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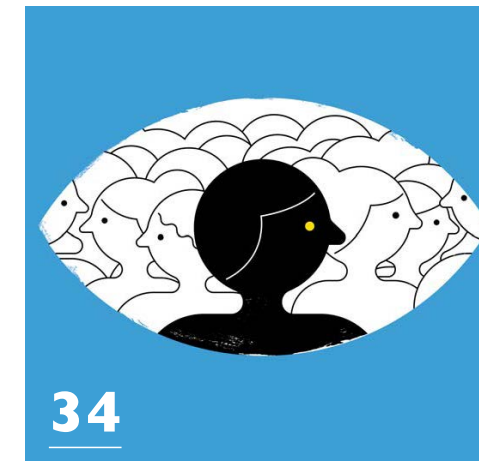
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DIGEST



SOCIETY

New Academic Strategy focuses on building resilience across society

As the COVID-19 crisis has shown, building resilience to react to rapid and sudden change is a crucial part of Imperial's contribution to society – which is why it's a core strand of the College's new Academic Strategy.

Alongside the development of a sustainable, healthy and smart society, the new strategy will help Imperial continue to push the frontiers of research, life-changing education and transformative innovation. It represents the College's mission

to discover new knowledge and use Imperial's deep understanding of the world to address some of its most pressing challenges – and identify new opportunities to improve it.

"The frontiers of knowledge are expanding," says Imperial's Provost, Professor Ian Walmsley. "We are sending missions to Mars, building artificial cells that mimic nature and gathering data at a new scale. New opportunities arise every day as technology advances.

Society goals: Imperial's new Academic Strategy aims to help build a sustainable, healthy, smart and resilient society.

ILLUSTRATION: ABOVE: TOMMY PARKER
ABOVE RIGHT: MIKE LEMANSKI

"Building on a great foundation of world-leading research and education, the new Academic Strategy spurs us to go even further to push the frontiers of discovery, transformative innovation and education."

The strategy will also identify and develop activity and projects that will help realise the College's potential to deliver transformation, such as Transition to Zero Pollution, a new research and education programme that was launched in September. ♦

Letters

WRITE TO US

Email: imperialmagazine@imperial.ac.uk
Due to COVID-19, we are working remotely and unable to receive correspondence by post.

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Please mark your message 'For publication'.
Messages may be edited for length.



Future innovation

The report on how Lewis Hornby came to create his Jelly Drops business because his grandmother was suffering from dehydration in a care home (*Imperial 48*), reminded me of when my mother was in a nursing home. She was a slow eater and would often not eat very much as the food had gone cold. So, if plates can be invented that stay warm for longer, then they will be providing a great service to hospitals, nursing homes and care homes globally.

Peter Riding (Physics 1964)

Don't forget nuclear

I'm surprised your feature on net zero carbon ignores the fact that nuclear energy must be THE most important part of the energy mix when it comes to decarbonisation. I'd recommend Imperial's Professor Gerry Thomas, whose work provides good insight into why people are so scared about nuclear.

Marie Zabell (MEng Earth Resources Engineering 2001)

Driving Jezebel

I loved My Imperial (*Imperial 48*). I read Physics at Imperial from 1956 to 1959, and was the driver of Jezebel during my second and third years.

Keith Diment (Physics 1959)

Remembering Felix

Reading David Cooper's letter (*Imperial 48*), I wonder if I am the last surviving member of the original *Felix* editorial team. I contributed some graphics for the binding margins of *Felix's* First Birthday edition. I believe I may have a copy, but ... where?!

John Evans (Electrical Engineering 1952)

Cosmic rays

As one of the proposers of the Cluster mission (Next stop: Jupiter, *Imperial 48*), space plasma physics continues to be my field of research. The facts about the aurora are even more interesting – the aurora is produced by electrons of much higher energy than those of the solar wind. They are scattered from the magnetosphere into the atmosphere where they produce ionisation, excitation and light. Those that create the brightest and most colourful types of aurora, the iconic curtains and rays, are accelerated during precipitation by a mechanism that appears to be similar to the plasma-wave surfing employed to accelerate electrons in tokamaks used for research into nuclear fusion. The power involved in an auroral display is at times comparable to that of the UK national grid.

Duncan Bryant (Physics 1955, PhD 1958)

> 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.

📘 facebook.com/alumni.imperialcollegelondon
🌐 www.linkedin.com/groups/87488

FROM THE PRESIDENT / PROFESSOR ALICE GAST

In challenging times we remain leaders in the battle – adapting, creating and advancing



It has been a challenging year for everyone around the world. Nobody has been spared from the disruption and sadness accompanying the global COVID-19 pandemic.

Yet amid this distress we see the absolute best coming from members of our Imperial community. We see their compassion as they work to help one another. We see their ability to adapt to new ways of teaching and learning. We see their resolve to keep moving forward during a period when time seems to have stopped.

In my annual Autumn message to the College, I drew on my experience of a ride on the Ultimate, said to be Europe's longest rollercoaster, as a metaphor for what we have all experienced this year.

The ride begins quite innocently: a lift hill followed by long smooth hills and some friendly bunny-hops. Then there is a second lift hill and a turn to the left toward the woods. Warning signs soon appear: "Hang On." Hang on, indeed!

Then it's chaos. Rapid turns jolt you left and right. You want to close your eyes to lessen the terror, but you need to see which direction you will be thrown in order to brace yourself.

This is what 2020 feels like to me. A benign beginning that turned into a nightmare ride, one that is lasting longer than any of us anticipated or wanted.

The moment when I realised that things would be much worse than imagined was at our Council meeting in February. One of the members remarked that as a leader in the battle against the

coronavirus pandemic, shouldn't we also be a leading university in emergency preparedness?

He was right. We began using our university's greatest resource, our experts, and their scientific evidence, to guide our planning and decision-making. We prepared for the worst, and our community pulled together to deal with the rapid changes and shutdown.

The pandemic brought us closer together. As we learned more about the virus, we also learned more about ourselves at the same time.

We learned that in adapting to the constraints of the pandemic world, we are creating new ways of moving forward. Our multi-mode teaching is one example.

It combines the best of remote learning with valuable time in-person, talking to peers and professors, experimenting in laboratories, practising in studios and gaining practical training. The pandemic accelerated these changes and provided more focus on how best to use our precious in-person time.

We know we are not doing enough to address racial inequality and injustice. Remotely and in person we are responding to this call. We can, and will, do more to improve the College to make it an equitable and welcoming place for all. You will see in these pages some of what we are doing to show that Black lives matter at Imperial.

We continue to be inspired every day by the ways our colleagues are mitigating the impacts of COVID-19 through advances in modelling, testing, treating and vaccinating.

The breakthroughs by Professor Molly Stevens and her colleagues in ultrasensitive medical diagnostics will

help us, not only in this pandemic, but with early-stage diagnosis of cancer, HIV and other diseases.

Other articles capture the inspiring work going on daily across the College. From the dramatic story of the asteroid that killed off the dinosaurs to uncovering the sketches hidden beneath a famous painting, the work of Imperial staff and students is enthralling.

Our students and alumni are reaching new heights, and I'm certain that you will find their

We must all hang on during the rollercoaster we never chose to ride – our community is part of the solution

work impressive. Our Science Fiction society, WE Innovate and our featured medics, staff, students and alumni remind us that Imperial people are creative, innovative, resilient and tenacious.

We must all hang on during the rollercoaster we never chose to ride. We do so with the comfort of knowing that our community is an integral part of the solution.

May you and your loved ones stay healthy and safe. I continue to look forward to a time when we can meet in person once again. ♦

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

OUTREACH

New maths school launched

Imperial has announced it is launching a new specialist school for sixth-form maths students in 2023, and will specifically target underrepresented groups such as female students, students from BAME groups and disadvantaged communities.

The new Imperial College London Mathematics School, developed in partnership with London's Woodhouse College, will become a beacon for high attainment in maths, part of a growing national network of maths schools aimed at increasing STEM graduates generally.



PHOTOGRAPHY: IMPERIAL COLLEGE LONDON/THOMAS ANGUS; ILLUSTRATION: MIKE LEMANSKI

CHRISTMAS LECTURE

Jackson on climate change

Imperial's Professor of Geology Chris Jackson will be one of three UK academics to deliver a Royal Institution Christmas Lecture this year. The series, which is to be on climate change, is called 'Planet Earth: A User's Guide'.

"It's important to look at the Earth's geological history to put our own influence on the climate into context," says Professor Jackson, who will be the first Black scientist to present a Royal Institution Christmas Lecture. "My lecture will focus on what studying rocks teaches us about climate change since the Earth first came to be."

The lectures will be filmed in December 2020 and broadcast on BBC Four between Christmas and New Year.



The Hitchhiker's Guide to the Galaxy says 42 is the answer. But what is the question? For Dr Marc Stettler it's how to alter the course of climate change.

Could a small tweak to flight paths significantly reduce global warming? Dr Marc Stettler, Senior Lecturer in the Department of Civil and Environmental Engineering, believes so. Along with his colleagues in Imperial's Transport and Environment Laboratory, he's working on what he calls "the fastest way for aviation to reduce its overall climate impact".

His focus is contrails, the white streaks that form in an aeroplane's wake when water vapour condenses on to soot particles and freezes as ice crystals. While the majority evaporate, some linger and form a barrier that traps heat that would otherwise escape the Earth's atmosphere.

Existing efforts to curb aircraft-related climate change focus on reducing or offsetting carbon dioxide emissions, but Stettler says these will take decades to implement, may work less well than expected and could be expensive. His research, based on in-depth analysis of flight data from Japanese airspace, weather and flight trajectories, breaks new ground in the finding that one small change could have huge impact.

"We found that two per cent of flights contribute 80 per cent of the warming effect related to contrails," he says. The research suggests that making a minor change to these flights' trajectories could be transformative, as it is possible to avoid the thin layers of the atmosphere where the (cold and humid) weather conditions are just right for contrails to persist.

The next step is getting the aviation industry on board. However, Stettler points out that if just one forward-thinking airline started considering contrails at the flight-planning stages, it would set a trend. "It's a small change that could have a really big effect and very quickly – within five years if there is an appetite to do it."

> Mitigating the Climate Forcing of Aircraft Contrails by Small-Scale Diversions and Technology Adoption by Roger Teoh, Ulrich Schumann, Arnab Majumdar, and Marc E. Stettler was published in February 2020 in Environmental Science and Technology. Dr Stettler leads the Transport and Environment Laboratory (@TransEnvLab_IC) at Imperial. Visit imperial.ac.uk/people/m.stettler for more.

IN BRIEF

Imperial dominates awards

Three out of four of this year's Mayor's Entrepreneur Programme awards, to find London's best student business ideas that will benefit the city, were given to Imperial student teams.
bit.ly/Imperial-49-entrepreneurs

New book launched

Professor Roger Kneebone has published his groundbreaking first book, *Expert: Understanding the Path to Mastery*, on the importance of expertise, the journey it involves and why a plasterer can have just as much of it as a fighter pilot.
bit.ly/Imperial-49-Kneebone

Special award

Professor Chris Toumazou has been awarded a President's Special Award for Pandemic Service by the Royal Academy of Engineering, for his work on a lab-free COVID-19 test that provides results in under 90 minutes.
bit.ly/Imperial-49-DnaNudge

OVERHEARD ON CAMPUS

'Campfires' on the sun: Ubiquitous miniature solar flares captured in unique images from the Solar Orbiter spacecraft.

ScaleSpace: A new 200,000ft² facility at White City that will be home to leading scale-ups and innovative businesses across the technology, digital and life-sciences sectors.

Andrew Gemant Award: Given by the American Institute of Physics to Leverhulme artist-in-residence, Geraldine Cox for her work "articulating deep physics concepts through visual arts and other media".

Imperial Lates Online: Free after-hours events exploring cutting-edge science and engineering in creative ways.

Unethical Optimisation Principle: A new mathematical principle that has been designed to combat artificial intelligence (AI) bias towards making unethical and costly commercial choices.

IMPERIAL INNOVATES

Fit and well

Arjun Panesar (*MEng Computing with Artificial Intelligence 2006*) is the founder and CEO of Diabetes Digital Media, using technology to transform healthcare.

Until recently, type 2 diabetes was considered to be a chronic, progressive disease that would eventually require medication. Thanks to my grandfather, though, I knew that didn't have to be the case.

In my first year at Imperial, he had an emergency quadruple heart bypass and was subsequently diagnosed with type 2 diabetes, which came as a huge shock. One day, he asked me what he should eat, and I had no idea. The lack of information online led me to start diabetes.co.uk, a digital community that now has 1.8 million active members.

My grandfather used the forum, and within four years had put his diabetes into remission by lowering his carbohydrate intake. Many other members had similar stories so, in 2012, I founded a company, Diabetes Digital Media, and we self-funded studies into the effectiveness of using a digital therapy to place type 2 diabetes into remission.

