPERIAL COLLEGE LONDON/THOMAS ANGUS

The spatial distribution of different air pollutants across Greater London

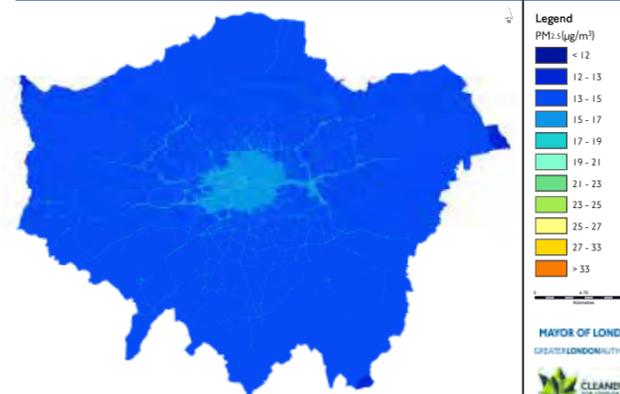
1. GREATER LONDON - ANNUAL MEAN NO₂ CONCENTRATIONS 2020



2. GREATER LONDON - ANNUAL MEAN PM₁₀ CONCENTRATIONS 2020



3. GREATER LONDON - ANNUAL MEAN PM_{2.5} CONCENTRATIONS 2020



Left

(1) The spatial distribution, in micrograms per cubic metre (µg/m³), of nitrogen dioxide across Greater London. The annual limit is 40µg/m³, so most of the road network is in exceedance.

(2) and (3)

The spatial distribution, in micrograms per cubic meter (µg/m³), of particulate matter less than 10 microns in diameter (2) and particulate matter less than 2.5 microns in diameter (3), showing values that exceed WHO health-based guidelines of 20 and 10 respectively.

Facing page:

The Environmental Research Group, part of the School of Public Health, is a leading provider of air quality information and research in the UK, combining air pollution science, toxicology and epidemiology to determine the impacts of air pollution on health and the causal factors.

Right: Professor Frank Kelly in the School of Public Health, based in the Sir Michael Uren Hub.

diseases like dementia. Kelly recently discovered, for example, that people living in the most polluted parts of London were 40 per cent more likely to be diagnosed with dementia than those living in the least polluted areas, an association that has since been confirmed in many other cities.

"The bottom line is that there are few chronic diseases that aren't linked to the quality of air we breathe. That's no surprise to me because we know that when air pollution reaches the lungs it causes inflammation and cell damage, effects that can easily move beyond the lungs," he says.

His vision for London's future includes the planned expansion of the ULEZ (due for autumn 2021), further investment in electric buses and taxi fleets, and greater co-operation between air pollution and climate change scientists, so that cutting carbon also nets cuts in other air pollutants. "For all these reasons I'm optimistic," Kelly concludes. "I dream of a private vehicle-free city environment with sustainable, emission-free public transport for those who need it. This will allow planners to transform cities into more enjoyable and pleasant environments for people to live and work. But I can also be very pessimistic when I look at low- and middle-income countries, where it's going to take another generation to get to where we are."

Kelly remains most proud of the achievements of the Environmental Research Group he leads. "I'm grateful that I have ended up undertaking research that can have an impact in my lifetime. And I'm thrilled that our team has developed the knowledge and experience to be a leading light in this vital field, and that our work in one of the most important cities in the world is now a model for others on a global scale." ♦



THE BUSINESS OF BEER



BEER. IT MIGHT SEEM A STANDARD PRODUCT TO PRODUCE, BUT ITS GROUNDING IN ART, CRAFT AND – PERHAPS ABOVE ALL – SCIENCE MAKES IT THE PERFECT CALLING FOR IMPERIAL ALUMNI.

Words: Megan Welford / Illustration: Harry Tennant

Beer runs deep in the British psyche. Even before the Romans arrived, we were brewing it in the British Isles. In medieval times, it was drunk as a safe alternative to water, and with the arrival of hops and industrialisation, it became big business. Yet despite its scale, it remains inherently fragile, or “challenging and utterly heartbreaking,” as one Imperial alumnus brewer puts it. Indeed, for something powered by a relatively prosaic set of chemical reactions, there is something about brewing that remains more akin to magic than science – a something that can fuel lifelong obsessions.

“My dad wanted me to go to uni,” says Eddie Gadd (Mining Engineering 1990), of Gadd’s Brewery in Ramsgate, Kent. “I studied mining engineering because it was relatively easy to get on to. Afterwards, I did some tunnelling for a bit, and in between London Underground contracts I worked in a pub. They had a little brewery in the basement, and I liked hanging around there. I thought the brewer was cool – he was finished by 2pm, with an unlimited beer supply. He taught me and I thought: ‘This is the kind of process I could spend my life doing.’”

Although it’s not rocket science, Gadd says, brewing does bring together a lot of other sciences. “There’s physics in moving liquids around; chemistry and microbiology in the fermentations; engineering in keeping the plant running and pumping the liquids and thermodynamics in the heat transfer. Yet my boss back then was a philosophy graduate and a good brewer. He sat around in corners thinking about it. Another mate is an art school dropout and I’d recognise his beer like I’d recognise an artist’s sketch. ▶



This is the kind of process I could spend my life doing

Eddie Gadd (Mining Engineering 1990)
Gadd's Brewery in Ramsgate, Kent.

