



Imperial ENGINEER

AGM

SEISMIC 2021

BEYOND CARBON

IMPOSTER SYNDROME

THE INVISIBLE MATTER

IMPACT PHOTOGRAPHIC CONTEST

For members of City & Guilds College Association
and The Royal School of Mines Association

ISSUE 35 / AUTUMN 2021

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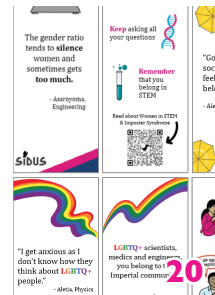
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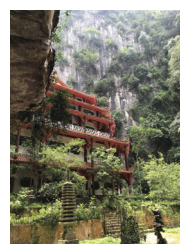
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Cover Image

The Lost Temple
© Nicholas Gerard

Winning entry in the
CGCA IMPACT
Photographic contest
(see page 6)

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Peter Buck (Editor)
David Bishop, Eilidh Campbell,
Tim Cotton, Paul Holmes,
Bill McAuley (Emeritus Editor)

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CORRESPONDENCE and ENQUIRIES

Eilidh Campbell
Alumni Relations Office
Level 1 Faculty Building, Imperial College London,
South Kensington Campus, Exhibition Road
London SW7 2AZ
Tel: +44 (0)20 7594 9238
Email: rsma@imperial.ac.uk for RSMA queries
Email: cgca@imperial.ac.uk for CGCA queries
Website: www.imperial.ac.uk/engineering/alumni/
CGCA website: www.cgca.org.uk
RSMA website: www.rsm-association.org

URLs at the end of items indicate more details online.
Where appropriate we use bit.ly short-links for readability and useability.
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Imperial College was recently ranked **University of the Year, 2022** by *The Times* and *Sunday Times*. The news comes as the College's student satisfaction as measured by the National Students Survey reached an all-time high. The Faculty of Engineering performed remarkably well in difficult circumstances, and we are proud of their achievements. We were fortunate to showcase the groundbreaking research by Imperial engineers through our virtual member events last year. The current edition of Imperial ENGINEER magazine highlights the Engineering Faculty's net-zero research programme (see page 16).

As we welcome the students back for the new academic year, there is a renewed excitement and anticipation at the College. In partnership with the Old Centralians Trust, City and Guilds Association (CGCA) will continue to work with the College and City and Guilds College Union (CGCU) to improve students' welfare, which is a priority for the Committee in the coming year. I am pleased to report that our membership is growing and reaching out to a wider cross-section of students and alumni throughout the world. We are continually striving to improve our onboarding process for these new members while reaching out to younger people.

This association always had a loyal, dedicated, and hard-working committee and an active wider membership. I would like to thank the CGCA Committee for developing and implementing these initiatives, and I look forward to working with you in my second year as President.

I very much look forward to seeing you at the CGCA Annual Dinner in February 2022.



**Atula
Abeysekera**

PRESIDENTS REPORT



**Tim
Cotton**

In the spirit of Groundhog Day, I find myself once again writing to you all in the capacity of RSMA President embarrassingly entering a sixth year in office. We are struggling to recruit new Committee members and as such, the Committee and I felt that for consistency I should stay another year. This motion was taken to the AGM in June this year and approved by the members present. Whilst the Committee has a reasonable level of membership, time commitments of the members mean that filling the Executive roles in the Committee is becoming harder. If you do have time, please do consider joining the RSMA Committee – it is truly worth it, as you can see first-hand the tremendous impact that giving back has on the current student body.

As a volunteer organisation, we rely heavily on the College Alumni Relations team in managing the communication channels with members, as they have the systems and people to do this type of work. The Committee has a good working relationship with these departments and they are a great help in running the administration side of the Association and getting any feedback from Members out to the Committee.

I am very happy to report that due to the success in 2021 the RSMA once again launched the RSMA Final Year Student Bursary Prize in June 2021. This award is open to students who are beginning their final year in September 2021. Currently, the Committee is planning to award a minimum of three prizes across ESE and Materials and, depending on applicants, may consider more. As we go to press, there are nine applicants being considered with a good mix across the disciplines in the RSM. The scheme was created to reward students who show the true RSM Spirit and act as an ambassador for the RSM. Successful candidates must be able to show commitment, achievement and excellence above that of their peers in areas such as academic excellence, community & RSM Union involvement, sporting prowess, or contribution to a sport or club within the RSM. Financial hardship will also be considered as a criterion. Working with Department Directors of Undergraduate Studies at ESE, Materials and the Faculty of Engineering we will be shortlisting and awarding the bursaries shortly. Remember the funds have been raised by YOU through your kind generosity at events and specifically by those members who have supported the 100 Club. This is an amazing achievement and is a concrete example of former students of the RSM who want to give back to the current student body. Lastly the 100 Club continues to slowly grow and I would encourage you, if you are able, to sign up and support the RSMA via the 100 Club or by a one-off donation. If you are already signed up then a huge thank you and please double check your banking details so that are continuing to pay yearly. As a small token of appreciation the Committee has arranged for all 100 Club paying members to receive a 100 Club lapel pin so please do check the post over the next coming weeks. Your support is truly appreciated! Read on for a more detailed review of the 100 Club in the AGM report (page 4).

Due to the COVID-19 Pandemic and the restriction on social gatherings, the 2021 Annual General Meeting of the Association was held virtually on the 24th June 2021 via video conference. Once again this meant the final year Bar-B-Q had to be cancelled as the College and associated faculty were closed. See the AGM report on page 4 for a full update.

On a brighter note the Committee has approved the 136th annual dinner to be held on Friday 26th November, 2021 at the Rembrandt Hotel in Knightsbridge. You can book your tickets by typing the following link to your browser.

<https://www.eventbrite.co.uk/e/rsma-annual-dinner-2021-tickets-170450201140>

The Committee continues to maintain a very active relationship with the RSMU and for the 2020/21 academic year, the new RSMU representatives are Jasmine Crocker and Thomas Burns, respectively President and Honorary Secretary. Jasmine is no stranger to us as she was also the President last year and for continuity has agreed to stay in the role for her final year. Between us, we are looking to continue to engage with students on careers evenings and supporting the students and associated societies throughout this challenging time.

I hope you find this issue informative and I look forward to seeing some of you in the RSM and /or at an RSMA event at some point soon.

DIARY

As a result of the still ongoing worldwide COVID-19 pandemic, events in many locations have been cancelled or converted to virtual events. Local restrictions are varied, therefore before considering attending any event, please contact the organisers to check whether the event is still taking place.

RSMA Toronto, Canada**Informal RSM meeting**

Last Friday of every month, noon.
Jason George Pub, 100 Front Street East, Toronto
Contact: rsma.1851@gmail.com

RSMA Perth, Australia**Monthly Sundowner**

First Friday of every month.
The Celtic Club, 48 Ord St, West Perth, WA, 6005
Contact:
Alan Dickson – alan@dickson.com.au
John Sykes – johnsykes@gmail.com

Imperial Alumni, Houston, US

Alumni social
Third Thursday of every month, 6pm
Capital Grille, 840 West Sam Houston Pkwy N, Houston, TX 77024
Contact: Matt Bell – matt@in2oilandgas.com

Imperial Engineering Alumni, Johannesburg, South Africa

Quarterly Johannesburg Lunch
(17th Nov, 16th Feb, 18th May)
Baron & Quail, Woodmead, Johannesburg, South Africa
Contact: Richard Gundersen – Gundersen@yebo.co.za

CGCA

Traditional Reunion Luncheon
Saturday, 13th Nov, 12:30 for 13:00
The Polish Club, 55 Prince's Gate, Exhibition Rd, South Kensington

RSMA

136th Annual Dinner
Friday, 26th Nov 2021
Rembrandt Hotel, South Kensington SW7 2RS
Book at <https://bit.ly/RSMA-AD2021>

CGCA

108th Annual Dinner
Friday, 25th Feb 2022, 18:45 for 19:15
Ironmongers' Hall, Shaftesbury Place, Barbican, London EC2Y 8AA
Booking form enclosed with this issue

An up-to-date calendar of events of interest to CGCA and RSMA members is always available on the CGCA and RSMA websites. Imperial College maintains a calendar of college events at bit.ly/IE-WhatsOn and the Friends of Imperial College regularly organise events of interest to alumni (see bit.ly/IE-FOI)

Please note that while many of these events are open to all and often free, they usually require registration in advance. Please follow the links in the entry to get more information including if and how to register and whether there is any cost.

For more information follow links, or see page 2 for contact details

2021 RSMA AGM Report

Fourteen RSMA members and Committee members connected via a video conference link on June 24th 2021 for the Annual AGM of the RSMA. The members heard various reports from the President, Treasurer and Chair of the RSMA Trust and salient points are noted below.

President

The President, Tim Cotton, highlighted that once again due to limited success in recruiting new Committee members the succession planning for the Association Executive was behind schedule. Furthermore, the challenges of handing over in the midst of a pandemic were seen as too great. Accordingly it was proposed that Tim should stay in the role for another year, all members present concurred. At the meeting, one Committee member was elected and the existing members and officers, as listed in the yellow box below, were voted in.