In 2015, we launched our first medical device, the Low Carb Program app. It guides people through reducing carbs in their diet and has been proven to place type 2 diabetes into remission – something no drug can do. In the general population, one in a thousand people is able to achieve type 2 diabetes remission through diet, but of the 440,000 people who've used our app, around 100,000 achieved remission within a year. We now have 13 NHS clinical commissioning groups using it, and our economic analysis shows that for every 3,000 people that go through the programme, we save the health service £956,000.

Imperial played a big part in our success. At first, I wasn't sure I could cut it, because you're sitting next to some of the greatest minds on the planet. But being in a high-pressure environment surrounded by exceptional students encourages you to be better, and fosters resilience and adaptability, which are essential in challenging times. When you tell people you learned your trade at Imperial, it's met with a lot of respect and I was particularly proud to win Imperial's Emerging Alumni Leaders Award in February.

Our next medical device is the Gro Health app, which goes beyond nutrition, adding sleep, activity and wellbeing. We've just launched in India, and we're also running studies in the UK and Europe. The plan is to become leaders in the field of personalised medicine, which is exciting. Things are going well for my grandfather, too. At 87, he's as fit as a fiddle – and I think he is proud of what he's inspired. ♦

> Find out more at ddm.health



One in a thousand people is able to achieve type 2 diabetes remission through diet, but of the 440,000 people who've used our app, around 100,000 achieved remission within a year

Arjun Panesar (left) with his grandfather (on screen).

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We have all been spending more time indoors with our heads in a book or absorbed in our favourite hobbies. The light we live under has far reaching effects. At this time of year as darkness takes over, it becomes even more obvious just how important light is to us. Poor quality light causes eyestrain and can affect our ability to read and concentrate.

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EDUCATION: PROFESSOR EMMA MCCOY (PHD MATHS 1994),
INTERIM VICE-PROVOST (EDUCATION AND STUDENT EXPERIENCE)

Multi-mode programme will take the Imperial experience to yet another level



What do bird song, tea bags and a virtual trip to the Pyrenees have in common? They have all featured in Imperial’s online teaching – in many cases surpassing what we could do in person – as part of our new multi-mode digital education programme.

A degree is about stretching students beyond what they already know, and at Imperial this is always our focus. We are proud of our reputation as a university that nurtures curious minds – and we see no reason why that should change as we move into a new era of teaching.

The multi-mode programme does not mean that everything will be online; while government directives and safety allow, we are still offering a significant portion of teaching on campus. What it does mean, however, is that we have been able to move a lot of our more didactic material online, freeing up our time on campus so it can be used more effectively. Our Learning and Teaching Strategy was already turning the idea of ‘the sage on the stage’ on its head, and multi-mode gives us the opportunity to focus more on ways to encourage problem-solving and thinking skills.

In our Dawn Chorus project, for example, students measured bird diversity from counts of unique songs they could hear from their locations around the world. In the Tea Bag Decomposition project, the students measured rates of microbial decomposition activity, based on the Tea Bag Index, by burying tea bags near their home. And 35 of our MSc Petroleum Geoscience students went

on a simulated overseas trip to the Pyrenees, where they used photo panoramas to observe more detail than they could have done in person.

We know that students come to Imperial in part for our incredible facilities and amazing labs, and this hasn’t changed. In light of COVID-19, to ensure staff and student safety at all times, we have reconfigured our labs and our timetables with staggered starts and cohort-based teaching. This new way of working is not only safer but means that the contact time we have will be more valuable.

We’ve also provided alternatives to some lab-based work in the form of Lab-in-a-Box, which means students can run the experiments themselves at home and discuss the work with other students remotely. The Department of Surgery and Cancer has developed a simulation for interventional radiology students, using the Microsoft HoloLens 2 headset, helping trainees perform medical procedures.

Everything is focused on the student journey. The learning outcomes of our programmes remain vitally important to us and it’s essential that students enjoy the same quality of learning. It’s why our Global Online MBA was recently ranked first in the UK and second in the world in the QS Online MBA rankings 2020. It’s why we have a focus on inclusivity – the new multi-mode approach affords us real potential to reach people we haven’t had the chance to reach before. And it’s why we listened to student feedback from our lockdown teaching to design our future learning.

For instance, our EdTech teams have designed technical solutions for

the multi-mode approach that allow us to deliver lectures, communicate through online discussion, set and mark assignments, and track student progress. We know already that this method gives us the opportunity to provide more instant feedback than we used to. And we have broad representation from across the College in our Education and Strategy

Students on a virtual trip to the Pyrenees used panoramas to observe more detail than they could have done in person

Operations Group, which comes together to work collaboratively, share best practice and discuss progress.

Already this is enabling departments to communicate with each other in new ways. In addition, the Guild is a newly established group made up of our EdTech leads across the College, our education leads, and representatives from ICT and our Digital Learning Hub who come together to share good practice.

We cannot pretend that this coming year is going to be what any of us expected it to be, but what we can do is be confident that we’re offering a safe – and intellectually rewarding – experience. ♦

> *Professor Emma McCoy is a member of the Royal Statistical Society council.*

Lend him your ears
 Dan Simpson, Imperial's Poet in Residence, is a seasoned performer with a passion for maths and science.



ADVENTURES IN ... POETRY / DAN SIMPSON

A man with a way with words

Imperial's Poet in Residence Dan Simpson brings the worlds of art and science together.

Words: **Megan Welford** / Photography: **Angela Moore**

Poet and spoken-word artist Dan Simpson isn't scared of looking silly. Indeed, he's equally at home wearing a sandwich board – which he did at an Imperial Lates event just before lockdown – as he is performing and writing.

"I've always loved maths and science," he says, "and I have a natural curiosity. I'm all about starting conversations about science with lots of different people in a way that is inclusive and allows for two-way dialogue."

As Imperial's Poet in Residence, Simpson has been collaborating with researchers and the public to experiment with words. A recent speed-writing challenge saw him write haiku over Twitter (@ImperialSpark) in response to whatever science topic academics, students and the public sent his way – from synthetic chemistry to static electricity. Here's one on scientific theories: "Sometimes physicists/ Make quantumly complex jokes/ They then must disprove."

An experienced and engaging performer – he's a Glastonbury veteran – Simpson hosted a recent live-streamed Poetry Slam featuring an impressive line-up of spoken word performers as part of Imperial Lates Online. But, for him, it's as much about getting everyone else to take part as it is about making his own work. In fact, his latest spoken word composition for Imperial – *Back to Nature* – was entirely crowdsourced and inspired by conversations with Dr Ans Vercammen at the Centre for Environmental Policy. The public were asked to respond to prompts from those conversations, and Dan crafted the contributions into a poetic meditation on our place in the natural world. He then went on to collaborate with Vercammen on an original poem. "I challenged her to jot down her feelings. Her interests are in mental health, scuba diving and blue space, and it flowed from there. It was a lovely collaboration.

"People are often nervous about poetry but in the original oral, campfire tradition it was just a way of telling people things. It was only when we started writing it down that it became thought of as a textual medium, rather than a spoken one – but there is a lot of overlap between the two." Once reassured, people are eager to get involved, he says. "I'll say, 'Don't focus on a poem; just think about three words to describe something'. They find it rewarding to see or hear their words. That's all a poem is; it's not mystical or magic."

Inspiration has come from Imperial researchers' liveliness and creativity. "Science itself is a creative act. You reinterpret, question and challenge. You expect that from both artists and scientists. We are all human, trying to understand the world and communicate it; there's an overlap."

Following residencies at Waterloo Station and the National Trust, alongside his ongoing work with primary schools, Simpson says coming to Imperial feels timely. "Science is dominating the headlines. For tragic reasons, we have become more engaged, but I hope our interest grows around a wide range of areas of science. We're interested in climate change, in our mental health, in how cities are organised. The more we can talk about research in lots of different ways, the more everyone can connect with research and researchers.

"So now is a great opportunity for public engagement with research, and what I particularly like is hearing about researchers' passion for something they've devoted their whole lives to. Enthusiasm makes me enthusiastic." ♦

Symbiotic smile clownfish and anemones art and science touch.

An original haiku from Dan Simpson reflecting his Imperial residency.

WE CAN DO MORE

... AND WE WILL. DISCRIMINATION AND INEQUALITY MUST BE CHALLENGED AT ALL LEVELS, AND IMPERIAL IS PLAYING ITS PART.

Words: Lucy Jolin / Photography: Sophia Spring

As the world watched the shocking footage of the killing of George Floyd – reigniting global attention on the Black Lives Matter movement – Imperial’s President, Professor Alice Gast, knew that the university had a duty to respond quickly, and thoroughly. “I felt a deep anger and despair at such a senseless death,” she says. “It brought to the surface my shock and disappointment that racism, and the violence that it breeds, continue in the United States. I am also saddened by persistent racial inequality and injustice here in Britain and around the world.

“Racism and violence have no place in society. Our spirit of common purpose must prevail, and we must pull together and collaborate as a community to support those who are afraid and mourning. We are a university committed to equality, diversity and inclusion. I am determined to not just talk about solidarity, but to listen to all members of our community, so that we are better placed to enact change. We all have the responsibility and opportunity to contribute our excellence toward addressing racial inequality and injustice. We can all do more – and we will.” ▶



Left: Kitan Oyeleke (Chemical Engineering, Third Year) is Vice-President of the African Caribbean Society and the driving force behind the Black People of Imperial project, inspired by the earlier 56 Black Men campaign, designed to address stereotypes.

“I wanted to create something that changed misconceptions”

Kitan Oyeleke



Left: Sean Bazanye-Lutu (Design Engineering, Fourth Year), is former President of the African Caribbean Society, and is committed to spreading the message that Imperial is inclusive, that students will find people they can relate to and that it is a positive option for students from diverse backgrounds.

“It’s important that our voices are being heard and we’re part of the solution”

Sean Bazanye-Lutu

Immediate steps taken by Imperial included: working with the College's BAME staff network, Imperial as One, to develop a concrete action plan to make a tangible difference in the College's community and wider society; rolling out new advice and support to equip staff and students to be better allies; driving forward a new outreach programme targeting Black students in London with the aim of doubling the number coming to Imperial by 2024-25; establishing a new scholarship fund to support Black students; ending the use of the historic Latin motto in any new materials, in order to better reflect the College's culture, values and commitment to diversity; and commissioning a working group to examine the College's history and legacy.

But the work had already started, says Professor Stephen Curry, Assistant Provost for Equality, Diversity and Inclusion, pointing out that #BlackLivesMatter has enabled it to reach a much wider audience – and, hopefully, encourage more people to take part. But there is a lot of work to do, he acknowledges, and no single solution or one-size-fits-all policy: tackling diversity means properly reaching into every aspect of Imperial's operation, from admissions and research to student and staff wellbeing.

He hopes that Imperial's 2018 Equality, Diversity and Inclusion Strategy will provide the information and inspiration to improve. "For example, the data shows that we admit as many British-Asian students to medicine at Imperial as we do white students," he says. "But our numbers of African and Black-Caribbean medical students are very low, so we need to seriously do something about that. We are committed to doubling the number of Black students we admit within the next five years."

Faculty-led, top-down programmes – such as Athena SWAN, a charter that recognises gender-equality work in higher education, and its equivalent, the Race Equality Charter – are, of course, just one part of the plan, and Curry is eager to bring in those at Imperial who have recognised the importance of this work. Dr Sarah Essilfie-Quaye, Project Manager in Research Strategy, Faculty of Medicine, is co-chair of Imperial As One and a member of the Race Equality Charter Self-Assessment Team. Essilfie-Quaye first started working at Imperial in 2002.

"I always knew making it to the top in academia was difficult for anyone," she says. "I watched as people around me progressed, and observed who was supported and retained – the majority were male and white. One day, I looked up the number of Black female professors at Imperial. It was zero. Since then I have found out that the number I was looking at wasn't even professors – it was academics. No lecturers, no readers. But it's not just Imperial that's at fault because, right now, there are only 35 Black female professors in the whole of the UK.

"There is a lot of work still to be done but there are positives coming out," she says. "We recently hosted the 4th BME Early Career Researcher conference, an entire day tailored to helping Black and minority-ethnic researchers stay in academia. Imperial is working on tackling some of the barriers underrepresented people can face, looking at our recruitment processes, and making scholarships available. People are starting to listen, and one of the biggest things you can do is listen when people tell you about their experiences of racism. When you dismiss them, or try to debate, you are not debating something in a bubble, you're debating people's existence and their lived experiences, and that takes up a lot of energy. A series of candid interviews called 'Belonging', started at the beginning of lockdown, is growing in popularity, with students, academics and professionals sharing their experiences and insights in finding their sense of belonging."

Last year, Kitan Oyeleke (Chemical Engineering, Third Year), Vice-President of the African Caribbean Society (ACS), was awarded ►



Left: De-Shaine Murray (PhD Neurotechnology, Third Year), co-founder of Imperial's Black Doctoral Network, established to discuss experiences, support and strengthen its members – and to provide an outward focus that can serve the wider community.

“We aim to provide an environment that allows us to thrive and be retained as young academics”

De-Shaine Murray



Left: Debbie Adegoke (Molecular Bioengineering, Second Year), is a member of the Race Equality Charter Self Assessment Team and behind the We Imperial initiative, a series of discussion events aiming to generate ideas to improve the multicultural environment at Imperial.