Some qualified brewers have amazing technical abilities, others don't." A year or so later, Gadd had turned down a permanent £27k a year post with London Underground to train as a brewer on £9k (plus unlimited beer, of course). "The maths was obvious," he says.

A TRADITIONAL BUSINESS

Jeremy Phipps (Civil Engineering 1985), chairman and, he says, "family relic" of 200-year-old Phipps Brewery, spent 25 years in the City before returning to the family business to help rebuild the brewery. "My engineering degree came in handy as I helped to plan the kit," he says. "We built the new brewery in an old one, a nineteenth-century building. Breweries were tall, because they used gravity – you hoisted everything to the top then let it fall. Nowadays, we use pumps."

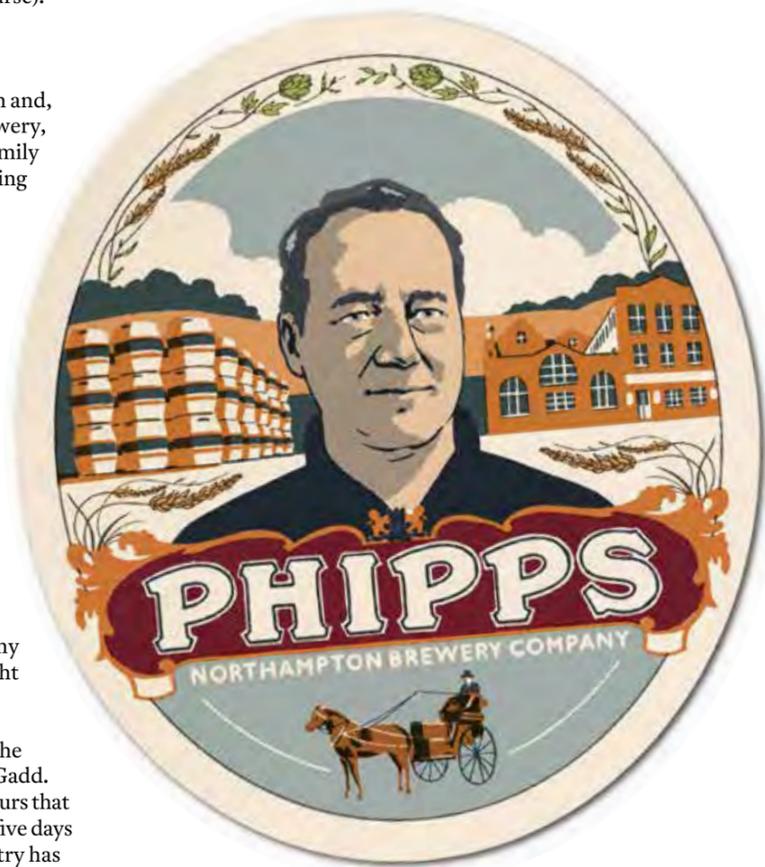
To make traditional English cask ale, you mix barley, hops and water together in a vessel called a mash tun, "like a porridge". You heat the water and add yeast, then let the mixture ferment for one to two weeks in a fermenting vessel. You need to add a clarifier, which traditionally would have been a little bladder of the sturgeon fish ("Goodness knows how they discovered that," says Phipps). The beer then ferments a second time in casks and the yeast is activated a final time in the publican's wooden tap, the action of which, combined with some skill, produces the nice creamy head of a fine English cask ale. "The beer is alive right until you drink it," says Phipps.

And therein lies the heartbreak. "Horrible things can happen inside a cask if it's moved too often, or the temperature fluctuates too much," explains Eddie Gadd. "This can upset the yeast, which then produces flavours that upset us." And, crucially, the cask only lasts three to five days before it spoils. This is why the English beer industry has traditionally been very localised, and also why pubs are so important. "A cask is seven gallons, or 70 pints – so it has to be drunk by many people," Gadd explains. "That's why we have pubs – so people could drink the cask together."

And people are loyal to their local beer. So worried was Winston Churchill, during the Second World War, about the effect on morale if a town's brewery were to be bombed, that he built a lab in deepest Suffolk to store a yeast sample from each. When Phipps Brewery wanted to reopen their Northampton brewery in 2008, they retrieved their sample from the store. "It was too flocculent when we first brewed with it," Phipps remembers, using a term that only applies to yeast. "It came flying out of the top of the mash!"

THE YOUNG PRETENDERS

But a bigger threat to English cask ale would come from a European innovation – lager. Lager is beer that is pasteurised, so it lasts longer, and its bubbles come from



Horrible things can happen inside a cask if it's moved too often, or if the temperature fluctuates too much

Jeremy Phipps (Civil Engineering 1985), chairman and "family relic" of Phipps Brewery.

carbonisation instead of yeast. It's fermented at a lower temperature, just once, in kegs, and heavily filtered. It can be bottled and canned, lending itself to high volume production and transportation. By the 1970s, says Phipps, the British beer industry had consolidated into six breweries, and the Phipps family sold up to Watney's.

Towards the end of the 1990s, the pendulum swung back with an explosion of craft beer. "People got bored by the big players getting bigger and bigger," says Ronnie Janssen (MBA 1997), who runs Lost Pier Brewing in Brighton. "Macro lager like Bud and Carling is great for volume, but it's very bland. That created an opportunity at the other end of the scale for the craft beer market."