Chris Webborn and Paul Holmes expressed interest in supporting the RSMA Committee and will be invited to forthcoming meetings for the 2021/2022 year

Treasurer

The Treasurer reported that the RSMA and Trust are in good financial health and have the necessary funds available to continue to support the RSM. The year was marked by a further, additional donation of £17,378 from the Illing Trust, at the wishes of a former student. With this endowment and a growing "100

| 100 Club | 2020 | 2019 | 2018 | 2017 | 2016 | 2015 |
|-----------|-------|-------|-------|-------|-------|------|
| Donations | £6805 | £6383 | £4550 | £7170 | £4552 | £0 |

Club", the Trust was able to give more bursaries in 2020, some £5,000 in total. Furthermore the funds allow the Committee to continue to award bursaries in the Autumn 2021 Term to final year students who show the true RSM spirit and act as an RSM ambassador. There have been 9 applicants and names are currently being shortlisted.

Since the Club was started in 2016 there have been 42 members, as of today only 38 remain active. The original idea was sound but unfortunately, the take up has not been what was originally envisaged but through the generosity of the 100 Club members almost £30,000 has been raised since 2016. See table above. The drop in members is due to:

- 2 members thought it was a one off £200 payment and not a yearly £200 payment.
 - 2 members have been unresponsive to further communications and have only made one payment.
- It is pleasing to note that all but 3 members are current and the Association is sending reminders to these members.

2018 saw the first three £1000 Bursaries awarded, in 2019 a further three £1000 Bursaries awarded in 2019 and in 2020 five £1000 bursaries were awarded.

To try and reinvigorate the 100 Club the Committee has sent emails and letters to all members reminding them of the goals of the Club and

allowing members to join at a lower rate and/or pay in instalments. So far, this has added one new member and we are hopeful more will sign up over the next months. In addition each 100 Club member will now receive a special 100 Club lapel pin that recognises their generous contribution.

Chair of the RSMA Trust

The Chair of the Trust (Fiona Cassidy) reported that in terms of the Trust's Trust Deed, the President, Honorary Treasurer and Honorary Secretary of the Association and the President of the RSMU are appointed as trustees ex-officio. The following offered themselves for election as trustees: Professors Rees Rawlings and John Monhemius, Fiona Cassidy, Coen Louwars, John O'Reilly and Peter Waugh and were duly voted in by a show of virtual hands.

In other Trust matters, the following awards were made and presentations will be made at some point during the 2021/2022 academic year; (maybe even at the 2021 RSMA Annual Dinner)

- Peter Harding Memorial Award will not be awarded;
- Rees Rawlings Young Member Award will not be awarded;
- RSMA Trust Essay Prize Winner went to Disha Bandyopadhyay.

Finally, the Society of Petroleum Engineers' annual Seismic Conference, normally held in Aberdeen, once again became a Virtual Event in 2021. The Trust was pleased to sponsor the conference attendance for a second year undergraduate student of Geophysics.

100 Club draw

After the video conference, the draw for the 100 Club £250 raffle prize was won by TG (Tom) King who has since very graciously donated the prize back to the 100 Club.

Election of officers and committee for 2021/22

President: Tim Cotton
Senior Vice-President: Vacant
Junior Vice-President: Vacant
Past-President: John O'Reilly
Hon. Secretary: Hannah Bungey
Hon. Treasurer: David Bishop
VP International: Vacant
Membership Secretary: Vacant

Members: Lorraine Craig
John Monhemius
Rees Rawlings
Daniel Hill
Sam Casement
Eleanor Jay
Ben Moorhouse
Seb Turner
Richard Griffiths
Jasmine Crocker (President RSM Union)
Thomas Burns (Hon Sec RSM Union)
Teigan Collins (GeologicalSoc President)
Jessica Dring-Morris (MatSoc President)
Lisanne Blok (GeoPhys President)

Overseas: Celia Hayes (Australia)
Harry Fisher (Australia)



Tim Cotton remains as RSMA President for another year

2021 CGCA AGM

This year, as last year, we had to hold our Annual General Meeting as a virtual event due to COVID restrictions. On Monday, 14th June, over 30 members joined the online AGM on the Zoom platform.

Review of 2020

CGCA President Atula Abeysekera presented a review of 2020 in which he reflected on a year that had seen the most dramatic changes in a life time. Up until March the world ran as normal. We held a very successful Annual Dinner in February, literally weeks before the UK joined many other countries in a total lockdown. By the time of the AGM 2020, CGCA, like many other organisations, had to operate differently; we successfully held a number of large and small events using Zoom.

A virtual 'Reunion' event was held in November and was well attended with members from around the world and across many age groups.

Sadly, the restrictions meant we had to cancel the 2021 Annual Dinner.

Atula thanked the members of the Committee and our colleagues in the Imperial Alumni Relations Group for all their hard work and support for the Association.

Accounts

Peter Chase presented the accounts as his final task before standing down as Honorary Treasurer to become Chair of the Old Centralians' Trust. Andrew Hill takes over as Honorary Treasurer.

Election of Officers

The major changes in Officers are that Andrew Hill takes over from

Peter Chase as Honorary Treasurer, Milia Hasbani stands down as Deputy Honorary Secretary, Chris Lumb retires as Chair of the Old Centralians' Trust, handing over to Peter Chase. All the current officers, and committee members are shown in the table below.

Award to Chris Lumb

We finished the AGM with a special award to **Chris Lumb**, standing down as Chair of the OC Trust after 22 years in the role. A remarkable time and Chris's quiet but firm hand has guided the Trust in helping students, supporting expeditions and enabling presenters to attend conferences. Chris was made an Honorary Member of CGCA and presented with a Tankard to mark his time as OC Trust Chair.



Screenshot courtesy of Eilidh Campbell

Chris Lumb and Gill as he is presented with his Tankard at the virtual AGM

Presentations

As is traditional, we had guest presenters at the AGM. Both were addressing AI and data science.

Alumnus **Richard Ahlfeld**, CEO of Monolith AI, presented on the use of AI to accelerate the design process by using models of previous designs to predict the outcomes of new designs.

Professor Aldo Faisal, Professor of AI and Neuroscience at Imperial College talked about Imperial-X, a collaborative environment encompassing AI, data science and digital technologies.



Richard Ahlfeld (Aero 2014-17)



Prof Aldo Faisal

Election of officers and committee for 2021/22

| | | | |
|------------------------------|------------------------------|----------------------------|--|
| President: | Prof Atula Abeysekera | Aero | Departmental Reps |
| Senior Vice-President: | Prof Anil Bharath | Bioengineering | Vacancy / Vacancy |
| Vice-President: | Vacancy | Chem Eng | Poppy Oldroyd / Millie Tsang |
| Immediate Past-President: | Prof Richard Kitney | Civil Eng | Peter Lynch / Judith Hackitt |
| Honorary Secretary: | Nigel Cresswell | Computing | Atula Abeysekera / Colin Kerr |
| Deputy Hon Sec: | Vacancy | Design Eng | James Prince / Alessandro Bonardi |
| Honorary Treasurer: | Andrew Hill | E&E Eng | Michael Hofmann / Audrey Gaulard |
| Deputy Hon Treas: | Owen Heaney | Mech Eng | Chris Baker-Brian / Andrei Pogan |
| Younger Members Hon Sec: | Tim Munday | | Owen Heaney / Vacancy |
| Chairman of OC Trust: | Peter Chase | | |
| IC Exploration Board: | Colonel Kevin Oliver | | |
| Imperial Academic Staff Rep: | Vacancy | Australia (Melbourne) | Regional Reps |
| Membership Secretary: | Vacancy | Australia (Sydney) | Dave Bishop |
| CGCU President: | Hayley Wong | Hong Kong | Vacancy |
| CGCU Alumni Rep: | Leah Redmond | Malaysia | Leslie Swann |
| Imperial Alumni Relations: | Nicola Pogson | South Africa | Cheah It Tee |
| | Eilidh Campbell | | Richard Gundersen |
| Annual Dinner Organiser: | Colin Kerr | | |
| Decade Reunion Organiser: | Peter Chase | | Co-opted Members |
| London Walks Organiser: | Alice Spain | | Milia Hasbani |
| IE Editor: | Peter Buck | Communications & publicity | Fatima Khan |
| | | Past Chair of OC Trust | Chris Lumb |

IMPACT PHOTOGRAPHIC CONTEST 2021

Theme: Whatever GREEN means to You

We are delighted to be able to showcase the winning photographs from the CGCA IMPACT Photographic Contest 2021.

The contest attracted a significant number of entries, and the general standard was very high, making the judges' decision a little difficult!

This year the photograph was to be taken on a mobile phone and was to portray "Whatever GREEN means to You"

The winning entry was

"The Lost Temple"

by Nicholas Gerard (Chem Eng).

Joint second places went to

Yasmine Chan (Aero Eng) for

"Freedom — Suffocation"

and

Konstantinos Kalyviotis (Bio Eng) for

"Green and Purple Bee Flight".

A special mention also went to Ellen Player (Chem Eng) for *"Ever Reds"*.

The IMPACT contest will be back in Sumer Term in 2022 – theme yet to be announced.