“We can all be allies if we take action. Your actions have a lot more weight than what you say you believe”

Debbie Adegoke

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Equality and Diversity seed funding for the ACS Outreach Programme. She has also had personal experience of Imperial's reputation as overwhelmingly white and male.

"When I was applying, my maths tutor asked me about my first-choice university. I told her it was Imperial, and she said: 'Yikes! There are no Black people, there are no women!' So, I expected to feel othered," she says. "But when I got here, I realised that it wasn't that bad! Although there is a diversity problem, the Black community is very close-knit. I wanted to create something that changed misconceptions about the Black community within Imperial. I felt that the ACS could be doing a lot more, and that we have a huge responsibility to the wider community regarding how Imperial is seen."

The resulting ACS Outreach Programme is designed to provide pastoral and welfare support, mentorship and advice to high-achieving Year 12s and 13s from minority-ethnic backgrounds. Applying for the funding was easy, says Oyeleke. "All we had to do was prepare a plan of what we hoped to achieve, and our KPIs." Initially, it will run at the London Academy of Excellence in Stratford, as members of the committee attended the school and have a relationship with it already. However, Oyeleke hopes to open it up to wider application in the future.

She's also responsible for the Black People of Imperial Instagram project. Based on the much-shared 56 Black Men social media initiative, which shares personal stories and images to highlight and challenge stereotypes, the project seeks to capture experiences of Black people at Imperial across the board, from students to support staff to academic staff. "We want to show all those people without whom Imperial would not run," says Oyeleke.

Debbie Adegoke (Molecular Bioengineering, Second Year) is BME Officer at the Student Union. Coming from a predominantly white area of the UK, in north west England, she thought Imperial would be far more multicultural and reflective of its London base. "I was shocked to see that it wasn't as diverse as I expected," she says. "I decided that I wanted to try to do something to make a difference."

The role doesn't have defined responsibilities, and Adegoke says part of the challenge is working out exactly what needs to be done, and the best way to do it. To that end, she spends a lot of time talking to different student communities and communicating their needs and expectations back to the Union council. She is also a member of the Race Equality Charter Self-Assessment Team, and has worked with outreach organisation the Blueprint Project on Bridging the Gap 2020, the UK's first graduate-led conference for Black and mixed-race A-level and International Baccalaureate students.

"Outreach is crucial if we're going to understand and address the barriers," adds Amr AlWishah, (MSc Sustainable Energy Futures 2020), who has worked with Adegoke on a steering group of students, staff and experts, established to address key issues. "We're making progress; once you get a more inclusive curriculum, featuring the wider world of science and becoming much more diverse and inclusive, students from minority backgrounds start to see themselves represented. By creating that culture, those students will appreciate they are welcome, and that will hopefully drive up motivation and help close the attainment gap. This is a great opportunity for us to make a difference."

Taking action to drive equality, diversity and inclusion forward is something everyone can do, says Adegoke. We can all be allies, regardless of race or gender, if we're prepared to self-reflect, dismantle our own biases and prejudices, and, most importantly, take action, she says. "Start with your own community, but don't stop there. Being an ally isn't just about believing in your heart that racism is wrong. Your actions have a lot more weight than what you say you believe." ♦

Amr AlWishah
(MSc Sustainable Energy Futures 2020). Now an energy consultant, Amr helped establish a steering group to identify barriers to application and what could be done to address them.

"Just because we are a science university, it doesn't mean we shouldn't be diverse"

Amr AlWishah



HAIR AND MAKE-UP: NADIRA V PERSAUD

EXTINCTION DAY

NEW RESEARCH IS REVEALING EXACTLY WHAT HAPPENED THE DAY THE DINOSAURS DIED.

Words: Helena Pozniak / Illustration: Stuart Patience



For life on Earth, the day began like any other. Twenty-four hours later, dinosaurs – along with three-quarters of all other species – would be set on a path to extinction, smashed out of existence by an asteroid the size of a city travelling at speeds of up to 72,000km an hour. And, for the Earth itself, it was the end of the beginning.

“It was an unlucky day,” says Dr Matthew Genge (Geology 1989) in the Department of Earth Science and Engineering, in a masterpiece of understatement. “The dinosaurs would barely have seen it coming, but the asteroid would have a catastrophic impact on the evolution of the planet.”

Given that these events occurred 66 million years ago, understanding the scale of the mayhem is a feat of the imagination – and a triumph of science. The escaped piece of space rock, from the solar system’s asteroid belt, smashed into what is now the Gulf of Mexico at the worst possible angle. And, as a result of Imperial research, we now know – in unprecedented detail – what happened next.

By raking over physical evidence extracted by drilling hundreds of metres into the ocean-covered crash site, and feeding on-the-ground measurements from the crater into a supercomputer, Imperial scientists within Earth Science and Engineering are painstakingly creating 3D simulations of the moment of impact and generation of a fast-moving dust cloud that circled the Earth in a few hours, initiating an impact winter that ended the reign of the dinosaurs.

After the initial flash, seismic waves would have travelled around the planet many times. Anything within about 1,000km would have been burned to a crisp, says Professor Gareth Collins (PhD Environment and Earth Science 2001) of the Department of Earth Science and Engineering, who has analysed numerical models of the impact run by colleague Dr Thomas Davison (MSci Earth Science ▶

WHEN THE ASTEROID HIT

1) The asteroid was the size of a city travelling at supersonic speeds of up to 72,000km an hour. Researchers estimate the asteroid hit with the equivalent power of 10 billion atomic bombs of the size used in World War II. It smashed into what is now the Gulf of Mexico at a 60-degree angle (the worst possible angle).

Most of the asteroid, and a similar volume of rock that it struck, vaporised on impact – reaching temperatures of 5,000°C. Surrounding rock melted to form a pool of superheated melt 70km across and 3km deep. Further out, rock temporarily behaved like a fluid for about 10 minutes during crater formation.

As water rushed back into the crater, explosive steam jets shot into the sky. A molten curtain of debris – known as ejecta – catapulted above the Earth’s atmosphere and travelled around the world in a dust cloud, blocking out sunlight.

2) In a matter of minutes, this rebound – briefly – formed a mountain on the scale of Mount Everest, but as the unstable mound collapsed back down, it created a flat, shallow crater, as well as the peak ring that stands about 500 metres above the crater floor. ▶

and Engineering 2006, PhD 2011). Dinosaurs living thousands of kilometres away from the impact would have broken bones after being smacked down by the hurricane-force winds.

Surrounding rock would have been liquified to form a pool of superheated melt 70km across and 3km deep. Further out, rock temporarily behaved like a fluid for about 10 minutes during crater formation. As water rushed back into the crater, explosive steam jets would have shot into the sky. A molten curtain of debris – known as ejecta – would have catapulted above the Earth’s atmosphere and travelled around the world in a dust cloud, blocking out sunlight.

It would have felt like the end of the world. And while it wasn’t quite the end, the mystery of what happened on that day has fascinated scientists for decades. The asteroid theory was first suggested as the cause of the end of the dinosaurs back in 1980, but it wasn’t until 1991 that a 200km-wide crater was discovered beneath Mexico’s Yucatán peninsula and the Gulf of Mexico – it was named the Chicxulub crater, after a nearby town.

Four years ago, an international team, co-led by Imperial’s Professor Joanna Morgan in the Department of Earth Science and Engineering, began drilling deep into the crater site to extract samples of rock buried for millions of years – the first direct evidence to reveal accurate glimpses of the catastrophe. Led by the results of a meticulous ocean-based seismic survey, a rig drilled through 20 metres of water and 600 metres of sediment before reaching the crater, eventually venturing nearly a mile deep. It wasn’t the first drilling expedition, but this time scientists were more precise in choosing a site – in what is known as the peak ring – an inner ring of granite-like rock 500 metres

high and 45km from the crater centre that formed shortly after impact during crater formation.

Out in a boat in the Gulf of Mexico, where they had been for three months, Morgan and her team watched as more than 300 cylindrical cores just 6.5cm wide and three metres long were hauled on board for examination in six makeshift labs. “We’d pore over these pristine cores, which were encased in plastic to keep samples sterile,” says Morgan. Geochemists and physicists were looking at physical properties, geologists at composition and mineralogy, and microbiologists for ancient signs of life.

Scientists at that time were considering two different theories as to how the inner ring was formed, but, to Morgan’s delight, what they found proved beyond doubt what had happened. The granite-like rock they extracted was from the mid-crust, 10km deep, which was highly fractured and shocked by the impact. It proved what’s known as the ‘dynamic collapse theory’, suggesting a deep rebound and outwards collapse. “It’s a very dramatic model,” says Morgan. “Rocks moved tens of kilometres in the first ten minutes.”

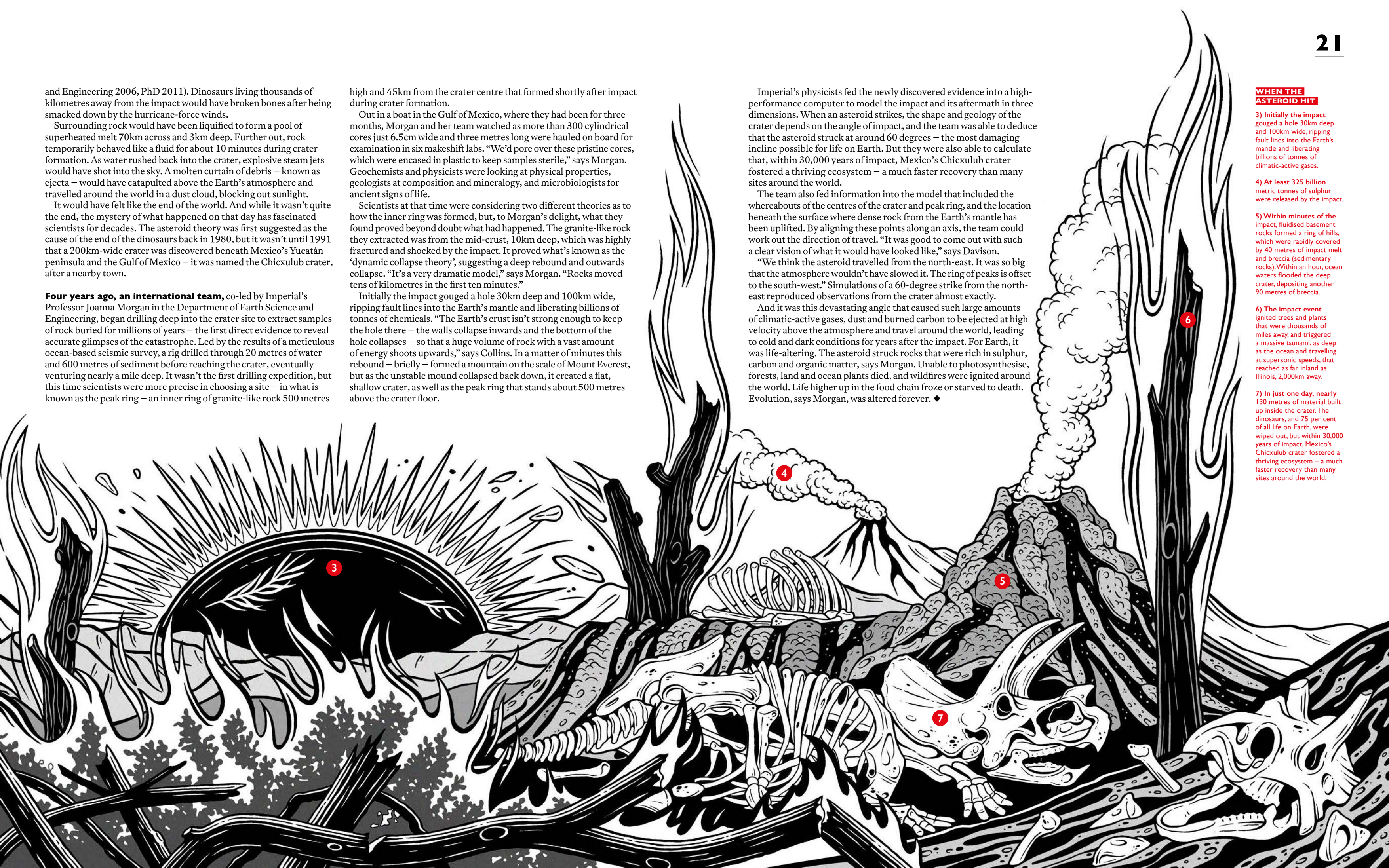
Initially the impact gouged a hole 30km deep and 100km wide, ripping fault lines into the Earth’s mantle and liberating billions of tonnes of chemicals. “The Earth’s crust isn’t strong enough to keep the hole there – the walls collapse inwards and the bottom of the hole collapses – so that a huge volume of rock with a vast amount of energy shoots upwards,” says Collins. In a matter of minutes this rebound – briefly – formed a mountain on the scale of Mount Everest, but as the unstable mound collapsed back down, it created a flat, shallow crater, as well as the peak ring that stands about 500 metres above the crater floor.