Craft beer can be pasteurised or not, lager or ale (both are beer), but is produced at small scale, with care. "You can play a lot with the blank canvas of beer," says Janssen. "It's like coffee – 30 years ago we were all drinking Nescafé. Now, it's Jamaican Blue Mountain. People want to drink perhaps a bit less, but better. There are 2,274 breweries in the UK now, and 1,978 of them are microbreweries."

It's still hard to make money, though. "Making beer is hugely capital intensive. Breweries have to spec-up to build up sales and then they need more kit again – it's hard to run at optimum level, or just to break even," says Janssen. He has got around these problems by being a "cuckoo brewer" – brewing at a co-operative facility run by Lord Limerick out of an old dairy in Sussex. Lost Pier produces vegan and gluten-free beers in gorgeously decorated cans. Cans protect the light-sensitive hops, he says, and have better margins than cask beer or even bottled beer. "My MBA taught me to choose my path carefully," he says.

THE HOME FRONT

Cans play well into another trend that was growing fast even before the lockdowns: that of entertaining at home, sounding an alarm that COVID-19 may turn into a death knell for some pubs. "The take-home trend for alcohol was increasing even before the pandemic," says Janssen. "That idea of cocooning, of your home being your castle, of big screens and entertaining at home, was at the expense of pubs, which had to start selling food to compete. Pubs will continue, though, because they're social spaces."

Eddie Gadd certainly hopes so. "Everyone loves a glass of beer," he says, "and after two, they start making friends. Pubs are soulful." Back in his friend's basement 27 years ago, Gadd was right – he could spend his life making beer. "I'm dealing with problems no-one has solved before," he says with relish. "At the moment, my yeast is behaving strangely. I've been sending pictures to top boffins and they're baffled." Ultimately, brewing is not about science, he says, it's about love. "It's having something really fun to do that people really like. You hand out your wares and see an immediate, positive reaction. It makes people happy." ♦

Beer is like coffee – 30 years ago we were all drinking Nescafé. Now, it's Jamaican Blue Mountain

Ronnie Janssen (MBA 1997), who runs Lost Pier Brewing in Brighton.



Are you celebrating a milestone this year?

Mark the occasion with a free commemorative pin badge

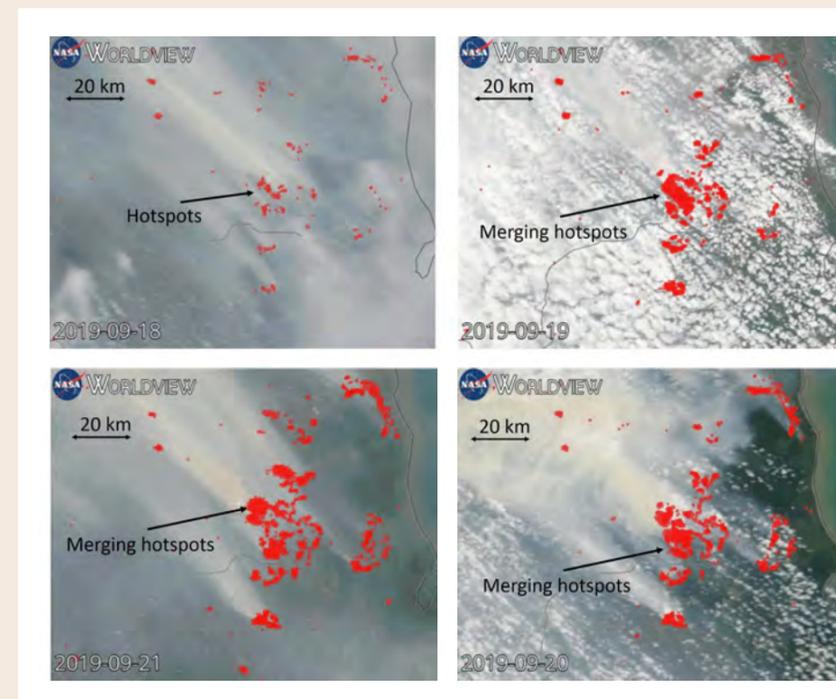


If you are celebrating a milestone anniversary of your graduation this year (any graduation year ending in 1 or 6), we would like to send you a special pin to wear with pride. Medicine alumni can also choose a pin from one of our constituent medical schools.

To request your free milestone pack, or find out how we can support you in organising a reunion this year, visit:

www.imperial.ac.uk/alumni/milestone

Photographs taken at our 2019 Alumni Weekend reunion at Imperial's South Kensington Campus



Wildfire: Satellite images of a peat wildfire in Sumatra, and its progression over four days in September 2019 (starting from top left on 18 September and moving clockwise).

DATASET / DWI PURNOMO, RESEARCHER, DEPARTMENT OF MECHANICAL ENGINEERING

Imperial research could dampen the dangers of peatland 'zombie fires'

Context

So-called 'zombie fires' – peat fires that appear to have gone out but continue burning underground and then reignite – produce a carbon haze near ground level so toxic that it can damage the environment and prove fatal to humans. Common in south-east Asia, North America and Siberia, these fires can occur naturally as a result, for example, of lightning strikes, but they are also an accepted, deliberate method by which farmers burn off excess vegetation. However they start, the organically rich soil composition of peat means that they smoulder rather than blaze and are incredibly difficult to extinguish.