JOINT SECOND PLACE

Green and Purple Bee Flight – Konstantinos Kalyviotis (Bio Eng)

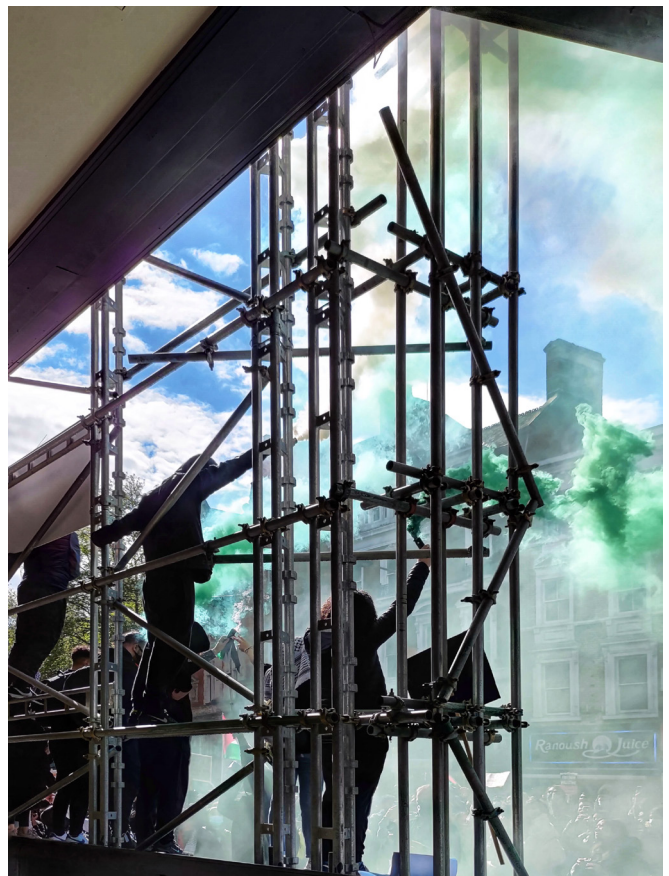
The judges recognised the incredibly detailed bee in flight and an underlying message that bees, the primary pollinator of our crops, are currently endangered by agricultural practices.



FIRST PLACE

The Lost Temple – Nicholas Gerard (Chem Eng)

The judges considered the overall composition excellent, with the contrast of manmade structures, vegetation and a rock face, with an underlying message that the green world will conquer everywhere, including man's work and a vertical cliff.



JOINT SECOND PLACE

Freedom — Suffocation – Yasmine Chan (Aero Eng)

The judges recognised the emotion of the composition reminding us that a green future is far from certain and may create confrontation in our society.

DEVELOPMENTS AROUND THE ENGINEERING FACULTY

Imperial academic awarded Royal Society medal

Professor Magda Titirici has been recognised with the Kavli Medal and Lecture by the Royal Society.

The Kavli Medal and Lecture is awarded annually for excellence in all fields of science and engineering relevant to the environment. The medal is of bronze gilt and is accompanied by a gift of £1,000.

Professor Magda Titirici, Chair in Sustainable Energy Materials in the Department of Chemical Engineering, was awarded the medal for her outstanding contributions to advancing the sustainability of energy storage and conversion technologies by performing interdisciplinary research at the interface between electrochemistry, materials science and chemical engineering.

Professor Titirici said: "It is a tremendous honour to receive such a prestigious award from Royal Society, the oldest scientific society in the world, which to me means the recognition of the hard work of my current and past research group and collaborators."

"I am especially flattered when looking at previous winners since the Kavli Medal and Lecture was established in 2011, scientific giants who I greatly admire for their outstanding research outputs. I am grateful to all those who have supported me to get here, especially my colleagues at Imperial College who nominated me."

Sir Adrian Smith, President of the Royal Society, said: "Through its medals and awards the Royal Society recognises those researchers and science communicators who have



Photo courtesy of Imperial College, London

played a critical part in expanding our understanding of the world around us."

"On behalf of the Royal Society I congratulate each of our award winners and thank them for their work."

Professor Titirici received her PhD in Materials Chemistry from University of Dortmund in Germany. She then joined the Max-Planck Institute of Colloids and Interfaces as a Postdoctoral Fellow and later became a Group Leader. In 2013 she moved to Queen Mary University of London as a Reader in Materials Science, receiving a promotion to Professor in 2014. In January 2019 Magda move to Imperial College London to take up a Chair in Sustainable Energy Materials.

Her current research interests involve sustainable materials with focus on carbon and carbon hybrids produced via hydrothermal processes, waste recycling into advance products, avoidance of critical elements in renewable energy technologies and the development of truly sustainable clean energy storage.

Imperial ranks first for Mechanical Engineering in *The Guardian* best UK universities guide for 2022

Imperial College London was ranked first for Mechanical Engineering in "The best UK universities 2022" guide published by *The Guardian*.

The good news comes in a year full of achievements for our university. *The Times and Sunday Times* Good University Guide has named Imperial College London as University of the Year 2022.

Professor Mike Lowe, Head of Department in Mechanical Engineering, said: "I am delighted to see that *The Guardian* newspaper has rated the Department in first position for Mechanical Engineering in their Best UK University guide 2022. This is a great achievement and is a tribute to all of the dedication and hard work by everyone in the department!"

Dr Linda Stringer (Senior Teaching Fellow and Undergraduate Admissions Tutor in Mechanical Engineering) said: "From an admissions perspective this is great news – it means we attract the dedicated mechanical engineers as well as the general engineers, who choose our course because it is the broadest of Imperial's engineering courses."

There is one downside of these high rankings – we do get so many excellent applicants that it is difficult to select the most deserving! Last year nearly 2200 people applied for our course – that's over ten applicants for every place. The majority of applications demonstrate great motivation for our subject and have excellent high school grades."

Rising Talents fellowships



Photo courtesy of Imperial College, London

Two Imperial academics have won their categories in the L'Oréal-UNESCO For Women in Science UK and Ireland Rising Talents Programme.

The Programme is designed to provide flexible and practical financial support, alongside tools and support, for early-career women scientists to pursue their research.

In a ceremony at Parliament on 15 September 2021, Dr Claudia Contini was announced as the winner of the Engineering category and Dr Jess Wade was announced as the winner of the Physical Science category.

They will both receive flexible Fellowships, each worth £15,000 to support a 12-month period of research. The researchers are shortlisted based on remarkable research, excellent academic records, and how the Rising Talents grant will enhance their careers.

Dr Claudia Contini is a Research Associate in the Department of Chemical Engineering. Her research aims to set inanimate matter in motion at the nano and microscale, with a focus on the design of synthetic life-like systems that mimic biological properties and functions for biotechnological and biomedical applications, such as drug delivery in the body.

She said: "Receiving the L'Oréal and UNESCO UK Women in Science Engineering Fellowship is an overwhelming experience and being among the great scientists selected for this prestigious award is a true honour. Science is fundamental to our society, and even if we continuously hear about the importance of equality, diversity and inclusion, women are still under-represented in the scientific community. As a woman, it is great to see an initiative like this award that supports women's career progression in the scientific community."

Dr Contini said the Fellowship

will allow her to translate her research ideas into reality. "Natural cells convert chemical signals into mechanical motion. Taking inspiration from Nature, my research aims to create minimal model systems of artificial cells capable of self-propelling in physiological environments following chemical signals. This will have a significant impact in biomedical sectors for the creation of the next generation of nanomedicine. Having a system capable of navigating in specific directions into the body will increase the efficiency of our current therapies and remove the consequences of side effects."

Dr Jess Wade is an Imperial College Research Fellow in the Department of Materials. Her research concerns new materials for optoelectronic devices, such as the LEDs used in TV and phone screens, with a focus on chiral organic semiconductors. Outside of the lab, Dr Wade is involved with several science communication and outreach initiatives. She is committed to improving diversity in science, both online and offline.

She said: "It is a real privilege to be recognised by the L'Oréal-UNESCO For Women in Science programme. I would love to become a professor someday, and lead an exciting, diverse and well-equipped research lab. This award feels like an important step in making that happen. I should say, there is truly no way I would be where I am today without Imperial. Specifically, the support of phenomenal professors like Sandrine Heutz, Matt Fuchter and Lesley Cohen. Honestly, I sometimes just have to pinch myself – every single day I get to wake up and be a scientist. How awesome is that!"

Dr Paz (Upasana) Tayal, from Imperial's National Heart and Lung Institute, was Highly Commended in the Life Sciences category.

DEVELOPMENTS AROUND THE ENGINEERING FACULTY

Imperial academics awarded prestigious Future Leaders Fellowships

Three of Imperial's next generation of world class engineers have been awarded UKRI Future Leaders Fellowships to boost their careers.

The Future Leaders Fellowship (FLF) scheme will support Dr Azalea Raad, Dr Oscar Calderon Agudo and Dr Emilio Martínez-Pañeda to boost their career and progress their work quickly by funding essential equipment and paying for researcher wages for up to seven years.



Photos courtesy of Imperial College, London

Dr Azalea Raad, Department of Computing

The fellowship will fund my research into an exciting new kind of technology called non-volatile memory, which will soon be in most digital devices, from smartphones and laptops to server farms and data centres. Non-volatile memory is persistent in that it retains its data even when it loses power, unlike traditional (volatile) memory. My research will help make sure we use this technology safely, efficiently and securely.