Imperial’s physicists fed the newly discovered evidence into a high-performance computer to model the impact and its aftermath in three dimensions. When an asteroid strikes, the shape and geology of the crater depends on the angle of impact, and the team was able to deduce that the asteroid struck at around 60 degrees – the most damaging incline possible for life on Earth. But they were also able to calculate that, within 30,000 years of impact, Mexico’s Chicxulub crater fostered a thriving ecosystem – a much faster recovery than many sites around the world.

The team also fed information into the model that included the whereabouts of the centres of the crater and peak ring, and the location beneath the surface where dense rock from the Earth’s mantle has been uplifted. By aligning these points along an axis, the team could work out the direction of travel. “It was good to come out with such a clear vision of what it would have looked like,” says Davison.

“We think the asteroid travelled from the north-east. It was so big that the atmosphere wouldn’t have slowed it. The ring of peaks is offset to the south-west.” Simulations of a 60-degree strike from the north-east reproduced observations from the crater almost exactly.

And it was this devastating angle that caused such large amounts of climatic-active gases, dust and burned carbon to be ejected at high velocity above the atmosphere and travel around the world, leading to cold and dark conditions for years after the impact. For Earth, it was life-altering. The asteroid struck rocks that were rich in sulphur, carbon and organic matter, says Morgan. Unable to photosynthesise, forests, land and ocean plants died, and wildfires were ignited around the world. Life higher up in the food chain froze or starved to death. Evolution, says Morgan, was altered forever. ♦



WHEN THE ASTEROID HIT

3) Initially the impact gouged a hole 30km deep and 100km wide, ripping fault lines into the Earth’s mantle and liberating billions of tonnes of climatic-active gases.

4) At least 325 billion metric tonnes of sulphur were released by the impact.

5) Within minutes of the impact, fluidised basement rocks formed a ring of hills, which were rapidly covered by 40 metres of impact melt and breccia (sedimentary rocks). Within an hour, ocean waters flooded the deep crater, depositing another 90 metres of breccia.

6) The impact event ignited trees and plants that were thousands of miles away, and triggered a massive tsunami, as deep as the ocean and travelling at supersonic speeds, that reached as far inland as Illinois, 2,000km away.

7) In just one day, nearly 130 metres of material built up inside the crater. The dinosaurs, and 75 per cent of all life on Earth, were wiped out, but within 30,000 years of impact, Mexico’s Chicxulub crater fostered a thriving ecosystem – a much faster recovery than many sites around the world.

FOUNDATION

The elevator was of the new sort that ran by gravitic repulsion. Gaal entered and others flowed in behind him. The operator closed a contact. For a moment, Gaal felt suspended in space as gravity switched to zero, and then he had weight again in small measure as the elevator accelerated upward. Deceleration followed and his feet left the floor. He squawked against his will.

The operator called out, "Tuck your feet under the railing. Can't you read the sign?"

The others had done so. They were smiling at him as he madly and vainly tried to clamber back down the wall. Their shoes pressed upward against the chromium of the railings that stretched across the floor in parallels set two feet apart. He had noticed the sign and had ignored them.

The operator pulled him down. He came to a halt.

He looked up in a white brilliance that hurt his eyes. The light, which had now been the recipient of, was immediately behind him.

The operator said, "It certainly seems so." He started for the door.

He said, "I've never seen anything like this before."

The man waved his hand. "It's a bit of a bit."

He could not see the cities of man-made structures stretching out to the horizon against sky, the surface of the planet, the land- surface of the planet, the pleasure-craft lazied against the sky.

There was no life other than man. Somewhere on the planet was the Emperor's palace, set amid one hundred square miles of trees, rainbowed with flowers. It was a small island in the sea, but it wasn't visible from where he stood. It might be a mile away. He did not know.

Before he could finish his tour!

He signalled finally that he was on Trantor at last; on the planet which was the galaxy and the kernel of the human race. He saw none of its weakness.

He was not aware of a jugular vein delicately connecting the forty billion of Trantor with the rest of the Galaxy. He was conscious only of the mightiest deed of man; the complete and almost contemptuously final conquest of a world.

He came away a little blank-eyed. His friend of the elevator was indicating a seat next to himself and Gaal took it.

FLIGHTS OF FANTASY

IMPERIAL'S SCIENCE FICTION LIBRARY IS A UNIQUE WINDOW ON OUR WORLD – PAST, PRESENT AND FUTURE.

Words: Victoria James / Illustration: Matt Murphy

As any science-fiction aficionado knows, things that appear modest – say, the TARDIS, or the monolith at the finale of *2001: A Space Odyssey* – may reveal unexpected dimensions. Such is the case of Imperial's Science Fiction Library which, over the course of five decades, has expanded from a handful of books in a padlocked cupboard to 10,000 volumes, plus 2,000 DVDs and 600 comics, containing an infinity of universes.

"When I was a student, the library was a few shelves of books on the ground floor of the Physics building in Prince Consort Road," recalls Diana Ayres (Mathematics 1971), who loved to "drop in to browse or borrow a book". By the time Simon Bradshaw, Tom Yates and Dave Clements arrived at Imperial in the mid-1980s, the collection "lived in some grey metal cabinets up on the top floor of the Union building", says Bradshaw (MEng Electrical Engineering 1990). But ambitious plans were afoot. A bequest from the then-warden of Beit Hall, Professor John Finlay, added some rare editions of early British sci-fi, including an 1895 edition of HG Wells's *The War of the Worlds*, and doubled the number of books.

And with the grant of a basement in Beit Hall to house the enlarged collection, the library achieved its current form – "a space down treacherous-when-rainy stairs in a dark corner of Beit Quad, with a sign on the door saying 'Beware of the Leopard'", recalls Yates (Physics 1988). "We now had a library!" says Bradshaw. "More importantly, we now had what was effectively a clubroom." The library became the heart of the Imperial College Science Fiction, Fantasy and Gothic Horror Society (ICSF), which went from a meeting held once or twice a week to a place where people would hang out in their spare time. "It helped that it was just across the quad from the bar," adds Bradshaw.

"At the time, ICSF was the biggest club at Imperial because we were the only club showing films, so we had a lot of money to spend," recalls former chair Clements (Physics 1986), now a Reader in Astrophysics and the published author of science-fiction short stories. The team went to the celebrated speciality store Forbidden Planet with a copy of the library catalogue. "Tom was counting the money, I started dashing around getting books I thought it would be good to have, while the rest started at A and bought everything on the shelves the library didn't have. They got to 'M' before we had to stop!"

Today, incoming Librarian Jean Lo (Mathematics, Third Year) describes the library as “a secret underground hideout made of bookshelves and couches. A room full of people who would look at a sci-fi gadget and have silly conversations along the lines of ‘So that’s Not How Science Works, but for the sake of argument what would happen if someone did build exactly that?’ It sounds trivial, but it feels uplifting.”

Of course, ICSF is much more than simply its superhero-bunker-with-bookshelves campus space. There’s the annual trip to the bookshop capital of Britain, Hay-on-Wye, where “we rent out a barn in the beautiful Welsh countryside and just hang out and go book shopping, hiking, tea-and-cake eating, and so on”, according to former ICSF Secretary Sequoia Trevorrow (MSci Geophysics 2020) – sadly, impossible this year due to COVID-19. And the society reaches beyond its core membership with its publications – a fanzine and newsletter – as well as the annual Picocon conference.

Picocon is a day-long convention that invites leading science fiction and fantasy (SFF) authors to mingle with almost 200 attendees, often spotting big-name talent before their career breakout.

Clements organised the third convention (not Picocon 3, but Picocon Pi) and celebrates how “we got, and still get, some really great authors along to Picocons. Highlights include a very young Neil Gaiman alongside a similarly young Charlie Stross.” Legendary author, the late Sir Terry Pratchett, was a repeat guest of honour, with Yates fondly remembering “being strangled by Terry Pratchett at Picocon 6. In a nice way, of course. Terry did everything in a nice way.” The con’s cosy atmosphere is summed up by its organiser’s designation as ‘Picocon Sofa’ – “More comfortable than a chair” states the official ICSF explanation, while the society’s committee is headed not by a chairperson, but a ‘Chair Entity’.

Most years see the publication of a fanzine with contents ranging from short stories and reviews, to poetry, artwork and essays. And in the pre-digital tradition of the very first pop-culture fanzines, it is still produced in handmade batches. Lo, who has been editor of the fanzine twice, says: “With all the new places and different ways people can put their writing and artwork out there, we’re so grateful to everyone who still writes to us, to see their work in little pamphlets compiled and typeset, often by a single

I don’t think it’s any coincidence that many of the world’s leading STEM universities have long-running science-fiction societies

person, printed and bound on campus. There’s something hard to articulate about this 40ish-year-old publication that feels really special to me.”

The importance of ICSF as both a community and social space is evident, as is the affection in which it is held by former and current members – many of whom remain involved, thanks to Picocon. But what is the contribution of a science-fiction library to a science-specialised university?

“I don’t think it’s any coincidence that many of the world’s leading STEM universities have long-running and active science-fiction societies,” says Bradshaw. “People tend to assume that science fiction is about the future. But a lot of good SF is really about the present, and the scientific and cultural changes that affect us all.” Clements rates Imperial’s collection as second only to that of MIT.

Lo sounds a note of caution. “I try to be careful about overstating the correlation between where sci-fi goes and where real-life science is headed,” he says. “Certainly, there are examples of uncanny prescience, like automatic doors and Tasers and all the things Jules Verne wrote about. On the other hand, in 2018 I read *Year 2018!*, a novel by James Blish, and learned that we are very behind schedule on the conspiracy to build a large bridge on Jupiter made of Ice-IV.” But many of ICSF’s champions see the reading of science fiction and the researching of science as complementary activities.

“SFF taught me that it’s not merely OK to enjoy thinking about science and technology, it’s vital that I continue to do so to keep my mind fresh and engaged,” says Yates, who runs a firm of consultants specialising in free software solutions for companies. “Playing with novel technical ideas for the sheer fun of seeing what can be done with them still drives much of my day-to-day work.”

“I’m sure my own interest and involvement in astrobiology research has more to do with SF than it does with the rest of my research, which is concerned with galaxy evolution and cosmology,” says Clements, ►

TREASURES OF IMPERIAL'S SCI-FI LIBRARY

Foundation series

Isaac Asimov

One of the most scientifically significant books in the library, as many of the theories contained in Asimov’s 1950s trilogy have proved influential in real-world social science, including the main character’s uncertainty or incompleteness principle: if a population gains knowledge of its predicted behaviour, its self-aware collective actions become unpredictable.

Dune

Frank Herbert

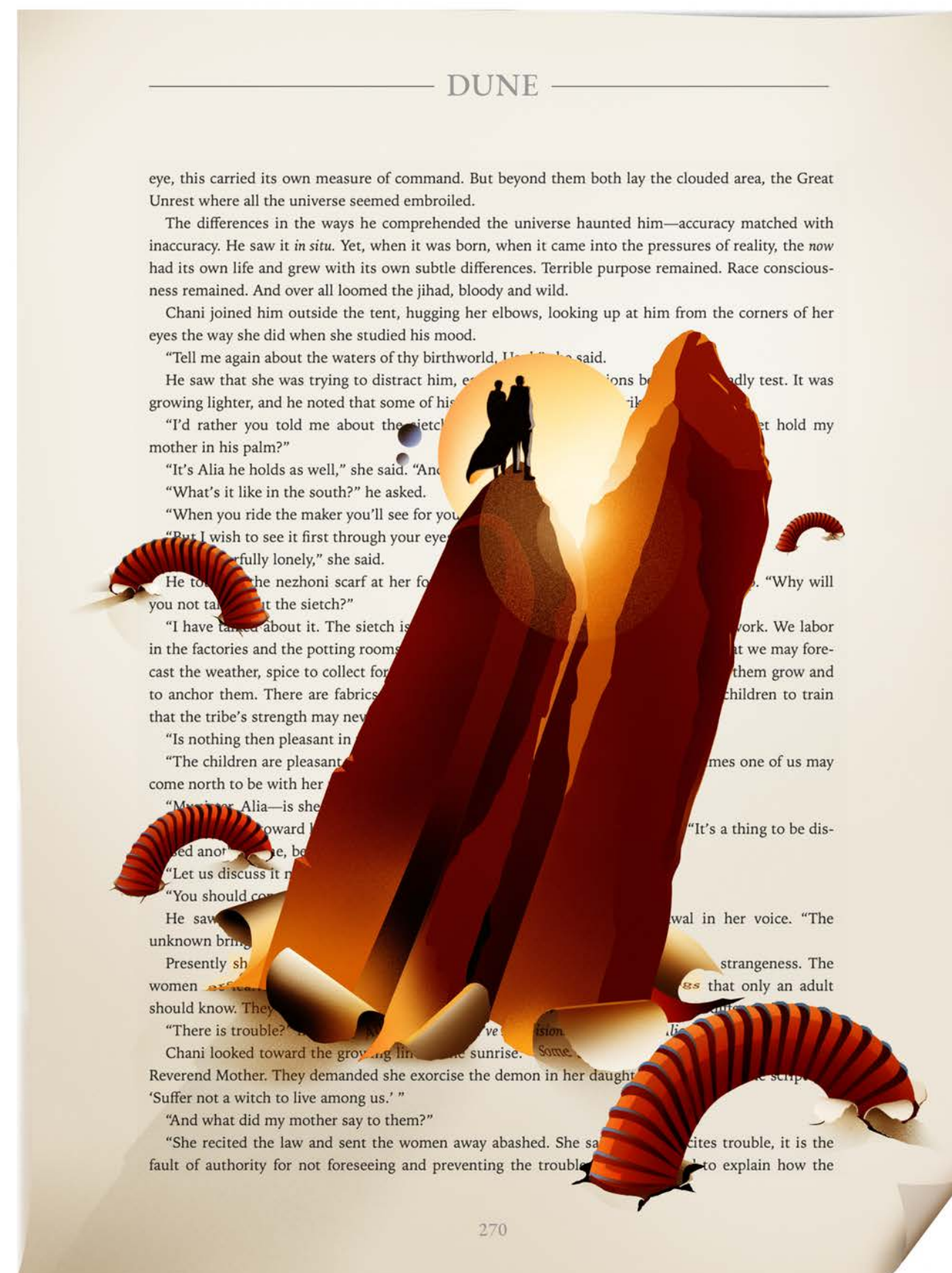
The most borrowed book in the library, the 1965 classic is regularly cited as being the greatest science fiction novel ever, having sold around 20 million copies worldwide. The ‘Duniverse’ has expanded to include prequels, sequels, films, TV mini-series and video games, and it’s argued that without it, *Star Wars* would never have been made.