Background

Having witnessed zombie fires at first hand in his native Indonesia, Imperial researcher Dwi Purnomo is examining how soil properties and atmospheric conditions impact the ignition and spread of zombie fires. "Peatland fires are the most persistent on earth," says Purnomo. "Flaming fires burn off the vegetation, but once they are extinguished, the peat below continues to smoulder, creating a low-level haze that can release up to 100 times more carbon than flaming fires. And because peat fires have a lower temperature, the smoke remains at a low level, and the pollutants it contains – such as carbon monoxide and ammonia – pervade residential areas and can cause severe respiratory and cardiovascular problems."

Methodology

Purnomo and his colleague, Professor Guillermo Rein in the Department of Mechanical Engineering, used advanced

computer simulations of smouldering and flaming fires in peatland. "We use a form of mathematical modelling called cellular automata, a grid system in which each cell displays unburned and burning cells that are determined based on simple rules. We then calibrated the models with the lab-scale experiments and upscaled to simulate field-scale peatland wildfires."

Findings

The results were able to pinpoint just how wet the soil needed to be to prevent ignition. "Our analysis showed that where peat soil had 70 per cent moisture content, 2.9 hectares was still burning after three months. If that soil's moisture was 100 per cent, that spread would have been reduced to just 0.02 hectares."

Outcomes

The hope is that the research will help landowners find safer ways to clear vegetation in peatlands, by, for example, changing planting schedules on peat areas so they are burnt off during the rainy season. "If landowners know the moisture level at which the soil ignites, as our model demonstrates, they can manage that and make the whole process much less harmful. The aim is that we eventually see peatlands safe from fire hazards, which would positively affect climate change. I will be using this model as a baseline for future research incorporating meteorological and topological conditions; we are one step closer to the solution." ♦

> *Dwi Purnomo is a research student in Hazelab, part of the Department of Mechanical Engineering.*

WORDS: PETER TAYLOR-WHIFEN



Above: A spontaneously organised 400-man showcase of the e.wash product at a local football pitch with the entire village, Rwanda.

SOCIETY

Imperial e.quinox Society

The human touch

Engineering students show Imperial reaches the parts of the world that other universities don't.

Words: Sarah Woodward

What do you do when you're in the Rwandan capital, Kigali, in desperate need of cheap spare parts for your prototype washing machine? Jump on the back of the nearest motorbike taxi and head to as many dodgy side-alley garages and blacksmiths as you can? That, at least, was where Soren Vines (Geophysics, Fourth Year) found himself in the summer of 2019. It was, he says, "one of the most fun experiences I have ever had".

It was all in a day's work for Vines, Chair of e.quinox, a student-led humanitarian organisation that brings cost-effective solutions and renewable energy to developing countries. "We think of ourselves as a humanitarian R&D society." Working principally in Rwanda, the society offers students the opportunity to join summer expeditions, but first they must develop a product that will help the local community.

The off-grid washing machine, e.wash, was part of a project to develop a local launderette, and is just one of the latest ideas incubating within e.quinox. "One of our translators mentioned to a few people in the local church that we planned a demonstration of the washing machine. By the time we were ready for the demo, a huge crowd of some 400 people had gathered. They had never seen anything like it, and we got a great kick from showing the community how this could save them so much time and labour."

Vines and the six other members of the team based themselves in Minazi, a remote village on top of a ridge in rural Rwanda. They were following in the footsteps of three Imperial Electrical and Electronic Engineering students (BBOXX founders Mansoor Hamayun, Christopher Baker-Brian and Laurent Van Houcke) who, in 2008, were working on a battery box for their final year project and chose Rwanda as their test bed. The aim was to develop a cost-effective, off-grid, standalone photovoltaic system to power rural villages. e.quinox was set up to allow future Imperial students to continue the work.

This practical aspect is one of the main draws of the society, Vines points out. "It is a great opportunity to see your idea put to the test and take it through a whole product cycle." Many of the members are engineering students, but the range of disciplines and projects is wide. Last year, Vines' own interests led him to develop a simple system for testing the level of the water table using electrodes, a car battery and a power inverter.

"The night before I flew out to Rwanda, I was desperate to know if it actually worked and ended up testing it on Queen's Lawn (on Imperial's South Kensington Campus), as Hyde Park was closed for the night. It was raining and my girlfriend was holding an umbrella (with electrical gloves to prevent shocks), using her mobile as a torch. We must have been quite a sight." The system did work and, during his visit, Vines managed to make a geological map of 18km² around Minazi, detecting outcrops in the mica schist that might indicate water.

e.quinox is proud of its record of bringing electricity to more than 400 households in remote communities and students receive a warm welcome. But Vines has a tip for new members setting out for their first visit. "Get used to the children shouting *m'zungu* (foreigner) at you wherever you go. And if you want to be really popular, know that everyone supports Arsenal – because His Excellency Paul Kagame, President of the Republic of Rwanda, does. The most desired gift you can bring is an Arsenal scarf." ♦

The most desired gift to bring is an Arsenal scarf

A WORKING LIFE

Living life at the extremes

Professor Gabriele Messori
(MSci Physics 2010, PhD 2014)



Above:
Gabriele Messori on the SCALE 2019 cruise (Southern Ocean Seasonal Experiment) Antarctic Cyclones project, July to August 2019.

People imagine that the life of a scientist researching extreme climate events is an intrepid one, working out in the field in far-flung locations. The reality is that I spend most of my time stuck in front of a computer screen. During the pandemic I have been working alone even more, and the experience has highlighted the most important element of my research – collaboration.