The funding for this project opens up a wide range of possibilities for my research. It will allow me to build my research group at Imperial by hiring talented postdoctoral researchers to join my team. It will also enable me to purchase specialist custom technology that will let me test and analyse the latest non-volatile memory hardware. I am also very fortunate to have strong links with amazing industrial partners

such as Amazon, Facebook and ARM, and this funding will reinforce our collaboration by allowing me to undertake secondments to spend some time embedded within these companies' R&D teams.

The fellowship, above all, means a chance to grow and develop as a leader in the field. It will give me the time and resources that I need for ambitious collaborations and research projects that I would otherwise not be able to do. This is not only a unique opportunity for me as a researcher, but also means I get to answer questions and develop solutions for important problems that affect the future of technology.



Dr Oscar Calderon Agudo, Department of Earth Science & Engineering

The FLF will allow me to grow my research team and focus on the development of a high-resolution ultrasound imaging technology for difficult-to-image targets, such as the human brain. Ultrasound is reflected, distorted, and attenuated at the skull, and conventional reconstruction algorithms fail to image the brain through the hard skull but also fail to give highly resolved images of softer tissues, such as the breast.

I will develop a medical device that uses advanced imaging algorithms, supercomputing, and customised sensors to provide images at sub-millimeter resolution, and I will validate the device in vivo. I will also investigate optimal pathways for

the translation of this technology to clinics, for instance for rapid diagnosis of stroke.

This fellowship is an excellent framework to perform adventurous research that can have a rapid impact on society, and it offers me the scientific independence and flexibility necessary to gather and lead a world-leading research group in high-resolution imaging.



Dr Emilio Martínez-Pañeda, Department of Civil and Environmental Engineering

The FLF will allow me to tackle complex material degradation challenges at the interface between mechanics and chemistry, from corrosion to batteries. I will use the funding to hire two postdoctoral research associates and acquire unique experimental and computational capabilities.

The extended and dedicated support of the Future Leaders Fellowship is key, as it will allow me to acquire interdisciplinary expertise. I am a Senior Lecturer in Mechanics of Materials and I will use the fellowship to become an expert in chemistry and electrochemistry. The solution to many of our pressing problems (corrosion failures, battery degradation, hydrogen storage) lies in the combinations of mechanics and chemistry, but these two areas that have been historically too distant.

Startup secures \$100M

Polymateria, a startup based at Imperial's White City Campus, has secured a near \$100 million agreement with Taiwan's Formosa Plastics. The deal will see Polymateria's additive being added to Formosa's products during the manufacturing process.

Polymateria has pioneered innovative 'biotransformation' technology that alters the properties of plastic to make it biodegradable in nature. Their technology enables plastic packaging waste such as takeaway containers, disposable cups and packaging to be digested naturally by microbes and decompose. Most biodegradable or compostable plastics do not break down outside of industrial composting facilities and leave behind harmful microplastics. Polymateria's plastic breaks down in as little as 226 days for polyethylene-based products, and 336 days for polypropylene products, leaving no microplastics behind. Polymateria's products are also recyclable, enhancing their environmental benefit.

The company focuses on what they call 'fugitive plastic' – waste material that isn't usually recycled and so is often disposed of in a landfill – such as carrier bags and bubble wrap. This waste accounts for almost a third of all plastic produced, and as much as 80% of it ends up in oceans.

Founded in 2015, the company is based in the Translation & Innovation Hub (I-HUB) at White City, one of the Campus' flagship buildings. A focal-point for White City's deep-science and tech ecosystem, the building provides office and laboratory space for businesses, start-ups and entrepreneurs alongside Imperial's extensive network of researchers, academics and other corporate partners.

Before moving to their own space, Polymateria was the first company to join Imperial's White City Incubator which provides space as well as an incubation programme and entrepreneurial training to help startups grow and develop.

Chief Executive Officer of Polymateria, Niall Dunne, said: "Our mission to develop more credible and scalable scientific solutions to address the world's plastic pollution pandemic has benefitted hugely from being part of Imperial's ecosystem. The Molecular Sciences Research Hub in particular has been instrumental in propelling us forward with the support of talented PhDs, leading-edge facilities and world-renowned professors."

Self-healing living materials engineered as 3D building blocks

Researchers in the Department of Bioengineering have created 3D building blocks that can heal themselves in response to damage. The engineered living materials (ELMs) exploit biology's ability to heal and replenish material and could respond to damage in harsh environments using a sense-and-response system. This could lead to the creation of real-world materials that detect and heal their own damage, such as fixing a crack in a windshield, a tear in the fuselage of an aircraft or a pothole in the road. Integrating the building blocks into

self-healing building materials could reduce the amount of maintenance needed and extend a material's life and usefulness.

Professor Tom Ellis said: "In the past we've created living materials with inbuilt sensors that can detect environmental cues and changes. Now we've created living materials that can detect damage and respond to it by healing themselves."

To create ELMs, the researchers genetically engineered bacteria called *Komagataeibacter rhaeticus* to have them produce fluorescent 3D sphere-shaped cell cultures, known

as spheroids, and give them sensors which detect damage. They arranged the spheroids into different shapes and patterns, demonstrating the potential of spheroids as modular building blocks. They then used a hole punch to damage a thick layer of bacterial cellulose – the scaffold-like material made by some bacteria on which ELMs are produced. They inserted the freshly grown spheroids into the holes and, after incubating them for three days, saw excellent repair that was structurally stable and restored the consistency and appearance of the material.

DEVELOPMENTS AROUND THE ENGINEERING FACULTY

Imperial experts elected as Fellows of the Royal Academy of Engineering

Four Imperial academics are among 69 experts to have been elected as new Fellows of the Royal Academy of Engineering.

Professors Aimee Morgans, Yanghua Wang, Daniele Dini, and Peter Haynes have been formally elected to the Fellowship. The new elections take the number of Imperial Fellows of the Royal Academy of Engineering – one of the highest honours an engineer can receive in the UK – to 101.

Sir Jim McDonald FREng FRSE, President of the Royal Academy of Engineering, said: “Our Fellows represent the best of the best in the engineering world, and we welcome these 69 excellent and talented professionals to our community of businesspeople, entrepreneurs, innovators and academics.

“This year’s new Fellows are the most diverse group elected in the history of our institution. The engineering profession has long suffered from a diversity shortfall and the Academy is committed to changing that, including by ensuring that our own Fellowship community is as inclusive as it can be. It is well established that diverse organisations tend to be more agile and more innovative, and as the UK’s National Academy for engineering and technology, we have a responsibility to reflect the society we serve in addressing the shared challenges of our future.”



Photos courtesy of Imperial College, London

Professor Aimee Morgans

Aimee Morgans is Professor of Thermofluids in the Department of Mechanical Engineering.

Her research focuses on aeroacoustics, aerodynamics and flames, and is aimed at making energy generation and transport more environmentally friendly.

Professor Morgans said: “It is a huge honour to be elected to the Fellowship of the Royal Academy of Engineering. I am grateful to all my collaborators, past and present, and those who have supported me. As both a woman and someone who came through the UK state school system, I look forward to promoting diversity and inclusion and progressive leadership in

Engineering, alongside excellence, creativity and collaboration.”



Professor Yanghua Wang

Yanghua Wang is Professor of Geophysics in the Department of Earth Science and Engineering and the principal of the Resource Geophysics Academy at Imperial.

His research focuses on geophysics and engineering for subsurface imaging and resource discovery, which includes inventing technologies that predict and characterise hydrocarbon reservoirs. Professor Wang also develops fundamental geophysics theory and practical implementations on the full industrial scale.

Professor Wang said: “I feel truly privileged and humbled to be elected as Fellow of the Royal Academy of Engineering. I am grateful to the Academy for this tremendous recognition and would like to dedicate this ultimate accolade to everyone who has supported me throughout my career from industry all the way to academia. Particularly, I very much appreciate my students, my colleagues and my family who have always been very supportive.”



Professor Daniele Dini

Daniele Dini is Professor of Tribology in the Department of Mechanical Engineering and an EPSRC Established Career Fellow.

His research in applied mechanics and tribology focuses on surfaces and interfaces, which range from solid mechanics, lubrication and

mechanics of materials to multi-scale modelling, soft matter physics, and biomechanics. His group performs fundamental research, often through collaborating with leading international institutions, while successfully supporting the application of tribology in industry.

Professor Dini said: “I am delighted to be elected as Fellow of the Royal Academy of Engineering. I will do my absolute best to champion the Academy’s values of engineering excellence, progressive leadership, diversity and inclusion, collaboration, and innovation. I am grateful to the Academy, and to the fantastic people I have had the fortune to work with over the years, for this recognition. A special thank you to my students and research staff, who work with me untiringly to advance science and enable the development of new technology for a better world.”



Professor Peter Haynes

Peter Haynes is Professor of Theory and Simulation of Materials at the Departments of Materials and Physics and Head of the Department of Materials.

His research focuses on computational materials science, in particular the development of new simulation tools that solve the equations of quantum mechanics for large numbers of atoms. These have been implemented in the ONETEP software that is marketed to industry by Dassault Systèmes BIOVIA.