The War of the Worlds

HG Wells

Some of the oldest books in the library are by HG Wells. *The War of the Worlds*, perhaps his best-known title, would go on to be serialised in *Pearson’s Magazine* in the UK in 1897, and is reportedly based on a discussion between the author and his brother Frank about the catastrophic effect of the British on indigenous Tasmanians. The book was most memorably dramatised in a 1938 radio programme directed by and starring Orson Welles, that allegedly caused public panic among listeners who did not know the Martian invasion was fiction.

Dune
by Frank Herbert



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Dr Hadi Alagha says he can't begin to describe how the generosity of Imperial alumni has impacted his life. Today, Hadi is an aspiring orthopaedic surgeon who specialises in the use of big data and AI to optimise patient safety.

In 2012, Hadi, then an undergraduate, was forced to leave behind his home, friends and family in Syria to continue his medical studies in Europe. "I fled a war zone," he says. "Without the generosity of the Imperial community, achieving my ambitions would have been very challenging. This opportunity gave me the peace of mind and freedom to focus on excelling in my development, and allowed me to undertake the research which I hope, one day, will influence the surgical management of orthopaedics and trauma patients worldwide."

Hadi received the President's Scholarship which ensures extraordinary students are free to excel. No one knows the value of an Imperial education – and of Imperial research – better than our alumni community, and it is your support that helps to ensure that financial barriers do not stand in the way of a talented student and their dreams.

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.

“Without the generosity of the Imperial community, achieving my ambitions would have been very challenging.”

Dr Hadi Alagha

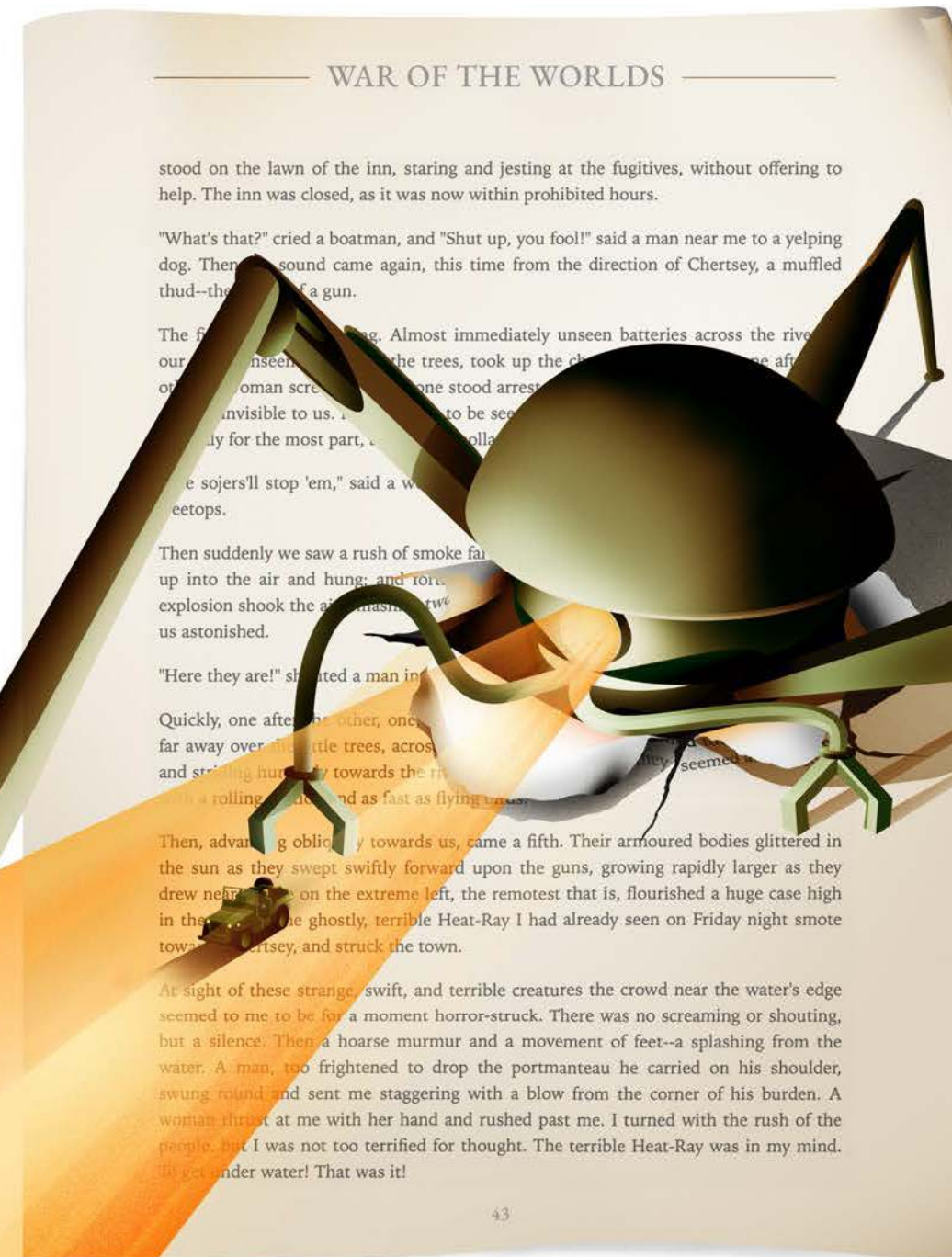
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www.imperial.ac.uk/giving/autumn-magazine-20

A lot of good science fiction is not just about the future, it's about the present as well

The War of the Worlds by HG Wells



one of the authors of the recent paper on possible evidence for life in the clouds of Venus. In addition to inspiration, he sees the library as offering interaction – between Imperial's students, the faculty and the wider community. "The library is a great place for students from different departments to meet and share ideas," he says. Trevor agrees. "It allows students and lecturers not only to have something in common and debate over, but also to explore other scientific areas that

they may not have otherwise thought about," she says. "And it helps both to connect with people who don't necessarily have a science background. Academics and researchers often struggle with putting concepts into words, while science fiction offers ways to do that." ICSF offers all that, plus – as Yates gleefully recalls – the opportunity to "get inside a genuine, working BBC Dalek". It's no wonder the Beit Quad basement and the myriad of worlds it contains are as popular as ever. ♦



DIAGNOSIS AT ANOTHER (MICRO) LEVEL

USING NANOMATERIALS AND BIOSENSORS, IMPERIAL
IS TRANSFORMING THE WAY DIAGNOSES ARE MADE. ►

Words: Megan Welford / Photography: David Vintiner



Early, and accurate, diagnosis is key to better patient outcomes. We know this to be true for treatment and, as the global pandemic has highlighted, for controlling the spread of infectious diseases. But it is incredibly difficult to achieve. Blood tests lack the required sensitivity, rare diseases may not be immediately recognised, and access to healthcare is not universal.

At Imperial, Molly Stevens, Professor of Biomedical Materials and Regenerative Medicine and recently elected Fellow of the Royal Society, and her team are making groundbreaking advances in the field of diagnosis. Using their unique position at the interface of chemistry, engineering and medicine, they are working to develop new biomaterials. In the process, they hope to democratise access to healthcare across the globe. “We want to highlight the opportunity not only to make sensitive diagnostics but to combine them with mobile technologies,” Stevens says. “To have this connected approach that can feed into online healthcare pathways, and hopefully transform the way that we can treat people within their community – both in early detection, but also in treatment and disease surveillance.”

It all starts with diagnosis.

Point-of-care, equipment-free tests – to detect disease at a molecular level – are already in use, but, as Stevens points out, they are simply not sensitive enough. So, she and her team want to go further. Not only are they developing ultra-sensitive nanomaterials for biosensing, but they are also manipulating what those materials can do. In the case of HIV, “we wanted to develop a test that could detect the virus itself, in particular some proteins on the surface of the virus called p24. That meant we needed new types of technology to give us really sensitive results.

“We work with nanoparticles: if you shrink the Sun down to the size of a football, then shrink it down by the same amount again, that’s the size we’re talking about. These particles

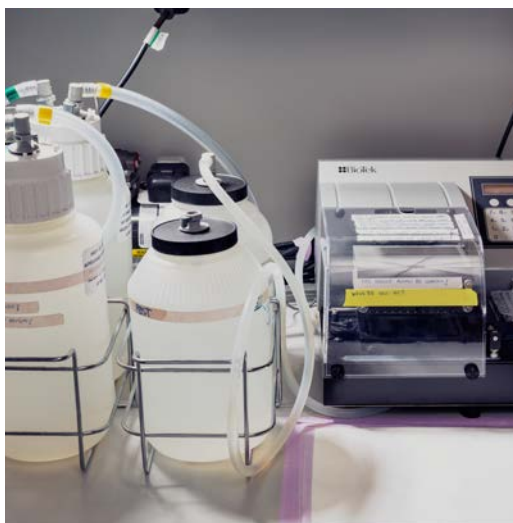
can be made of different materials, but we are interested in creating materials that generate colour changes. Then you can take those particles and decorate the surface of them with molecules that bind to the virus, and you’ll be able to know if the virus is present.”

The tests look like a standard pregnancy test and work in a similar way, using biological material such as blood or urine to produce a colour change in the presence of disease-indicating markers. Stevens’ lab also works with state-of-the-art microscopy, some of which, such as SPARTA, her team developed. “You know you have a high-quality product if you can visualise it,” she explains, “so we use electron microscopy and chemical imagery. It’s not just about making something, it’s about making the right thing.”

Elsewhere, in pre-clinical work involving animals, Stevens is using that same principle – manipulating molecular behaviour – but inside the body for non-communicable diseases. “We are developing powerful biosensing particles that tell us about diseases inside the body,” she says, “such as cancer but also malaria, for example. It works by detecting enzymes – we know about enzymes for digesting, but they also have lots of different functions. If you have cancer, you have a different level of certain enzymes from the normal baseline level in a healthy person.

“Along with MIT in the United States, we have developed tiny gold particles that are held together in clusters, but when they come into contact with these cancer-indicating enzymes they break apart. Those particles then disperse and become small enough to be filtered through the kidney and passed out in your urine. Once in the urine, we can add simple chemicals and the urine will turn blue. We don’t need complicated equipment to read it; it can be seen by the eye, and the urine will turn blue less than an hour after you’ve done the test.”

It is a marker of Stevens’ work that this test is not only scientifically sophisticated, but is also easy to use, even in a remote healthcare setting. “You can elegantly design materials that will be written about in scientific journals,” she reflects, “but what will you do with them? How will you make them useful to society? That’s always in my mind.” ▶



Previous page from left: Molly Stevens, Professor of Biomedical Materials and Regenerative Medicine and the Research Director for Biomedical Material Sciences in the Department of Materials, Department of Bioengineering and the Institute of Biomedical Engineering; Sample tubes for NMR spectroscopy.

This page, from left: Microplate washer for immunosorbent assay experiments; Mechanical pipette media dispensers.



The team (left to right): Brian Chen, Research Postgraduate; André Shamsabadi, Postdoctoral Research Associate; Leah Frenette, Postdoctoral Research Associate.



As she told the World Economic Forum at Davos: “Infectious diseases disproportionately affect low-income countries. HIV, AIDS, malaria and Ebola all have a devastating effect on these countries. We need to come up with diagnostics that can be cheaper, simpler, more effective and globally accessible, which can help with democratising access to healthcare.”

The Stevens Group’s point-of-care tests, such as the one for HIV, are designed to cost less than a dollar, and work in conjunction with mobile phones. “We are used to using mobile phones for web searches and social media,” she says, “but they can have really important applications when we use them connected to lab tests and as diagnostic tools; when we think of them as portable mini-computers.”