I meet colleagues on screen, but there is a big difference between scheduled meetings and free-form interactions. Many of my best ideas have come from unexpected encounters and discussions. Normally, I commute between Stockholm, where I live, and the university at Uppsala. Last February, just before the pandemic struck, I was running to catch the train and bumped into a colleague from the Faculty of Social Sciences. On the 40-minute commute we talked about combining numerical forecasts of climate extremes with the sociological perspective of effects on people.

That chance meeting led to a joint paper which has been well reviewed. It would never have happened if I had stayed sitting in my home office. I'm getting a lot more standard research done – but am doing less of what I call 'weird stuff'. I miss those moments of serendipity that lead to research breakthroughs.

Once I noticed a grant call requiring a South African partner for funding, I had just attended a conference where a colleague from the University of Cape Town gave a brilliant presentation, so I contacted him. I would never have done that if I had not first seen him speak. Together we got the project, researching cyclones in Antarctica, our understanding of which will lead to improved modelling of southern hemisphere sea ice.

My first experience of collaboration came as an undergraduate at Imperial. Physics students had to team up with a fellow class member for a project and I and Ann Winning chose water circulation in the Caspian Sea. I enjoyed working with someone who challenged my ideas – and best of all, it was fun. It is wonderful to find someone else just as excited about your research findings as you are, not least because you can egg each other on.

Climate scientists historically concentrated on single climate variables in isolation, but over the last decade it has become important to study compound extremes, such as temperature with drought, or heavy precipitation combined with strong winds. A PhD can be a relatively lonely affair and afterwards it took me a couple of years to start building up my own research network, collaborating outside my

department. Your work cannot live solely off your own ideas and it is important to give as much as you take.

The climate extremes community is a lively one and we stay in touch online, often discussing unusual weather events happening around the world. My focus is on large-scale atmospheric dynamics, but I sometimes enjoy taking a break from research and spending some time looking at live data from local weather stations in Sweden. Recently, I noticed that the Swedish village of Sveg, 250km inland, had hit -31°C , while less than 50kms away it was only -10°C . I just had to look into the phenomenon and share my findings – climate scientists are always curious. In my department we are obsessed by our competition to guess the first day of snow each year. We know that the background variability is so large, and the event so random, that it is nothing more than a guess – if an educated one – but we still enjoy the fun of arranging a competition around it. ♦

> *Dr Gabriele Messori (MSci Physics 2010, PhD 2014) was appointed Associate Professor at Uppsala University just five years after finishing his PhD; he is also an Affiliated Researcher at Stockholm University. He is one of this year's winners of Imperial's Emerging Alumni Leaders Award.*

INTERVIEW: SARAH WOODWARD

PUZZLE

Test your brain power



Ready to test your little grey cells? Imperial's best minds set the ultimate puzzle challenge.

1: HARD

If you follow my rule with 15, then you'll surely get 74. The routine can then also be seen, with what number you wish – say a score! With a score you can get 71, but with five just 80 you'll see. So perhaps you can figure for fun, what the answer with 30 will be.

Set by JAH Hunter in *Fun with Figures*, submitted by Robb Gosine, postgraduate student

2: VERY HARD

You are standing at the centre of a circular field of radius R . The field has a low wire fence around it. Attached to the wire fence (and restricted to running around the perimeter) is a large, sharp-fanged, hungry dog. You can run at speed v , while the dog can run four times as fast.

What is your running strategy to escape the field?

Set by puzzles.nigelcoldwell.co.uk, submitted by Naran Gorsia

3: FIENDISH

A scientist calls an old school friend – who is an artist – to arrange a drink that evening. The scientist, who prides himself on his accuracy, sets the time for them to meet. Both of them arrive at the correct time but the artist arrives 30 minutes earlier than his friend. How is that possible?

Set by Pete Champ (BSc Electrical Engineering 1984)

HOW TO ENTER:

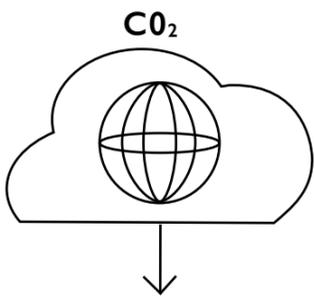
Senders of correct solutions for two or more of the puzzles will be entered into a prize draw to win a book e-voucher for the value of £10. Winners' names will be printed in Imperial 51 in November 2021, and solutions published at www.imperial.ac.uk/be-inspired/magazine/issue-50/brain-power. Entries close on 31 July 2021.

To enter, please email imperialmagazine@imperial.ac.uk

FOR ISSUE 49 SOLUTIONS:

www.imperial.ac.uk/be-inspired/magazine/issue-49/brain-power
Congratulations to: Nicholas Grogan (MSc Statistics 1978), Jason Klimach (BSc Mathematics 2008), Chris Johnson (BEng Physics 1973), Alex Dean (MSci Physics with Theoretical Physics 2018), Andrew Denham (MEng Mining Engineering 1987), Mike Grannell (BSc Mathematics 1967 and PhD 1970), Xin Yi Leong (BSc Mathematics 2012), Kathryn Sayer (MEng Mechanical Engineering 2016), Alan Cleugh (BEng Chemical Engineering 1960) and Jennie Yang (BSc Biochemistry 2006).

ILLUSTRATION: MIKE LEMANSKI



A balancing act

ACHIEVING NET-ZERO CARBON MEANS ACTIVELY FINDING WAYS TO REDUCE GREENHOUSE GAS EMISSIONS. IMPERIAL'S ALUMNI ARE AT THE SHARP END.