Professor Haynes said: “I am honoured and delighted to have been elected to the Fellowship of the Royal Academy of Engineering. I am hugely grateful to the current and former members of my research group, to my longstanding collaborators and to my colleagues in the Department of Materials and across the College. I look forward to participating in the Academy’s efforts to encourage young people to become engineers and support those at an early stage of their careers.”

Water planning research

Imperial’s Centre for Systems Engineering and Innovation (CSEI) will conduct novel research to collaboratively develop an innovative digital service for future water management that will support efforts to make urban growth more sustainable. VENTURA is a £1m EPSRC-funded digital research project between Imperial College London (ICL), the British Geological Survey (BGS), and University College London (UCL). Led by CSEI’s Director Dr Ana Mijic, the VENTURA team will help end users explore housing and water system planning options using new virtual and digital engagement methods.

The way in which the built environment can work with the natural environment to avoid degrading it is an important challenge for a range of stakeholders, not only engineers and geologists, but planners, landowners, local government and policy makers. The project will investigate how models of the natural and built environment can be applied to improve water management decisions in the context of local urban planning.

VENTURA includes the creation of a novel web-based virtual decision room (VDR) and digital tools for project stakeholders and end-users to explore the impact of different planning and decision scenarios and make decisions accordingly.

The VDR will be co-created with local government, the local community, regulators and water utility companies to collaboratively plan and evaluate the environmental sustainability of urban growth planning scenarios using water consumption and waste water treatment and reuse.

This will be achieved by integrating two state-of-the-art digital tools: a ground risk calculator (GRISC) and a whole-water system model (CityWat). The project team will work together with stakeholders and end users to properly define the question and potential solutions for a range of housing and water system planning scenarios.

VENTURA directly addresses the current UK Government’s high-profile strategic initiatives including the ‘Planning for the future’ White Paper and the ‘National Digital Twin Programme’. It will help to address reducing the length of time taken to produce and review evidence for local plans and development decisions. This should support overall improvements to environmental quality and community engagement in decision making.

DEVELOPMENTS AROUND THE ENGINEERING FACULTY

Imperial named University of the Year 2022 by *The Times* and *Sunday Times*

The Times and *Sunday Times* Good University Guide has named Imperial College London as University of the Year 2022.

The news comes as the College's student satisfaction, as measured in the National Student Survey, reaches an all-time high, and Imperial takes a further Good University Guide award as University of the Year for Student Experience 2022. Imperial has significantly increased its investment in learning and teaching, including developing a world-class hybrid education experience.

The awards follow more than 18 months of Imperial people leading the scientific response to COVID-19 as researchers, students, health workers, volunteers and innovators.

Professor Alice Gast, President of Imperial College London, said: "Imperial's success is thanks to its brilliant people. When COVID-19 struck, students and staff did not just think about mitigation, they raised their ambitions.

"When labs closed, we sent 'lab in a box' kits to students' homes. As borders shut, we developed virtual field trips. When the NHS needed doctors, we brought medical exams forward and online as our students stepped-up.

"This teamwork blurred the formal divide between researchers, educators and learners. Students and staff collaborated on virology, vaccine technology, epidemiology and testing innovations that leave a lasting legacy beyond the

pandemic. They worked together to rethink our curriculum. Imperial's experience is not just a case study in crisis, it offers a glimpse of what higher education can be."

Professor Ian Walmsley, Provost of Imperial College London, said: "This award is testament to the hard work, innovative thinking and pragmatic mindset of our students and staff. Faced with the need to change, our community collaborated in new and creative ways, across Departments, and worldwide. We delivered a transformative education and student experience, as well as impactful research that helped people – exactly when the world needed Imperial.

"We have learned a lot from rethinking how we operate in a pandemic, and we are applying those lessons to build a stronger, more flexible and resilient institution."

Students have taken leadership roles in shaping what aspects of the learning experience the College provides additional support for and at what pace.

Imperial invested over £7m in improving teaching spaces across all its campuses within the last year alone. This sits alongside a sustained level of investment in student wellbeing throughout the pandemic, including generous levels of hardship funding, sustained support for students with research funding from the College and funding bodies, and financial and training support for the shift to digital learning.

The College community also

worked hard to deliver a coordinated and comfortable experience for students that have had to self-isolate as COVID-19 contacts this past year, with meal deliveries, laundry service, and live-stream exercise classes delivered free-of-charge.

Professor Emma McCoy, Vice-Provost (Education and Student Experience), said: "I give thanks to the College's incredible student-facing staff, who have gone above and beyond in this past year to ensure our students have had a safe and enjoyable university experience.

"This award and our recent student satisfaction results demonstrate that the Imperial community has exceeded expectations in the most difficult of circumstances. It is important that staff and students work together to maintain this momentum as we enter a new era at the College."

Many of Imperial's departments have switched to a revolutionary new remote assessment format and have accommodated a range of different living situations when doing so, meaning students have been able to demonstrate their knowledge from afar. They have also been offered grading 'safety nets' to account for the unprecedented challenges they have faced in this past year.

Over the longer term, the College has dedicated the past four years to comprehensively updating its entire curriculum to make it more reflective of what students, staff, and employers think is needed

in the modern world. Teaching content and formats are now more engaging, more diverse, and more practical.

Last week a separate measure, *The Guardian's* university guide, found that Imperial retained its place as the UK's number one university for graduate employability. "No one did it better".

Alastair McCall, editor of *The Times* and *The Sunday Times* Good University Guide, said: "Imperial showed the university sector how to deliver higher education for undergraduates in lockdown. No one did it better, a fact reflected in this year's National Student Survey, where Imperial improved its scores for student satisfaction during a year that took a heavy toll on those scores elsewhere. It was a remarkable achievement and Imperial is a worthy winner of both our University of the Year award and the title of University of the Year for Student Experience.

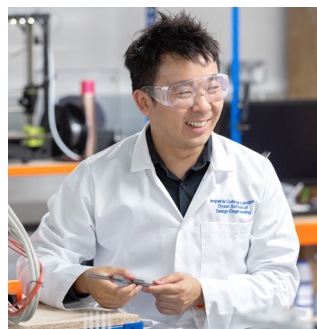
"While it innovated for its students to maximum effect during the pandemic, Imperial also played a critical role in the life of the nation. Its epidemiologists kept the country and the government informed of where the pandemic was going next, helping shape the government response to the unfolding situation. At a time of national and international crisis, Imperial demonstrated its worth as an academic powerhouse of global significance."

Imperial engineers awarded battery research fellowships

Three Imperial engineers have been awarded fellowships from The Faraday Institution. The Faraday Institution Industry Fellowships enable collaboration between industry and academia on critical issues affecting the UK battery industry. Each fellowship is to be used on an electrochemical energy research project.

The recipients from Imperial are Dr Billy Wu and Dr Haijun Ruan of the Dyson School of Design Engineering, and Dr Greg Offer of the Department of Mechanical Engineering in collaboration with Dr Alastair Hales of the University of Bristol.

Dr Wu will partner with Williams Advanced Engineering (WAE) to accelerate the deployment of advanced physics-based modelling to improve the diagnostic and prognostic capability of the WAE battery management system, targeting an extension in battery life.



Dr Billy Wu

Dr Wu said: "This exciting Faraday Industrial Fellowship will allow me and Dr Haijun Ruan to translate our work on battery diagnostics and control into real-world applications, with the goal of extending battery lifetime."

Dr Hales and Dr Offer will partner with Thermal Hazard Technology (THT) to develop a common testing framework to optimise the experimental techniques used to



Dr Haijun Ruan

parameterise battery models. The testing framework will improve the product development process and learnings will be incorporated into THT's market-leading thermal control apparatus used for battery testing.

Dr Offer said: "I am delighted to be able to support Dr Alastair Hales, an alumnus of our group, in establishing himself as an independent academic. Initiating research activities in the



Dr Greg Offer

first few years are crucial to lay the foundations for becoming a future research leader. Alastair definitely has this potential and I look forward to continuing to work with him and support him in his new Lectureship position at Bristol."

Two other fellowships were also awarded by the Faraday Institution to academics from the University of Sheffield and Coventry University.

DEVELOPMENTS AROUND THE ENGINEERING FACULTY

Imperial's Grantham Institute to measure climate impact of Coldplay tour



Photo: James Marcus Haney

Global rock stars Coldplay will work with leading researchers from the Grantham Institute at Imperial to quantify the impact of their **Music of the Spheres** World Tour. The group have pledged to do more to tackle climate change and want to use their global platform to make a positive difference.

The band will collaborate with researchers to understand the carbon footprint of the international tour, the impact of actions already undertaken to reduce carbon emissions, and to offer suggestions of how to reduce the environmental impact further in the future.

Coldplay, whose lead singer is Chris Martin and who met while studying in London, have expressed their interest in reducing the impact of climate change. In 2019, the band committed to making their future tours as environmentally beneficial as possible and the new partnership with the Grantham Institute is one of a set of sustainability initiatives and environmental commitments.

Coldplay said: "Playing live and finding connection with people is ultimately why we exist as a band. We've been planning this tour for years, and we're super excited to play songs from across our whole time together. At the same time, we're very conscious that the planet is facing a climate crisis. So, we've spent the last two years consulting with environmental experts to make this tour as sustainable as possible, and, just as importantly, to harness the tour's potential to push things forward. We won't get everything right, but we're committed to doing

everything we can and sharing what we learn. It's a work in progress and we're really grateful for the help we've had so far."