Stevens cites the eight billion mobile phone subscriptions worldwide – a number that is growing by the minute, even in places like sub-Saharan Africa. In Uganda, for example, she says, 20 per cent of people live more than 5km from a healthcare centre, but many of them still have access to a phone signal, despite persisting inequalities of access to phones, such as in age and gender.

“We’re interested in the camera capabilities of the phone,” she says, “so you can read the test result with a mobile phone and transfer the data through wireless connectivity. We have developed ‘i-Sense’ machine-learning algorithms that integrate within an app to analyse test results, so that we know it is robust.

We can then work with healthcare professionals to place that patient into a healthcare pathway. In South Africa, for example, it can take a year after a test to get into a treatment programme. So, we’ve been working with our partners at the Africa Health Research Institute, and they’ve trained community field workers to carry out tests and get the patients into care – it’s a nice continuation in treatment.”

Being able to build a very large dataset of people is also incredibly important for monitoring the way a disease spreads. “In Uganda, we are looking at serological surveillance, at people who have had Ebola and survived,

and detecting between three different species of the Ebola virus. This is important in understanding how the disease is spreading. We have developed a multi-marker test and an app that can generate geotag maps of spread. There are challenges around data and privacy, but we are engaged with ethicists and others in the community to get this right. It means we can then understand how to control the disease.”

During the COVID-19 lockdown,

Stevens assembled a crack team of volunteers from all over the world to work on a portable, point-of-care test called QwikZyme. It is designed to detect coronavirus very early, even in asymptomatic people, and to allow ongoing immune-response monitoring. “This work is in its very early stages,” she says, “but we have had an incredible response. We had a core team of 25 based at Imperial and we collaborate with different groups all over the world.”

COVID-19 may have brought home the importance of infectious-disease control to countries that are not used to having to worry about it too much, but Stevens’ approach is always global. “There are many diseases that are not as prevalent in the developed world and it’s important to achieve control of these,” she says. “It’s also important to prevent their spread, as has come to the attention of the developed world during COVID-19. Enabling all sectors of society to have access to early disease diagnosis, from cancer to cardiovascular disease to infectious diseases, is of massive societal importance.”

This is a motivation she has transmitted to her passionate and committed team at Imperial. “I did a PhD in fundamental biophysics, about how molecules interact with each other, and I loved it,” she says. “But, actually, being able to take the joy of science, and the interest of it, and make technology that really helps people, is something else. I travelled a lot in countries in the developing world before and after my PhD, and I saw a lot of inequality. I think technology is amazing, and, if you design it right, it can make a real difference.” ♦

Left: Marta Broto Aviles, Postdoctoral Research Associate.

Right: A machine showing a non-amplified LFI dipstick assay with serial dilution of protein.



FF

From the 2019 terrorist stabbings in London to the WannaCry ransomware virus of 2017 (with damage across 150 countries estimated in the billions of dollars), defence and security has never faced so many worrying and novel challenges. After all, it doesn't take much to cause huge disruption in such an interconnected world – and not always in the ways we might expect. Hollywood might think that terrorists like to hack into things to blow them up, but in real life, it can be rather more complex, as Alex Tarter (MEng Electrical and Electronic Engineering 2003) knows only too well.

As CTO-Cyber and Chief Cyber Consultant at Thales UK, Tarter also serves as a civil expert on cyber security for NATO's Civil Emergency Planning Committee. "It's phenomenally difficult to cause anything to go bang," he says. "But it is surprisingly simple to cause things to trip. Take a power station, for example. It would take a huge amount of skill and effort to cause physical damage to a power station, but there are plenty of ways that will cause it to trip and shut down safely. Likewise, it's very difficult to interfere with the road network in such a way that you can actually direct traffic and cause things to crash into each other, but it's easier than you might imagine to interfere and cause the system to glitch. And, often, that's enough."

Added to which, the threats the UK faces at home and abroad have intensified in scale, diversity and complexity, says Anita Friend,

Head of the Ministry of Defence's Defence and Security Accelerator (DASA). They include: the resurgence of state-based threats and increasing competition; the undermining and destabilising of the international rules-based order; the rise in cyber-attacks; and the wider impact of technological developments. "To counter these threats, we have to retain our strategic and technological advantage," says Friend. "The only way we can achieve that is to be innovative – it's absolutely crucial for our national security."

DASA aims to improve the UK's existing defence and security capabilities and find innovative solutions to key challenges, while generating economic value. It takes the lessons of successful startups and applies them to security and defence thinking, providing innovators with access to funding, technical expertise, end users, and opportunities for collaboration to improve routes to commercialisation. So, it makes sense for it to be based on the fourth floor of the I-HUB in White City, a facility that co-locates businesses, startups and entrepreneurs alongside Imperial's extensive network of researchers, academics and other corporate partners.

The partnership between DASA and Imperial is led by Imperial's Institute for Security Science and Technology (ISST), the interdisciplinary research hub that envisages, designs and coordinates the application of science and technology to answer pressing security challenges. "It's known as the triple-helix approach," says Professor Deeph Chana, Co-Director of the ISST and Professor of Practice at Imperial College Business School. "In more normal times, it will again allow for collaboration and cross-pollination and watercooler moments, which you don't always associate with the defence and security industry."

"We're working with people and places who wouldn't necessarily think of themselves as working in defence and security. We have close, regular engagement with companies such as Airbus, Rolls-Royce, Saab, Smiths Detection, BAE Systems, Wavestone and Northrop ▶

Safe and sound

Data. Infrastructure. Borders. Imperial specialists are leading the effort to keep the nation secure.

Words: Lucy Jolin / Illustration: The Project Twins



Grumman, and we previously hosted a NATO group of 30 people from 16 different countries. They chose to come to White City having seen the ecosystem that we're building over there." Innovation flourishes through collaboration and a wide range of voices and perspectives, agrees Friend. "It's important that we challenge the status quo and that we have a mature and broad level of thinking throughout our organisation. This melting pot of skills and experience is essential to enable innovation."

And that's vital because unpredictable threats to vast, complex systems often require fresh, counterintuitive solutions, says Tarter. "It's next to impossible to remove all vulnerabilities in systems, as they involve hundreds of millions of lines of code," he points out. "If we can't design out all the vulnerabilities, if the threat changes too quickly for us to adequately deploy resources against it, then the only thing left is how to minimise the impact."

Netflix, for example, might seem like an unlikely pioneer of such solutions. But its engineers use what's known as 'chaos engineering' to protect their systems. "Netflix realised that, at some point, one of their engineers was inevitably going to misconfigure something and cause a system to crash," says Tarter. "So, they send out a programme that randomly picks a server and intentionally turns it off – they call them 'chaos monkeys'. The engineers don't get to decide when that happens. The system is now designed to take account of someone randomly pulling the plug – and, over time, that's become phenomenally reliable. It also means that any attacks attempting to do something similar are also not so much of an issue, as the impact they will cause is minimal."

Chaos engineering is just one example of a security solution that isn't sector-specific. "That's the approach that we want to go towards in the future – looking at all of these problems as an abstraction and not worrying about the specific industry too much," says Chana. "You realise that many industries are doing the same thing. For example, I recently worked on a digital money index project funded by Citibank at the Centre for Financial Technology, where I'm the co-director."

"We are trying to take in data feeds about different countries that tell us which country is ready to have a digital banking infrastructure and transform into a purely digital banking entity. That involves us taking structured and unstructured data from multiple sources running algorithms, coming up with a mathematical way of actually analysing that data and then writing that up in an algorithm. That's not necessarily a direct security issue. But once we are able to generate these indexes and measures, we could also look at infrastructure resilience, for example, or cyber-security readiness."



It's difficult to cause anything to go bang, but surprisingly simple to make things trip

Another project developed a two-stage machine-learning algorithm to detect network traffic in a cyber-physical system – a factory, for example, with a mixture of computing and physical systems. The aim was to monitor the network traffic between the various components and detect bits of information that could be potentially dangerous, a method that's easily applicable to other situations.

He has also worked on CrowdVision, a crowd analysis technology startup originally designed to monitor the movement of pilgrims at Mecca. Pivoted to the transport sector, it has also been used at London City Airport to monitor how quickly people were being processed through the security checkpoint. This helps avoid overcrowding and can also check to see if the security value of those checks is being undermined because people are being rushed through.

Whatever the threat to a nation, Chana believes the solution is the same: convergence of domains and disciplines, diversity of thought, and an end to silos. "We're looking to create a new way of driving innovation in security and defence that cuts across infrastructure resilience, from cyber security to physical security," he says. "If you've got new problems, and the current global COVID-19 crisis is a prime example, then you need to look for solutions in new areas." ♦

PUZZLE:
Can you find the transmitter?

A spy, S, needs to inform one of his co-conspirators, C, of the exact location of a buried radio transmitter hidden somewhere along a straight road on which lie four towns. The distances between these towns are, in order, 6 miles, 8 miles and 5 miles.

S sends the following cryptic set of instructions to C. The names of the towns have been redacted deliberately to confuse the enemy.

"Start at town [■■■■■■] and go half the way to [■■■■■■]. Then go one third of the way to [■■■■■■] and finally travel one quarter of the way to [■■■■■■]."

Where along the road does C find the radio transmitter?

See page 43 for the solution.

IMPERATIVE / PROFESSOR MAGGIE DALLMAN
VICE-PRESIDENT (INTERNATIONAL)

Ahead of the curve: how Imperial is driving diversity in innovation and entrepreneurship

Today I spend my time working out how to support entrepreneurs – but, back in the late 1990s, I was on the other side of the table, as the co-founder of what would become a successful biotech startup. Back then, although we had lots of great ideas, there was very little actual support. Nobody advised us on what our involvement should be, how to pitch to investors and venture capitalists, how to manage our IP or in what direction we should take the company. It was a fantastic experience and I learned a lot. But perhaps if we had had a little more support, we could have ended up in a different place.

Today, of course, Imperial is ahead of the curve in terms of entrepreneurship and innovation. Not everyone wants to be an entrepreneur – and that's fine: it's just one of the many ways in which we, as a university, contribute to society. Our job is to encourage everyone who has a brilliant idea to put it out there, bring it to life and see where it takes them. We also want to increase the diversity of our entrepreneurs. Throughout the entrepreneurial world, fewer women lead companies than men – but there are statistics to show that the female-led companies are often more successful. That's why we've created a range of support for female entrepreneurs. And we are seeing some incredible results.

WE Innovate, for example, is for women who are developing an early-stage business idea. It offers

masterclasses, pitching advice and one-to-one support, with teams competing for £30,000 in prizes every year. Entrepreneurs receive a huge amount of support and mentoring throughout the whole process, and we've found some extraordinary students who are somehow managing to fit in these enormous projects alongside their study.

It's been astonishing – and incredibly gratifying for me personally – to see how diversity in the projects coming forward has increased since we started offering specially tailored support for women. If we want to be innovators, we must recognise the importance of diversity. People with different lives have different needs. That means that someone else will come up with ideas that you wouldn't come up with, because you don't have that particular need.

Olivia Ahn, CMO (MBBS Medicine 2017), and Aaron Koshy, CEO (Bioengineering 2015, MSc Innovation Design Engineering 2017), wanted to tackle the 200,000 tonnes of sanitary-product landfill waste every year in the UK. Their idea, the Polipop – the world's first biodegradable, flushable sanitary pad – won the WE Innovate first prize in 2017 and will soon be available to trial.

And the 2019 WE Innovate winner, Suchaya Mahuttanatan (Biomedical Science 2019), was inspired by her orthopaedic lectures to create Cadget – a breathable, washable cast that is 60 per cent lighter than the more traditional, heavy casts worn when you break a bone.



Having this specific support has enabled women who have brilliant ideas but don't necessarily think of themselves as entrepreneurs to come forward. We know that a lack of confidence can be a barrier, and we use a range of supportive approaches to build confidence and skills.

Our work on pitching, for example, uses a simulated audience so that

**Whether you have
expertise, ideas or
financial support
to offer, everyone
has a part to play**

entrepreneurs can get used to that environment without having to be in front of people. And, interestingly, since we started WE Innovate, we have actually seen increased engagement from women with all the other projects we run at the Enterprise Lab.

Everybody should care about having diversity in everything that we do here at Imperial. This work is just another dimension of that. And everybody has a part to play, too. Whether you have expertise, ideas or financial support to offer, we are encouraging everyone to get involved. Diversity in innovation is good for everyone: for Imperial, for business and for wider society. ♦

> *Maggie Dallman is Vice-President (International), Associate Provost (Academic Partnerships) and Professor of Immunology.*

A WORKING LIFE

Great expectations

Ambassador Yvette Stevens (*MSc Electrical Engineering 1973*) has forged a career out of making her actions count.

As a six-year old child in Sierra Leone, I listened to BBC outside broadcasts with my uncle and found them fascinating. It was like a story book. I never imagined that one day I would be part of the story of helping people around the world.