CARBON MANAGEMENT

NIGEL JENVEY

*(MSc Petroleum Engineering 1995)
Global Head Carbon Management,
Gaffney Cline & Associates*

Q. When did you first become aware of planning for net-zero carbon?

My undergraduate degree was in mining engineering at Leeds, where I studied with mature students whose careers had already been shaped by government energy policy (such as closure of coal mines in the UK). I look back at my time at Imperial, specialising in oil and gas, as like drinking from a fire hose of knowledge. Renewable sources of energy weren't really a major part of the energy mix back then, but the fundamental science and engineering, along with the economics of oil and gas shared gave me the building blocks to do what I do now.

Q. How did you move into carbon management?

In 2004 my employer, Shell, asked me to work internationally. I moved to Houston, Texas, intending to gain global expertise and experience beneficial to continued operations in the North Sea. There was a meeting with the other big energy players at the time to discuss joint research, development and demonstration in CO₂ Capture and Storage (CCS). The Shell representative from HQ in the Netherlands couldn't make it at the last minute so I stood in and saw an opportunity to apply the capabilities in the team I worked with to emerging CCS projects. By 2012 I found myself appointed as Chair of this organisation, the CO₂ Capture Project, a partnership of seven major energy companies working together to advance the technologies underpinning the deployment of industrial-scale CO₂ capture and storage.

Q. Do you still draw on your student experience?

I stay in contact with the research coming out of Imperial to understand how research insights in other areas could be applied to carbon management, as there is something new to learn every day in my sector. Studying at Imperial taught me the importance of collaboration, being among multiple different disciplines and cultures and being taught by internationally renowned lecturers. And it taught me the value of being humble, to listen and learn from others' insights. ♦

> *Nigel Jenvey has more than 23 years of global oil and gas industry experience with several major operating companies.*



ENERGY POLICY

BIQING YANG

*(MSc Environmental Technology
2014) Energy Policy Officer at
the British Embassy in Beijing*

Q. When did you first become interested in environmental issues?

I grew up surrounded by traffic in Tianjin, a major port city near Beijing, so I was aware of air and plastic pollution from an early age. My parents are great nature lovers and we went trekking for our holidays. I felt a responsibility on my shoulders to protect the natural world, and read environmental biology for my undergraduate degree at Warwick to get the right skills. But through internships, I realised pure science wasn't for me, so I signed up for my Master's at Imperial's Centre for Environmental Policy to learn a more interdisciplinary approach.

Q. Did the course meet your expectations?

The diversity and range of the teaching helped me see how the diverging strands of policy and science fit together when you are studying the environment. The Master's attracted people from all over the world: lawyers who wanted to specialise in environmental law; scientists from environmental engineering; climate change specialists; NGOs; and economists with interests in energy policy. But we all cared passionately about the same issues.

Q. How did you come to work on energy policy?

Every single day since graduating my positive energy has been focused on the need to address climate change, particularly in China. I worked at Conservation International on nature-based solutions, but I wanted to be a part of the complicated discussion around clean energy transition. I have always seen environmental issues as interdisciplinary and now, in my role at the British Embassy, I am working with many different stakeholders. There are eight different ministries in China involved in formulating policy on electric cars alone. It is really complicated but there are solutions. ♦

> *Biqing Yang is the policy lead for low-carbon transport and emerging energy technologies at the Foreign and Commonwealth Office, and Energy Policy Officer for the UK Foreign, Commonwealth and Development Office in China, having previously worked at Conservation International in Beijing.*



LOW-CARBON INFRASTRUCTURE

TIM CHAPMAN

*(MSc Soil Mechanics 1987)
Director, Infrastructure Design,
Arup, London*

Q. Was net-zero carbon on the agenda when you were a student at Imperial?

I finished my degree a third of a century ago, when the hangover from the oil crises in the 1970s had led to increased concern for building efficiency, through a focus on window frames and lightbulbs. Thinking about low-carbon infrastructure, which has become my passion, was almost non-existent. My experience at Imperial, delving deep into soil mechanics, gave me the technical confidence later in my career to challenge other experts in very different fields.

Q. When did you get involved in low-carbon infrastructure?

In 1992, I started work on Crossrail as a geotechnical engineer. From the outset, Crossrail played a major part in the low-carbon plan for London. I worked alongside architects and social scientists as well as engineers, using the soft skills as well as the technical ones I had acquired at Imperial. It is not just about how you build infrastructure, but also how people will use it.

Thirteen years ago, I was asked to advise on a planned zero-carbon black ski run in the mountains behind Abu Dhabi. I thought the idea was bonkers and, thankfully, it was never built, but the issues it raised reinforced my belief that zero-carbon infrastructure is always about the big picture. When you choose to build a new road, you must take responsibility for the whole-life impacts of the scheme and all its users.

Q. Are you optimistic for the future of zero carbon?

The pandemic has accelerated trends in work, transport and leisure and I am optimistic that the post-pandemic world will be better for the environment. But we must learn to create technical solutions in partnership with communities and engage with people as we plan new infrastructure. That not only means becoming technically proficient in a core skill, but also learning to mix social sciences with physical sciences as we create holistic answers for society's problems. ♦

> *Tim Chapman is a Fellow of The Royal Academy of Engineering, and is chairing the Institution of Civil Engineers' workstream on system level reductions in infrastructure carbon.*

POLICY AGENDA / DR EMMA LAWRANCE, MENTAL HEALTH INNOVATIONS FELLOW AT THE INSTITUTE OF GLOBAL HEALTH INNOVATION

Mental health solutions: how data is changing the use of digital technology

CONTEXT

More people than ever before are seeking help for mental health issues, and digital technology opens up seemingly infinite opportunities to help those in need. The pandemic served to increase both the need for such services and the digital support available to those who need them.