Dr Jem Woods, Reader in the Centre for Environmental Policy at Imperial and lead researcher in this partnership said, "On their last tour, Coldplay had a staggering five million fans attending their concerts with countless more fans listening to the music. They are able to reach huge numbers of people with their environmental messages."

Part of the research aims to understand how impactful the band's messages on environment and sustainability are in influencing persistent and positive changes in their fans' behaviour.

"Well-off countries and people simply can't continue with the behaviours and activities that we used to do if we are to stand a chance of effectively combatting climate change and mitigate the terrible impacts it will have on our society and environment," added Dr Woods.

"Influencers, and other high-profile people such as the band members from Coldplay can play an important role in showing the way forward and getting this message out to parts of society that climate scientists find it difficult to reach."

Luke Howell, Founder & Director of HOPE SOLUTIONS, an environmental sustainability supplier to the arts and entertainment sector, who is working on the project, said, "An independent assessment has been undertaken to audit the **A Head Full of Dreams** tour in 2016/17

and that has informed many of the actions and steps that are now being taken to reduce emissions and increase efficiencies across the upcoming **Music of the Spheres** World Tour."

Professor Martin Siegert, Co-Director of the Grantham Institute at Imperial, said, "We are delighted to be forming a partnership with one of the biggest bands in the world to help them to understand and reduce the environmental impact of their forthcoming tour."

"Tackling climate change will require rapid action across all sectors of society and it is genuinely exciting to work with Coldplay to help identify direct carbon savings and potentially to consider how bands can engage with their fans on this important issue."

Coldplay's sustainability commitments that Grantham Institute researchers will work to quantify, include to:

- Cut direct emissions by 50% compared to the band's most recent tour (2016-17).
- Power the show entirely by renewable, super-low emission energy – with solar installations at every venue, waste cooking oil, a kinetic stadium floor and kinetic bikes powered by fans. This power will be stored in the first ever mobile, rechargeable show battery (developed and made in partnership with BMW from recyclable BMW i3 batteries).
- Draw down significantly more carbon dioxide (CO₂) than the tour produces with a range of nature- and technology-based

solutions, including planting one tree for every ticket sold.

- Provide each venue with a sustainability rider requesting best environmental practices.
- Encourage fans to use low carbon transport to and from shows via the official tour app built by SAP, rewarding those who do with a discount at venues.
- Ensure all merchandise is sustainably and ethically sourced.
- Offer free drinking water and strive to eliminate plastic bottles at every venue.
- Put 10% of all earnings into a fund for environmental and socially-conscious causes, including ClientEarth, One Tree Planted and The Ocean Cleanup.
- Establish a partnership with climate change experts at the Grantham Institute to quantify the impact of the tour – both positively and negatively – on the environment.

9 things you can do about climate change

The Grantham Institute has produced a guide to the most achievable ways you personally can make a difference.

While individuals alone may not be able to make drastic emissions cuts that limit climate change to acceptable levels, personal action is essential to raise the importance of issues to policymakers and businesses.

Using your voice as a consumer, a customer, a member of the electorate and an active citizen, will lead to changes on a much grander scale.

1. Make your voice heard by those in power
2. Eat less meat and dairy
3. Cut back on flying
4. Leave the car at home
5. Reduce your energy use, and bills
6. Respect and protect green spaces
7. Invest your money responsibly
8. Cut consumption – and waste
9. Talk about the changes you make

Visit the Grantham Institute web pages for more details or to download a flyer:

<https://bit.ly/IE35-Climate>

Adapting to change

2021 Autumn message from Imperial's President Alice Gast

The saying, "change is the only constant in life" is attributed to the Greek philosopher, Heraclitus around 500BC. Our adaptation to change has taken many forms through the centuries, with each generation perhaps feeling as though they are coping with more rapid change than the generations that came before.

The pandemic wrought big changes to institutions and individuals throughout the world. The impacts on our personal and professional lives and habits have been profound. Some have suffered tremendous emotional and financial losses and others have felt less secure and more uncertain about the future than ever before. Through it all, we as a community have shown fortitude and resilience. Our community has come together, and we have accomplished much under difficult conditions. We will be shaped by our shared experiences of these past few years, and we can use the lessons we learned to help us navigate the changes ahead.

As we return to some of our traditional ways of conducting research and educating students, now is a good time to think about what is needed to effectively manage change. We aim to retain the lessons learnt and collaborations we built during the pandemic while also regaining the best of our tried and tested ways of doing things. There is a tremendous amount of change afoot and we will need to work together to help one another navigate it and embrace the opportunities it brings.

Different cultures deal with change and uncertainty in different and sometimes subtle ways. After years of attending conference dinners and observing the growing complexity in the diversity of people's diets and schemes like coloured dots on name tags, I was pleasantly surprised at a banquet in Australia. The staff delivered alternating vegetarian and meat dishes to every other person at the table. My Aussie colleagues explained that everyone could swap with one another and "it all works out". That level of flexibility and ease impressed me. As many people are flexible omnivores, the group was able to take care of those who had more specific dietary needs.

How can we ensure that flexibility and adaptability prevail as we deal with the changes ahead of us?

How can we lead the sector in adapting to change?

How can we find ways as a group to take care of one another?

Here are three thoughts that I think are relevant to finding the right ways to adapt going forward:



Photo: Thomas Angus / Imperial College, London

- Learn from how we set priorities during the pandemic;
- Show our leadership through our mission;
- Balance the difficult with the easy.

Learn from how we set priorities during the pandemic

In our personal lives, the illness and loss of loved ones heightened our sense of vulnerability. We reflected on how we use our time and whether our priorities needed to be adjusted.

When we had to transition to almost entirely remote operations and online working, our highest priority was to provide our students with an excellent education. Our colleagues went to great lengths to ensure that learning outcomes were met and experiences, online, at home, and on campus, when possible, were the best they could be. Our students took note and registered their satisfaction and appreciation for the tremendous extra effort they saw in their responses to the National Student Survey.

Working together at a distance is not easy. We had to work harder to sustain the social and informal relationships that bind us as colleagues, collaborators and friends. In some cases, we came to know one another better. This understanding of personal and professional life helped us to sharpen our focus on staff and student well-being. We found new and collaborative ways of working together to set priorities. Ideas, innovations and decisions came from all parts of our community. Students and professional staff

working together with academics transformed education, while operational and academic experts designed a safe working environment. These collaborations persist and will be an asset in the future.

Our research and innovation also pivoted to doing everything possible to understand and mitigate the disease. Covid-19 has been a top priority. From modelling to making hand sanitiser to new detectors and vaccine platforms, Imperial has been there for the community, the UK and the world.

Show our leadership through our mission

As the world and our country emerge from the pandemic, we know that there is much that needs to be changed and there are many economic, environmental, social and health challenges we must face. Rising to challenges like these is one of the things that we do best. Our mission, enduring excellence in research, teaching and innovation for the benefit of society, has never been more important. Our focus on it will be critical as we adapt to the changes occurring in society and higher education.

We have, as an energetic, path-finding institution, an opportunity to show the way forward for universities as the UK government embarks on its spending review. We are advocating for a strong and sustainable research base so that we can drive the research needed to make the future better for all. Along with this, we must support our pipeline of talent in STEM fields.

Universities provide the world with a strong foundation of excellence in discovery research, strong links with industry and a supply of highly-skilled and entrepreneurial talent. The discoveries of fundamental research drive innovation, and university graduates fuel its implementation. In a thriving innovation economy, research and teaching should be tightly connected and pursued as one. Too often, we hear teaching and research set counter to one another; this must stop for the UK to be successful. We need strong integrated support for the entirety of our university mission. We welcomed the government commitment to increase R&D investment to 2.4% of GDP and we stand ready to help define that roadmap to the future in a manner that integrally combines research with teaching.

The brilliant graduates from Imperial make the case for this support and Imperial's changing entrepreneurial landscape. I saw this the other day on a visit to the I-Hub and ScaleSpace at our White City campus. I

DEVELOPMENTS AROUND THE ENGINEERING FACULTY

spoke to Henrik Hagemann, one of the co-founders and CEO of Puraffinity. After success in our WEInnovate and Venture Catalyst Challenge programmes and winning external support, they have grown their company, designing smart materials for environmental applications, and are now establishing a new manufacturing centre near Middlesbrough to make materials to clean up water. This green job creation by a small company, started by Imperial's international students, illustrates how our global outlook contributes to the UK government's goals of Levelling Up and Building Back Better.

We lead the sector as one of the most international universities and looking ahead we will continue to advocate for open exchange of students and scholars from around the world. We will also maintain the marvellous and inspiring integration of teaching and research that we displayed so effectively during the pandemic.

Balance the difficult with the easy

Sometimes the world's challenges seem insurmountable. The effects of climate change, the geopolitical tensions, the inequalities in health care and other societal problems can leave us despairing about the future. We take heart that, at Imperial, we are dedicated to ensuring that our research, teaching and innovation benefit society by dealing with many of these very difficult things.