Many years later, in my adult life, I was working as an engineer in Sierra Leone when the opportunity to get into humanitarian work came to me quite by chance. One day a man from the International Labour Organisation (ILO) came from Geneva on a recruitment mission. He was planning a project for which he needed an economist, a sociologist and an engineer from Africa. He had ruled out the idea of an African female engineer – and then he met me!

I initially dismissed his offer as I had left London to come back home to care for my five children. But, most surprisingly, he agreed that my mother should come with me to Geneva as primary dependent, to look after them. Only much later, when I told colleagues this story, did I realise how unusual that was at the time.

In my very first year working for the ILO something happened that has stayed with me throughout my working life. Working as a UN Technology Expert, I went on a mission to Fallu in the north of Sierra Leone. We were greeted with great ceremony and I joined in with the women in their traditional devil dance as we made our way to the mud-walled, thatched community centre where the village chief was waiting to greet us. On our arrival he expressed disappointment that the expert had been unable to attend.

The local official explained that the expert was me, a Black woman from Sierra Leone. The village chief had expected a white male, but, to his credit, he covered his astonishment and turned the situation to the advantage of the village, using me as proof that educating girls was worthwhile. I was later told that the next morning there was a long queue of parents at the village school ready to enrol their daughters.

But it was what the chief said to me at the end that has remained one of my guiding principles. "You have come to us as yet another UN expert. You have raised our expectations. You are one of us and if we never see you again bringing help, as is the case with all the others, then we leave it to your conscience."

The chief's words struck me then like a bolt of lightning in a tropical storm and have guided my actions throughout the more than 30 years I spent working with the UN. It was a defining moment in my career. When I returned to Geneva to update my boss on the mission, he told me the outcome of our work would be a report. But I insisted I would personally return to the village to make sure they got the equipment they need, and he eventually agreed.

Coming from a disadvantaged part of the world myself, and with the privilege of an education at Imperial, I was in a position to help others, and I did everything possible to make my actions count. It is not enough to tell people what to do. You have to show that you have done it yourself. Though, now that I am writing my memoirs, I wonder how I did it while raising five children – one of whom achieved a doctorate degree in Engineering. I hope that the village chief would be pleased with me! ♦



Breaking the mould
Yvette Stevens was Sierra Leone's first female engineer and, later, the country's first Permanent Representative to the UN in Geneva.

"The chief's words struck me like lightning in a tropical storm and guided my actions ever since"

Susan Rutter asks...

Q. The heat capacity of a gas can be determined by counting degrees of freedom and using the equipartition theorem. Name the only type of degree of freedom in monatomic ideal gases.

Quiz team from left:

Oscar O'Flanagan (MSci Physics, Second Year); Gilbert Jackson (MSci Chemistry, Second Year); Stefan Sitorus (MSc Applied Computational Science and Engineering); Susan Rutter (MSci Mathematics, Third Year). Photos were taken in September and adhered to safety measures at that time.

Oscar O'Flanagan answers...

A. Translational degrees of freedom [though we'd accept 'centre of mass motion'].

**SOCIETY****Imperial College Quiz Society**

Starter for ten

From the local pub to the bright lights of University Challenge, Imperial quizzers show some impressive feats of knowledge.

Words: **Helena Pozniak** / Photography: **Hannah Maule-ffinch**

When Jeremy Paxman declared Imperial the champions of University Challenge last April, there was one audience member who was particularly satisfied – and relieved. As outgoing chair of the Imperial Quiz Society, Susan Rutter (MSci Mathematics, Third Year) had a personal interest in the team's success – which is why, when it came to it, she could barely watch. "I'd run a mile rather than actually compete on air," she says. "At the last recording, I just sat in the audience squeezing my neighbour's arm too tightly."

University quiz teams are famous for their geekery and their oatmeal jumpers. Team members – usually male – display weird depths of knowledge, impressively swift recall, and are occasionally floored by popular culture. The odd fist pump after a correct answer is as racy as it gets. Add cameras, bright lights and Paxman, and you've got an adrenaline rush like no other.

But it's not all glamour. Imperial College's Quiz Society offers contests for every taste, from arcane academic knowledge to popular culture, and revels in the traditional pub-quiz challenge as much as the high-profile events. "We tell newcomers that it really doesn't matter if you get questions wrong now and again," says Rutter, who joined the society keen to try her hand at inter-university competitions and to sharpen her reactions.

"Pub quizzes are more about random knowledge – what we call 'old men's knowledge'. We go along for the social. But, underneath

it all, students at Imperial care a lot about being smart, and being perceived as knowing things. That's the premise of this hobby."

There are different approaches to absorbing facts. "Personally, I like finding out what I know and whether I can apply my knowledge in different ways," says Rutter, a mathematician with an in-depth knowledge of late nineteenth-century Impressionism. She'll browse Wikipedia and even BBC Bitesize, following her own interests. "Some people are naturally just good and fast and know things. Some like to systematically look things up. I know someone who spends two hours a day memorising facts from flashcards so he can improve."

But when it comes to the biggest quizzes, everyone gets stage fright. Imperial doesn't necessarily outperform on science questions at university level, says Rutter. "Sometimes the hardest questions to answer can be on your own subject. Everyone is staring at you and you just have no idea. I'm a mathematician but I had to get a chemist to sit next to me to answer the most simple maths question."

Quiz teams are often mainly male, which is why Rutter was keen to take the chair this year. "I hate to recognise that an aspect of knowledge is 'gendered'. You get a question on feminist literature and you see three male teammates turn to their one female member. I hope we can change that."

People quiz because "learning new stuff is fun", she says. "I think everyone at Imperial genuinely enjoys finding out new things. It is nerdy. But, in a sense, everyone at Imperial is nerdy." ♦



RESEARCH / PROFESSOR PIER LUIGI DRAGOTTI, PROFESSOR OF SIGNAL PROCESSING

Beneath Da Vinci's *The Virgin of the Rocks*

Context

Art lovers have always been fascinated by the creative process behind a masterpiece, including the practice of painting on top of previously used canvases. While X-ray imaging has been around for half a century, it's only recently that non-destructive, non-invasive techniques have been able to break down the layers of an artwork into its individual chemical elements.

However, art historians have had to analyse this data manually – no automated, precise, analytical tool has been able to measure and read each element of each pigment of each layer. Until now.

Background

The National Gallery's imaging and manual analysis techniques had revealed that Leonardo da Vinci's *The Virgin of the Rocks* was not his first attempt at the work and that there were sketches beneath it.

So, its principal scientific officer, Dr Catherine Higgitt, turned to Professor Pier Luigi Dragotti, who created an algorithm for the automatic extraction of the sketches.

According to Dragotti: "This algorithm takes all the specific data from the chemical elements of the painting to visualise hidden drawings, to reveal these much clearer than ever before."

Methodology

The new algorithm was combined with macro X-ray fluorescence (MA-XRF) screening, a non-invasive scanning process that maps chemical elements within paintings. While MA-XRF is widely used, previous analysis relied on manual selections of various elements and expert user-interpretation.

The Finite Rate of Innovation theory algorithm developed by Dragotti and his team separates all elements in all layers

Magical moments
Professor Dragotti's algorithm revealed hidden drawings beneath the surface of Leonardo da Vinci's *The Virgin of the Rocks*.

automatically to an unprecedented level of precision. "We analysed each pixel individually to break each pigment down to a minute degree," says Dragotti, "and then put them all together to make up a truer map of all the chemical elements in the painting."

Findings

The new algorithm revealed hidden drawings beneath the surface of *The Virgin of the Rocks*. As well as showing in clearer detail a sketch of the Virgin Mary higher up the canvas, it also showed an 'abandoned' sketch of a winged angel and an infant Christ.

"It was a magical moment, to finally reveal that image," says Dragotti. "And, as an Italian, revealing something from a work Da Vinci created 500 years ago was extraordinary."

Outcomes

"By revealing Da Vinci's creative process, we can enhance the experience of looking at and understanding how great works of art came into being," says Dragotti.

"We see earlier versions, finished sketches and abandoned sketches. But this can also help art curators and historians contextualise the work, understanding which artists used which materials when and in which regions – and how these might reveal relationships between artists – which is of enormous benefit to the understanding of art.

"We've always known canvas was scarce and artists often created new works over existing paintings, but this helps us reveal those layers.

"We are looking to apply this to other masterpieces – we're currently looking at works by Titian – but we are also working to develop AI, where the algorithm keeps learning to become more and more detailed.

"And this may not be restricted to paintings but may give us insights into how other objects were created too." ♦

> **Pier Luigi Dragotti** is Professor of Signal Processing in the Department of Electrical and Electronic Engineering.

WORDS: PETER TAYLOR-WHIFEN. PHOTO: THE NATIONAL GALLERY, LONDON

PUZZLE

Test your brain power



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

1: HARD

Milly Miffen made a muffin more than Molly's mother made, and Milly Miffen's mother made a muffin more than Molly made; and Milly, Molly's mother, Molly, and Milly's mother made 50 muffins, but Milly and Molly's mother made four muffins more than Molly and Milly's mother made. So murmur now how many muffins Milly made.

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

2: VERY HARD

Is it possible to find five points in an equilateral triangle of side 10cm so that each pair of points is more than 5cm apart?

Dr Lynda White, Department of Mathematics.

3: FIENDISH

My maths teacher drew three arbitrary circles on the whiteboard. She then drew the common external tangents to a pair of the circles, which, of course, intersected. She challenged me to demonstrate that the intersection points of the three tangent pairs were collinear.

Professor Myron L. Good, submitted by **David Lloyd Owen** (BSc Physics 1972).

HOW TO ENTER:

Senders of correct solutions for two or more of the puzzles will be entered into a prize draw to win a copy of *Superhuman Innovation: Transforming Business with Artificial Intelligence* by Chris Duffey. Winners' names will be in *Imperial 50* in May 2021, and solutions published at www.imperial.ac.uk/be-inspired/magazine/issue-49/brain-power. Entries close 31 January 2021.

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



FOR ISSUE 48 SOLUTIONS:

www.imperial.ac.uk/be-inspired/magazine/issue-48/brain-power

ISSUE 48 WINNERS: Congratulations to: **Peter Alexander Dean** (MSci Physics with Theoretical Physics 2018), **Shengqin Yang** (MSc Advanced Materials Science & Engineering 2015), **Faye Karababa** (MEng Civil Engineering 2001), **Paul Holt** (BSc Physics 1983), **David Rowe** (BSc Chemistry 1984), **Caroline Barnes** (BEng Mechanical Engineering 1979), **Kathryn Sayer** (MEng Mechanical Engineering 2016), **Stewart Bean** (BSc Chemistry 1975), **Pete Champ** (BEng Electrical Engineering 1984) and **Robert Maciejczek** (BSc Physics 1991).

SOLUTION TO THE PUZZLE IN THE DEFENCE FEATURE FROM PAGE 37

The transmitter is found at a distance of $[6+(8+6)+(8+6+5)]/4$ miles (= 39/4 miles) from the first town along the road. Let the distances of the four towns along the road, from some fixed point, be a, b, c and d in the order they are named in the message. The first instruction takes C to a point at a distance $(a+b)/2$ from the fixed point. The second instruction takes C to $(a+b)/2 + [c-(a+b)/2]/3 = (a+b+c)/3$. Similarly the final instruction takes C to $(a+b+c+d)/4$ from the fixed point. This is symmetric in the four distances and we can calculate it without knowing which town is which as it gives their centre of gravity.

ILLUSTRATION: MIKE LEMANSKI

On the frontline

NOT CONTENT WITH THE EASY LIFE, IMPERIAL ALUMNI ARE DEDICATING THEIR CAREERS TO RELIEF WORK IN SOME OF THE MOST DANGEROUS CONFLICT ZONES IN THE WORLD.



CONFLICT AND CATASTROPHE MEDICINE
MOHAMMEDABBAS KHAKI
(MBBS Medicine 2010)
 General Practitioner

Q. Did you always plan to become a GP?

In my first weeks at med school I worked at a GP practice and absolutely loved it. I saw at first hand the intimacy of a doctor's relationship with their patient and the degree of trust placed in them. I had always planned to do some charity work and appreciated that the flexibility of the GP role would help me do that.

Q. What was your first experience of medicine in a conflict zone?

In my third summer as a student I went to Bosnia with ICAB (Imperial College Aid to the Balkans). There was real desperation among the people we were treating and some of their stories were heartbreaking. I still have the letters and drawings from the children. I had stepped outside the Imperial bubble and my first thought was, 'That could have been me'. I knew then that I had to use the skills I had been lucky enough to be taught to help others who were simply victims of circumstance.