THE PROBLEM

In a field where the establishment of rapport and trust between those seeking and providing support is so essential, the idea of remote, virtual services that lose in-person face-to-face connection potentially comes with challenges. But when done well, digital services, particularly 'blended' with in-person support where allowable, provide an accessible and scalable route to support individuals when they need it. "We are seeing a rise in emotional disorders, distress and self-harm," says Dr Emma Lawrance of Mental Health Innovations and Fellow at Imperial's Institute of Global Health Innovation (IGHI). "Digital offers exciting opportunities to support people in a scalable, timely and tailored way, but not all digital services are alike, and a lot of people don't maintain engagement with tools like mental health apps. Different things work for different people at different times, and for digital mental health services to work most effectively we need to understand those nuances."

AN INNOVATIVE CROSS-SECTOR APPROACH

Lawrance's research combines real-world experience and data from mental health charities, including Shout 85258, the UK's first 24/7 mental health text support service, and Imperial's own technology

experts. The result is a unique, interdisciplinary, cross-sector perspective on how digital mental health services are being used and can be made more accessible. "Shout has a huge dataset of anonymised text conversations, which we can use to better understand mental health needs and the impact of services, with help from Shout experts and Imperial's mathematicians, neuroscientists, psychologists, machine learning and natural language processing experts."

The result, she hopes, will set a standard for policymakers and other organisations to ensure the digital mental health space is as open and accessible as possible, and crucially that it can reach people in need who might otherwise have nowhere else to turn.

"Previously we've seen academic organisations develop evidence-based interventions which fail when put into real-world scenarios – or vice versa, digital tools such as apps that have no evidence base or robust evaluation. Our team's research brings all these things together, putting frontline organisations together with an innovative academic partner.

"We've done work with patient and public involvement and engagement experts atIGHI's Helix Centre, and run workshops with Shout users. That experience gives invaluable context to the data, enabling Imperial teams to ask the right questions of the data, and develop insights that then feed back into the charities to provide even better services. We also ran an Imperial Lates event, and a NIHR People's Research Café, that both asked: 'What does the public want to know? How do they feel about this data being used? What are their hopes and fears around this?' Collaboration is essential."



A SHARED VISION

As with any technology, data privacy is key. "Shout has an extremely high standard of data protection," says Lawrance. "Anonymity is taken extremely seriously. But when we spoke with Shout texters we found there is very much a shared vision: most people want their (anonymised) data to be used positively, with insights fed back to the entire sector and the service users themselves, to make digital engagement in mental health services as accessible as possible. There's a real appetite for how the results and impacts of this research can be rolled out to help others.

"We want our work to help inform policy across the mental health sector, to help everyone understand what it means when people seeking support move to an online space, and we're trying to make those messages as accessible and understandable as possible." Lawrance was part of the team that published a report and framework for the World Innovation Summit for Health to improve the development and implementation of digital mental health services.

"Ultimately, it's about how we help individuals with mental health issues, and understanding what's going on for people, many of whom are not accessing other services and could slip through the net. If we can understand the issues they face and listen to them, we can develop evidence-based interventions and the most suitable, appropriate support to help them as individuals." ♦

> *Dr Emma Lawrance leads the mental health strategy for the Institute of Global Health Innovation, and founded the youth mental health charity It Gets Brighter.*

ALUMNI LIFE

Connecting alumni groups

Imperial's network of alumni groups is global, connected and influential. Here's how to get involved.

Illustration: Giacomo Bagnara

How can you start a job search, look for new opportunities or find out what it's really like to live on the other side of the world – during a global pandemic? At Imperial, our global network of alumni groups has been key in helping alumni to stay connected, providing critical support and information.

"Our alumni community is global, connected and influential," explains Chloe Lee (Biology 2017), of the Imperial College Alumni Association of Malaysia. "So if you are looking for a job, an internship opportunity or someone to fund your project or venture, or if you are just looking for someone who can go hiking with you, we can reach alumni who can help with just a phone call."

Group events are also key – whether in person or online. Regional group leaders came together regularly this year, for instance, and a number of groups – such as in New York, Bristol, Singapore, Hong Kong and Tokyo – held online events, attracting alumni from both the local and much wider community. "I've been part of many groups in New York, Los Angeles and San Diego," says Panos Vagenas (Biochemistry 1999, MSc 2000, PhD Clinical Medicine Research 2003), "and I think the first thing we can offer is a sense of belonging."

The network can help you 'pay it forward'. As part of the College's graduation project, groups were invited to record welcome messages and share their advice with 2020 graduates, as well as introducing their regional group over Zoom. Thirty-four volunteers took part, showing the warm welcome graduating students can expect from the alumni community, and the commitment from alumni groups to maintain a supportive, friendly network for recent grads. Similarly, a call for alumni group volunteers to be virtual student recruitment ambassadors resulted in more than 60 international and UK alumni signing up to be Unibuddy volunteers, answering questions from prospective students about their experiences at Imperial.