We must also seize opportunities to make a

difference on a local or smaller scale. To "pick the low hanging fruit" is an important concept that builds momentum, rewards successes and prepares us to tackle the hard problems. It is important to take the time to thank people who are finding easier ways forward amidst the large list of challenges ahead.

All institutions and all sectors are grappling with how to best use time and space going forward. One area with immediate opportunity for Imperial is to support one another as we combine the benefits of technology that enabled working from home with our renewed ability to meet in person. This hybrid way of teaching, pursuing research, collaborating, discussing, and planning will require some adaptability, but we have already demonstrated our ability to do it. Our commitment to effective and timely two-way communication will help us embrace these changes in our ways of working.

Seizing opportunity

We all have different outlooks on life. These past two very disruptive and difficult years have changed the way we think about the future. Our outlook is shaped by our age, past experiences, personality, financial status, health, culture and other factors. It is more important than ever that we share our different perspectives to gain a broader understanding of the way they affect the way we view the world. By doing this we can help one another adapt and cope.

We learned during the pandemic that

compassion and understanding are paramount. If we engage in open dialogue, listen carefully and are sensitive to the needs of others we will have the flexibility and adaptability to navigate the changes ahead.

I am an optimist and I bring that personality trait to my positive view of the future. Every day I see something in our news to buoy my spirits. A heart-warming story of outreach to our community, an accolade and support won by a younger colleague, a transformational research discovery, an exciting entrepreneur with a good idea or an inspiring student design project making a difference to the world. These all make me confident that Imperial College London will continue to improve the world for everyone. Taking the time to enjoy and appreciate all that we have at Imperial lifts our spirits and expands our collective sense of what the future can hold.

A major change will occur in ten months when my successor, Professor Hugh Brady, takes on the role of President. It is a privilege to lead Imperial and I am pleased to be handing over an inspiring and exceptional institution to an academic leader of his calibre. We will work together next summer to ensure that this change is a smooth one for all.

This time of change is as exhilarating as it is unsettling. We have opportunities to seize and changes to navigate. I know that we can lead in this rapidly changing world if we learn from our experiences in the pandemic, pursue our mission single-mindedly, balance the difficult with the easy and understand and support those with different needs.



Photo: Thomas Angus / Imperial College, London

Professor Hugh Brady has been confirmed as President-designate by Imperial's Council. Professor Brady will take up the role on 1 August 2022, after Professor Alice Gast's term as President concludes. An international authority on the pathogenesis of renal inflammation and diabetic kidney disease, Professor Brady has been Vice-Chancellor and President of the University of Bristol since 2015. Professor Brady formerly served as the youngest ever President of University College Dublin (UCD), Ireland's largest university, where he is also an alumnus. His academic career also included roles at Harvard Medical School and the University of Toronto.

Impact of a volcanic eruption in

Recent research by the University of Cambridge and the UK Met Office has shown that human-caused climate change has important consequences for how volcanic gases interact with the atmosphere. Large-magnitude eruptions will have greater effects as the climate continues to warm, whereas the cooling effects of small and medium-sized eruptions could shrink by as much as 75%. Since smaller eruptions are far more frequent, further research is needed to determine whether the net effect will be additional warming or cooling. In this article, Wyss Yim (Geology 1971-74) looks at the impact of the 1982 El Chichón volcanic eruption in Mexico.

Rainfall is an important indicator of climate change but has rarely been studied with the aid of reliable observation records. In support of anthropogenic global warming, temperature rise is assumed to increase the amount of water vapour entering the atmosphere to increase rainfall including the higher frequency and greater magnitude of floods. In this study, the eruption cloud from the 1982 El Chichón volcanic eruption in Mexico tracked by satellites for the first time is revisited to explain both the timing of rainfall and a record-breaking wet year in Hong Kong located over 14,000 kilometres away across the Pacific Ocean.

Volcanic eruptions release large amounts of water vapour, dust and ash into the atmosphere. They also produce large quantities of carbon dioxide and sulphur dioxide. If the eruption is large and tropical, any material in the stratosphere can circulate the globe and be transported pole-wards. The addition of aerosols, water vapour and particulates can also reflect solar radiation, causing a negative radiative forcing while their settlement through the atmospheric column contributes large amounts of condensation nuclei for generating rainfall.

The Total Ozone Mapping Spectrometer (TOMS) was a satellite instrument of the National Aeronautics and Space Administration (NASA), specifically a spectrometer, for measuring the ozone layer. The satellites carrying TOMS were first launched in 24th October, 1978 and operated continuously until 1st August, 1994 making it the first ever tool available for the tracking of volcanic eruption clouds.

In late March to early April, 1982 three successive eruptions of the El Chichón volcano in Mexico on 28th March, 3rd April and 4th April created a maximum cloud column height reaching 26 kilometres above sea level. The Volcanic Explosivity Index was ranked 5 while 7 million tonnes of sulphur dioxide aerosol and 20 million tonnes of particulates were estimated to be ejected into the stratosphere. Global maps of the volcanic cloud migration were made after the eruption, by combining information from the geostationary GOES East and GEOS West satellites and the polar-orbiting NOAA 7 satellite. The westerly drift of the volcanic cloud at an average rate of 20



Photo: United States Geological Survey

The 1982 El Chichón eruption, Mexico

metres/second was measured for the first time to completely circle the globe in 21 days.

An analysis of the rainfall record of the Hong Kong Observatory's Headquarters Station near Nathan Road from 1884 to

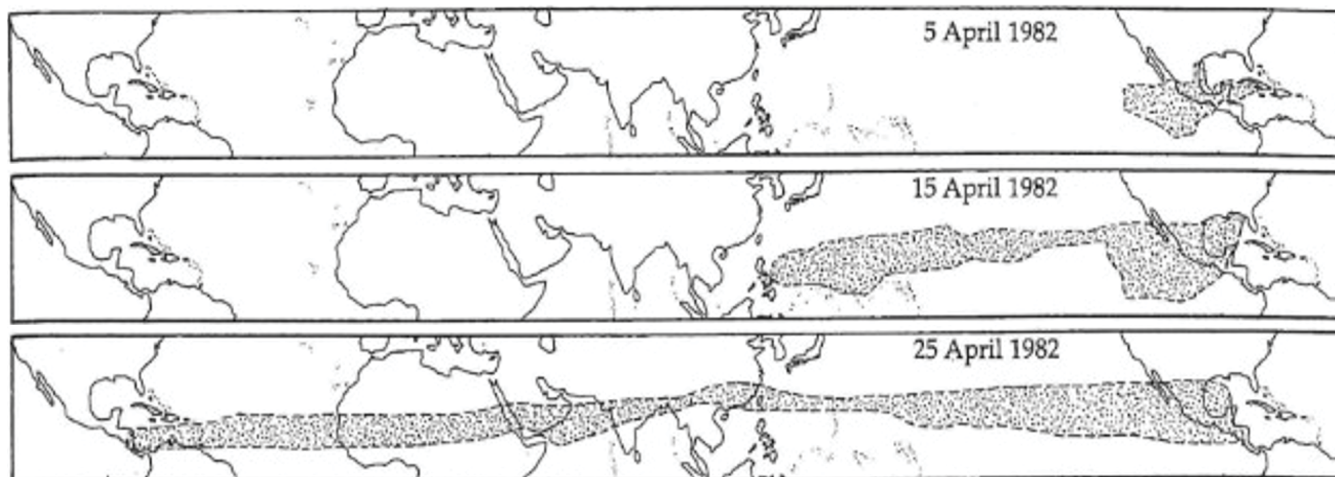
2020 has revealed a mean annual rainfall of approximately 2,230 mm with a range of 2,441.9 mm. The driest year on record (901.1 mm) is 1963 and the wettest year on record (3343.0 mm) is 1997 one of the strongest El Niño year in the instrumental record. Previously 1982 (3247.5 mm) another strong El Niño year was the wettest year on record. This high rainfall variability found may be accounted for by Hong Kong's location on the coast of the large Asian continental land mass making it susceptible to wind shifts. Onshore winds are moisture laden and are largely responsible for rainfall in contrast to the dry offshore winds.

The westerly drift of the El Chichón volcanic eruption cloud from Mexico had significant impact on rainfall in Hong Kong in spite of the city's location over 14,000 kilometres away across the Pacific Ocean. The arrival date of the stratospheric cloud above Hong Kong on 16th April, 1982 coincided with the record low relative humidity measured at ground level (fifth lowest on record) and is consistent with the stratospheric influence of aerosols, ice crystals and particulates settling through the troposphere providing condensation nuclei for

| | |
|----------------------------|--|
| Location | Latitude 17.33°N Longitude 93.2°W |
| First eruption | 11.32 pm on 28th March, 1982 |
| Second eruption | 7.35 am on 3rd April, 1982 |
| Third eruption | 5.22 am on 4th April, 1982 |
| Volcanic Explosivity Index | 5 |
| Cloud column height | Maximum elevation 26 km |
| Average migration speed | 20 m/second |
| Volume of tephra | < 1 km ³ of trachyandesite |
| Aerosol | 7 million tonnes of sulphur dioxide |
| Particulates | 20 million tonnes |
| Major climatic impact | Intense El Niño of 1982-3 through changes in atmospheric circulation |

Statistics of the 1982 El Chichón eruption in Mexico.
Source: Wikipedia and Global Volcanism Programme.