Q. What lessons from Imperial have stayed with you most in your relief work?

It is a tough old slog to get through your training in medicine, but the ethos at Imperial has always been one of mutual respect and closeness among the student body, steeped in support from older members to the younger. I was the Union Welfare Representative in my third and fourth years and I learned how important a holistic, long-term view was in supplying pastoral care. It's a lesson I try to apply to all my work. Recently, I was in the Rohingya camps in Bangladesh, where some of the stories told by the women are horrific. I helped in the training of more than 100 doctors from 66 different NGOs. You need to recognise that you won't be there to help forever. ♦

> *Dr Khaki works as a GP in London and is the resident phone-in doctor for Sky channel Zee TV, expert contributor with Channel 5 news and BBC radio, and contributor to the Metro and The Independent. He has a Diploma in Conflict and Catastrophe Medicine and was one of the winners of the inaugural Emerging Alumni Leaders Award in 2020.*



MIGRATION CRISIS PROGRAMME
STEFANOS TSALLAS
(MSc Surgical Science 2015)
 Medical practice professional/
 Médecins Sans Frontières (MSF)

Q. What prompted you to volunteer to work with MSF?

My thesis was on micro-surgical procedures used in reconstructive surgery for breast cancer. These can involve a team of up to ten working in the operating theatre for 12 hours, so they require a great amount of skill and resources. I was writing up my thesis at the height of the refugee crisis in Europe and this felt personal for me. I left Imperial disillusioned with the contrast between the high level of technical care and expertise available to some in a world where others did not even have access to paracetamol. People were drowning in my homeland of Greece and I felt I had to do something.

Q. Was there much call for plastic surgeons to help out?

Not at all! I was handing out medicines, helping with psych support, doing basic paediatrics. But the fantastic insights I had gained at Imperial alongside the soft skills I had learned were essential. I soon realised that, precisely because of my training, I was able to work with the local healthcare professionals to not only improve conditions for the refugees but also organise health education programmes for them. When I came back, I climbed Mount Kilimanjaro to raise funds for MSF. Fundraising is not a big thing in Greece in the way it is in the UK, so when someone suggested I go climb a mountain to raise money it was an original idea for me! At Imperial you get introduced to new ways of doing things.

Q. What are your plans for the future?

I've been working in a hospital in Athens during the COVID-19 crisis, but I hope soon to work with MSF again. Plastic surgery is my passion and there is an amazing MSF centre in Amman, Jordan, where they specialise in treating injuries from adjacent war zones. It is often forgotten that the big advances in plastic surgery came from the Great Wars, and today there is enormous need for plastic surgeons alongside orthopaedic and vascular specialists to treat the horrific injuries that result from conflict. ♦

> *Dr Tsallas put his career in plastic surgery on hold to volunteer for Médecins Sans Frontières in Lesbos as part of the European migration crisis programme. He is currently working in a hospital in Athens.*



REFUGEE HEALTHCARE
AULA ABBARA
(MBBS 2005, MD (Res) 2017)
 Consultant, Imperial College
 Healthcare NHS Trust

Q. What was your first experience of working in conflict medicine?

As a student, I did a placement in a Palestinian refugee camp in Beirut, which was organised by the International Federation of Medical Students' Associations, shadowing doctors. It was useful to gain experience in the health concerns that the patients had. I was worried that I would not be able to continue similar work when I started training but, at the end of my foundation year, I was able to spend a month volunteering in a refugee camp in Damascus in the summer of 2006, before the war, when refugees arrived from Lebanon to Syria during an escalation of violence.

Q. What is the most important lesson you pass on to your students?

The most important thing is to be humble and understand that local people and healthcare workers will know far more about their context than you will. As such, it is important to listen and to go without preconceived notions. This will also help build a rapport and a relationship with the people you will be working with, and this is key to building trust and supporting cross-learning. I am always clear I have learned far more from my experiences than I could teach.

Q. How has your work in refugee zones fed into your career?

In the summer of 2015, I took a break from clinical research to volunteer with Médecins du Monde in Sierra Leone for the Ebola response. Later that year, I volunteered as a clinician in Greece when refugees were arriving in large numbers on the islands; this led to me being asked to manage a project where we were providing primary healthcare to refugees. These experiences have helped me develop key management and leadership skills, including problem solving in challenging environments, resilience and supportive communication, all directly relevant to my clinical work in the UK during the COVID-19 pandemic. ♦

> *Aula Abbara is a consultant clinician in infectious diseases and acute medicine and an Imperial teacher providing training for healthcare professionals affected by conflict. She was one of the winners of the inaugural Emerging Alumni Leaders Award.*

POLICY AGENDA / DR NEJRA VAN ZALK,
LECTURER AND RESEARCHER IN PSYCHOLOGY AND HUMAN FACTORS

Next-generation privacy: why we need to do more to avoid mass datafication



THE SITUATION

What does sharing our – and especially our children’s – personal information mean for wider society?

This is the key question that policy makers should be asking themselves, says Dr Nejra van Zalk, Lecturer and Researcher in Psychology and Human Factors at the Dyson School of Design Engineering. “While older generations may see the world as online and offline, for the younger generation there is no such dichotomy,” she says, pointing out that, across the world, 70 per cent of those aged 15-24 have access to the internet. “Their world is online, and they are far less concerned about the implications for privacy – and manipulation.”

THE ISSUE

Face-to-face social interaction is multifaceted, but social media was not designed to foster deep relationships – and few foresaw the extent to which this can have a detrimental effect on self-esteem, especially for the young.

But that is not all. The more you use social media, the more information companies have about you as a person.

“There is little public awareness of the collection of personal data through everyday household items such as smart toothbrushes, hairbrushes and toasters, which, when linked to apps,

allow targeting of marketing, even to children,” says Van Zalk. “My concern is that young people are being turned into non-autonomous individuals who can be easily swayed without realising it is happening. The attention economy is not conducive to good mental health.”

THE OPPORTUNITY

Van Zalk’s colleagues at the Dyson School of Design Engineering produced research on how much data is being collected through everyday items, and she is working with the Information Commissioner to design

We need to educate our children rather than lock them up in a digital shed. Transparency is key, but it is doable

age-appropriate guidelines for privacy and security.

“We are seeking to make policy makers aware of the mass datafication of our children. Concerns about the impact on democracy are pushing the issue to the fore of governments’ minds. But there is far less awareness

of the extent to which the emotional privacy of our young people is being invaded. We need to educate our children rather than lock them up in a digital shed. Transparency is key but it is doable.”

Another part of the answer may lie in introducing more paid-for services. “If I pay for a service then I have more rights as a consumer and the company is not so desperate for my attention. We must find a way to make companies accountable for the way in which they use our data.”

THE CHALLENGE FOR POLICY MAKERS

Van Zalk points out that currently there is no legislation for information protection on the most basic household items. “Awareness needs to move hand in hand with greater legislation on a global scale.

It may be too late to change the way the tech giants such as Facebook are designed, but their usage is slowly changing and even dying out among the young. The challenge is to ensure the next generation of social media takes privacy concerns into account.” ♦

> *Dr Nejra van Zalk is a Lecturer and Researcher in Psychology and Human Factors at the Dyson School of Design Engineering.*

ALUMNI LIFE

Our alumni programme is now fully digital

Imperial’s events are now online, with more opportunities than ever to join our global alumni community.

Illustration: **Andrea Manzati**



The Imperial world of events may have had to adapt, but the result is that we’re able to offer even more opportunities for our global community to connect and learn. Our new online events programme offers expertise and insight, focusing on sharing knowledge, supporting each other and celebrating the success of our alumni and the College’s work. We hope to see many of you in person again soon but, in the meantime, here’s just a taste of the wide range of events open to our alumni community:

ALUMNI SPOTLIGHT

Shining a light on talented and passionate alumni from our global community, each event features an Imperial alumnus who shares their career journey, expertise in their sector and thoughts on leadership and making an impact.

MEET THE EXPERTS

Our world-class Imperial academics and alumni leaders share their opinions on current policy, industry and research issues.

EVENTS FOR RECENT GRADUATES

A series of events such as webinars and masterclasses designed for alumni who graduated within the last ten years, to support your professional development, help you make professional contacts and give you an exclusive insight into different industries.

CONNECTING REGIONAL NETWORKS

Local alumni groups – from London and Bristol to Singapore and New York – have been hosting events featuring alumni and Imperial speakers, or tapping into their own professional networks to share industry knowledge and support each other.

COLLEGE ONLINE LECTURES AND EVENTS

Take advantage of our new events series showcasing the very best of Imperial’s teaching expertise, such as: the Science Breaks series demonstrating the impact and relevance of Imperial’s research and work taking place at the College, and covering topics such as reinventing capitalism, when art meets science, from the Big Bang to AI; and Imperial Lates Online, free after-hours events exploring cutting-edge science and engineering at Imperial in creative ways. ♦

> *Keep up to date on Plexus, via our monthly events newsletters or at imperial.ac.uk/alumni/events*



MY IMPERIAL

A walk in Kensington Gardens

David Tyoember (*Chemistry, Third Year*) finds the perfect getaway.

As founder of Imperial's first Rap Society, you might think the peace and quiet of the flower walk in Kensington Gardens is the last place I'd like to be. But the solitude is often just what I need, and having such a beautiful place on my doorstep helps me to make the most of my Imperial experience.

Sometimes I'll just walk and take in the scenery, but often I'll sit on a bench and listen to audiobooks for hours – it's a place that helps me think. You won't ever find me here with chemistry books; it's not somewhere I come to study. Chemistry is an intense degree, so this is the perfect chance to get away and clear my head.

Often the weather is better in the afternoons, which is when you might find me listening to podcasts and audiobooks. My playlist is mostly non-fiction – recently I've been fascinated to learn more about social mobility. It's a topic close to my heart because of my own experiences. I came to Imperial from a south-east London state school and neither of my parents went to university – I've had to learn a lot to be able to capitalise on the opportunities at Imperial, and I want to help others going through similar experiences.

Kensington Gardens is also a good place to plan all the extracurricular stuff I'm involved in. Imperial has provided so many opportunities. I've been president of the Investment Society and now I'm focusing on music and leading the Rap Society. And I'm also recording a series of podcasts – interviews with Black men who are pursuing a career in financial services. My aim is to help dispel "impostor syndrome" through increasing visibility, giving students an insight into various roles, and inspiring people who might feel too intimidated to enter the sector. After all, I'm the guy who stood outside a tube station with a sign reading: "Seeking work experience in the asset management sector. Ask for my CV. It's not where I'm coming from, it's where I'm going." I learned many things about the finance sector from colleagues during my resulting year of internships in the asset management sector, and I hope this series will help more students access insights along those lines.

I'm a sociable person but I do like the solitude of the park, and this walk in particular. Although it's just across the road from the Royal Albert Hall, it's always quiet and I can be in my own world. Perfect. ♦

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.

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

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

Science Breaks

This summer we launched a brand new virtual event series showcasing the impact of work taking place at Imperial.
bit.ly/Science-Breaks



Professor Chris Jackson

Exploring volcanoes, old and young

Professor Chris Jackson takes us through his work for the BBC documentary *Expedition Volcano* and his research in the world of basin analysis.
bit.ly/YT-ExploringVolcanoes

When art meets science

Professor Pier Luigi Dragotti speaks about working with the National Gallery and using AI to reveal what lay beneath the layers of Da Vinci's *Virgin of the Rocks*.
bit.ly/YT-WhenArtMeetsScience

After Cassini

Professor Michele Dougherty explains how the Cassini mission has fed into the planning for JUICE, the next Cassini scale mission to Jupiter.
bit.ly/YT-AfterCassini

Ongoing during 2020–21

Great Exhibition Road Festival

Celebrate science and the arts through our programme of free and family-friendly online workshops and talks.
www.greatexhibitionroadfestival.co.uk

30 November – 6 December
Imperial Lates Online: Dinner plans

Explore the future of food, how our choices might impact the environment and local economy.
www.imperial.ac.uk/be-inspired/lates

9 December, 17.30 (GMT)
Imperial Inaugural: Andrew Tolley

Professor Andrew Tolley talks cosmology, gravitational physics and quantum effective field theories.

13 January, 17.30 (GMT)
Imperial Inaugural: Cristina Lo Celso

Professor Cristina Lo Celso explores how we might use the 'scars' of infectious diseases to enable interventional proactive treatment.

19 January, 12.30 (GMT)
Science Breaks: Martin Brazeau

Discover why the fossil of an ancient bony fish forced a rethink of how sharks evolved.



Professor Jennifer Doudna, Professor Sanjeev Gupta, Professor Cristina Lo Celso

3 February, 17.30 (GMT)
Imperial Inaugural: Jim Crawley

Professor Jim Crawley discusses basic molecular mechanisms associated with haemostasis and vascular biology.

9 February, 12.30 (GMT)
Science Breaks: Sanjeev Gupta

As the Rover nears Mars, Professor Sanjeev Gupta discusses his work on the NASA Mars 2020 Perseverance Rover and his hopes for the mission.

24 February, 17.30 (GMT)
Schrödinger Lecture 2021

Professor Jennifer Doudna, joint winner of the 2020 Nobel Prize in Chemistry, takes us on a journey through her pioneering work in gene-editing.

10 March
President's Address 2021

Professor Alice P. Gast, President of Imperial College London, presents her seventh annual address to the community.

1 December, 12.30 (GMT)
Science Breaks: Engineering Chocolate

Join Professor Maria Charalambides for Science Breaks as she discusses her work on engineering better-tasting, healthier chocolate.

Our *What's On* pages are regularly updated with the latest information about all of our events – online and on campus → www.imperial.ac.uk/whats-on