And that network can also be invaluable when you're looking to move on. "I've been for an interview with someone in the Imperial network and the only way I found out about the opportunity was through that network," says Pawit Chantaworakit (MEng Electrical & Electronic Engineering 2017). "I know friends who have found jobs working with seniors in Imperial and friends who have done business with members of the Imperial networks." ♦

> *To get in touch with your local group leader, visit www.imperial.ac.uk/alumni/groups/regional-groups. If there isn't a group near you, why not start your own? Contact Eilidh Campbell in the Alumni Relations team at eilidh.campbell@imperial.ac.uk to find out more.*



MY IMPERIAL

Pop shove-it!

On board with Jessica Powell (*Design Engineering, Fourth Year*) in Imperial Park.

Interview: **Diane Shipley** / Photography: **Joe McGorty**

Don't be fooled by the photo – skating really improves my mood, but I wouldn't say I'm good at it. It's something I wanted to try for ages; I even asked for a skateboard for my 15th and 16th birthdays – but never got one. Then a couple of years ago, a friend of mine took it up and told me how amazing it was, which inspired me to buy a board of my own.

Skating is a great escape from day-to-day stress because you have to stay focused on what you're doing. But just being outside is great. Every morning, one of my flatmates and I get up before sunrise and walk or jog along the river to Imperial Park – by Imperial Wharf – to do some skipping and really get our endorphins pumping. There's a guy who runs past us all the time and says: "Well done, keep going," and we always say hello to the other people exercising in the park.

Seeing friendly faces is a lovely way to start the day. It also helps to be in such a nice environment. You can hear birds chirping and kids playing, and smell the Botanical Gardens nearby – there's a real sense of serenity. If I need to recentre myself, I'll go outdoors and walk or skate around and enjoy the fresh air.

I haven't mastered any tricks on the board yet, but I've tried and failed to do an 'ollie', where you jump in the air with the board. I did once manage a 'pop shove-it', which involves keeping your front foot still while your back foot spins the board – but I'm not confident I could do it again.

I didn't skate much last year because I lived on my own for six months and found it hard to stay motivated. There's no skate park nearby but the paths at Imperial Park are really smooth, which is great for practising. It can be challenging at certain times of the year because of the conditions, but I'm planning to get back to it and hopefully I can take my flatmates, too. I might even film myself trying some new tricks.

What makes this area special is that it captures the best parts of London. There are high-rise buildings nearby, which means you can see the beauty of the city, especially at night with all the twinkling lights. But it's close to nature as well and I love that contrast. I feel very privileged to be here. ♦



You can hear the birds and kids playing, and smell the gardens – there's a real sense of serenity

Get Connected

Be inspired by science as we share the wonder of what we do. Our programme of online events and activities is available on a range of platforms, so you can connect with us from anywhere in the world. www.imperial.ac.uk/whats-on

Sign up to receive updates about our monthly programme of events and online activities:

www.imperial.ac.uk/whats-on/events-signup

#ScienceBreaks

Our virtual event series, Science Breaks, showcases the impact of work taking place at Imperial. bit.ly/Science-Breaks



Professor Sanjeev Gupta

Finding life on Mars

Professors Sanjeev Gupta and Mark Sephton discuss the aims and approaches taken by the Mars Perseverance Rover. bit.ly/YT-FindinglifeonMars

Rocking rocks and shaky earthquakes

Dr Anna Rood explains how rocks can help us estimate the amount of ground shaking caused by large earthquakes. bit.ly/YT-RockingRocks

The bloody battle against leukaemia

Professor Cristina Lo Celso discusses the impact of stem cell research in the battle against leukaemia. bit.ly/YT-TheBloodyBattle

How the shark lost its bones (and maybe why)

Dr Martin Brazeau reveals how new fossil discoveries are providing unique insight into the ancestry of vertebrate animals. bit.ly/YT-SharkBones

Imperial College London

on YouTube

Our YouTube channel is packed full of content. Visit our page to watch one of our lectures, experience a day in the life of one of our students or to discover some of our ongoing research.

www.youtube.com/imperialcollegevideo

Schrödinger Lecture 2021: CRISPR

Dr Jennifer A. Doudna discusses the science and opportunity of genome editing in the 2021 Schrödinger Lecture from the Faculty of Natural Sciences. bit.ly/YT-CRISPR

AI for you and I

Professor Björn Schuller charts the history of human-centred AI focusing on aspects of artificial, emotional and health intelligence. bit.ly/YT-BjoernSchuller21

Not just damned lies: why you need to embrace statistics

Professor Alex Bottle explores the history of patient data and statistics to monitor healthcare performance and how patients use healthcare services in his Imperial Inaugural. bit.ly/YT-AlexBottle

Current and Future

Women Luminaries

Join a special series of conversations, hosted by Professor Alice P. Gast, with our inspirational luminaries, where they discuss their dreams, innovations and aspirations. bit.ly/Imperial-Luminaries

Catch up: From London to Jupiter

Part of the Current and Future Women Luminaries series, Professor Michele Dougherty and Efa Amankwa explore physics breakthroughs, innovations and discoveries as they discuss life experiences and the teachable moments that shape who we are and what we do.

bit.ly/YT-LondontoJupiter

Great Exhibition Road

Festival returns

Celebrate science and the arts through our family-friendly programme of free workshops and talks. Set to return in October 2021 with organisations on and around South Kensington's Exhibition Road.

www.greatexhibitionroadfestival.co.uk



Efa Amankwa, Professor Martin Brazeau, Professor Michele Dougherty

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