Mexico on Hong Kong rainfall



Rainfall distribution and statistics at the Hong Kong Observatory's Headquarter Station in 1982

| Month | Rainfall (mm) |
|-----------|---------------|
| January | 16.0 |
| February | 23.1 |
| March | 30.6 |
| April | 310.0 |
| May | 767.4 |
| June | 205.9 |
| July | 296.2 |
| August | 872.0 |
| September | 466.8 |
| October | 163.7 |
| November | 95.8 |
| December | trace |

Total 3247.5 mm
Annual average 2214.3 mm
146% above average

Normal for April 139.4 mm
- 222% above normal
- 9th wettest on record
- Relative humidity 5th lowest on record

Normal for May 298.1 mm
- 257% above normal
- 5th wettest on record
- Worst landslips since 1976

Remote sensing satellites tracked the westerly drift of the El Chichón eruption cloud continuously and precisely. The eruption cloud was over Hong Kong after 11 days.

Source: Rampino, M.R. and Self, S. (1984) *Scientific American* 250/1: 34-43.

rain. On 19th April the first trace of rainfall was detected becoming heavier on 22nd April with 70.9 mm.

During 1982 rainfall distribution in Hong Kong shows a bimodal distribution pattern with the first peak in May followed by a stronger second peak in August. The first peak can be explained by the first and second time drift around the globe of the El Chichón eruption cloud while the second peak shows subsequent drifts at least several more times contributing anomalously large amount of rain until November 1982.

In conclusion, volcanic eruptions are a natural cause of climate change responsible for the second wettest year in Hong Kong's instrumental record since records began in 1883. The year 1982 was notable for extreme weather events including disastrous floods and landslips. Based on the study of the observation record of the El Chichón eruption volcanic cloud, anthropogenic global warming may be ruled out as a cause. Further studies on the impact of other volcanic eruptions on rainfall are however needed to support this underestimated natural cause.

| Date | Rainfall mm* | W i n d direction* | Inference |
|-----------|--------------|--------------------|--|
| 19/4/1982 | Trace | 080 | Rain fell several days after the arrival of eruption cloud above Hong Kong; the influence of stratospheric aerosols is in agreement with the low relative humidity recorded at ground level and prevailing wind direction; total April rainfall of 310 mm was the ninth wettest on record. |
| 20/4/1982 | 0.1 | 050 | |
| 22/4/1982 | 70.9 | 150 | |
| 23/4/1982 | 59.9 | 040 | |
| 24/4/1982 | 31.0 | 050 | |
| 25/4/1982 | 11.6 | 060 | |
| 26/4/1982 | 7.3 | 030 | |

* Source: Hong Kong Observatory.

Daily rainfall at the Hong Kong Observatory's Headquarter Station and wind direction at the Waglan Island apparently attributable to the first arrival of the El Chichón eruption cloud over Hong Kong on 16th April, 1982.



Professor Wyss Yim DSc PhD DIC FGS was at Imperial College in the Department of Geology from 1971-1974. After that he spent 35 years until retirement at the University of Hong Kong where he taught civil engineering, geosciences and environmental management students, and helped found the Department of Earth Sciences. He was awarded the DSc by the University of London in 1997. Wyss served as the deputy Chairman of the Climate Change Science Implementation Team of UNESCO's International Year of Planet Earth 2007-2009.

Beyond carbon:

Systems approaches to sustainable infrastructure

On 27 June 2019, the UK became the first major economy to pass a net zero emissions law requiring that all greenhouse gas emissions are brought to net zero by 2050. The new law poses major economic, scientific and engineering challenges, and a complete transformation of the way we think of and deliver infrastructure, including Net-Zero cities, as well as several hundred billion pounds of investment. A large body of evidence, from both research and industry, sets out what needs to be done, and by whom, in order to reduce both infrastructure and industry's carbon footprints. It is in this context that Imperial's Centre for Systems Engineering and Innovation (CSEI) – a Faculty of Engineering initiative established in 2010 with the aim to provide a hub for work that brought systems approaches to civil infrastructure – carries out research on how a systems approach to infrastructure and seeing infrastructure as a system of systems are key to achieving climate change mitigation not just through a reduction in carbon but also in other forms of pollution. Dr Jeni Giambona agreed to tell us about the Centre and its Research Agenda.

The Centre is research-led and brings together world-class systems research, academic excellence and industry expertise with the aim of providing a hub for work that brings systems approaches to civil infrastructure. Over the last decade it has been deepening its engagement with industrial partners and members to develop world-leading research with a focus on six interconnected research themes – **Carbon Neutral to Net Zero Pollution, Complexity and Resilience, Systems Integration, Data-Driven Systems Engineering, Transforming Construction, and Infrastructure Lifecycles**¹.

Above all, the Centre's work sets out to answer the following question: with the world facing unprecedented challenges of climate emergency and economic uncertainty, the question is how can we continue providing the quality of life through infrastructure in a sustainable, cost-effective and fair way, while minimising its impacts on environments?

It is precisely with this in mind that we have developed our 2020-2030 Research Agenda² which advocates for an approach that sees the natural environment as all-pervasive, where the built infrastructure is inseparable from it and is an adaptation of the natural systems to suit societal needs, using its materials and resources. We see this work as relevant for both the academic community and a wide range of industry and policy applications that are working on infrastructure transition pathways towards fair, safe and sustainable society.

How we work

We work closely with industry partners and policy bodies to understand their real-world problems, bring those insights back into the university to develop next generation solutions which are then fed back into practice to ensure that our research has impact on their processes and practices. This means being able to accelerate the process of implementation of research outputs and new technologies, delivering value to our stakeholders by

Imperial College
London

Our approach to working with industry members



First, we examine existing planning, design and operation practices to develop new knowledge on the opportunities and challenges for Systems Engineering to transition to resilient, sustainable and safe infrastructure.



Second, we develop novel tools and approaches from a systems perspective, using a range of modelling, simulation and data analysis techniques



Third, as part of an 'open innovation' ecosystem working across traditional boundaries, we rapidly address issues to solve the fundamental engineering problems that arise in complex infrastructure projects and net-zero infrastructure transition

Photos and figures courtesy Imperial College, London

improving efficiency and so reducing costs, increasing returns and extending lifecycles.

All members have the opportunity to:

- Shape the Centre's research in line with real-world needs;
- Engage in relevant, co-created research when opportunities arise;
- Upskill the workforce;
- Access cutting-edge research and knowledge base;
- Keep abreast of the latest cutting-edge developments in the sector.

We are delighted to work with partners in the following fields who are developing their sustainability strategies:

- Governments and government agencies;
- Infrastructure owners, developers, construction companies;
- Consultancies;
- Management;
- Corporations – i.e., corporate sustainability;
- SMEs;
- Start ups.

We are also proud that our research is contributing to Imperial's systems research³ focused on solving global societal and environmental challenges.

Need for integrated planning and digital transformation

To bring Systems Engineering and Innovation to Civil Infrastructure, we need to better understand the natural and societal impacts of infrastructure interventions under uncertainty. This requires a change in current approaches to infrastructure systems engineering: starting from the natural environment and its resources, encompassing societal use of infrastructure and the supporting infrastructure assets and services. In the coming years, we see the Centre as a platform for discussing and creating knowledge to support this new thinking by developing novel modelling methods and forms of model integration and multi-criteria indicators for complex infrastructure problems that go beyond boundaries of individual infrastructure systems. We have summarised our ideas in the recently published

'Research Agenda on Systems Approaches to Infrastructure' which highlights the following points:

- At a time of system shocks, significant underlying challenges are revealed in current approaches to delivering resilient infrastructure, including the need for holistic assessment and that infrastructure-users in many societies feel distant from nature.
- Our research focuses on the transition towards zero pollution, resilience and complexity, systems integration, data-driven systems engineering, and infrastructure lifecycles, as key themes that can further our understanding and evaluation of all-pervasive infrastructure-environment systems.
- We argue for modelling that brings natural as well as built environments within the system boundaries to better understand infrastructure and to better assess sustainability.
- We set out a 2030 research agenda with the aim to develop novel modelling approaches to better understand the natural and societal impacts of infrastructure interventions under uncertainty.

As mentioned, one of the most significant challenges that we have identified is that infrastructure-users in many societies feel distant from the natural environment, i.e. assuming that water comes from the tap, without questioning the taken-for-granted infrastructure and its connections with nature. While interdependent civil infrastructure systems depend upon and directly embed natural resources, such as land, water and construction minerals, the delivery of infrastructure displaces natural activities both in situ and in distributed locations across supply-chains. Society can feel distant from nature as these connections become obscured by complexity.

This is why our interdisciplinary work has identified a pressing need to better understand the natural and societal impacts of infrastructure interventions under uncertainty. We then argue for a change in current approaches to infrastructure that redraws the boundaries of the system to start from the natural environment and its resources, encompassing societal use of both the infrastructure itself and its supporting assets and services. Having reviewed the various ways of describing infrastructure and its relationship with nature, we advocate that researchers need to develop novel modelling methods, forms of model integration, and multi-criteria indicators. Moreover, our research shows that we need to move beyond carbon!

Environmentally-Positive Infrastructure (EPI)

A systems approach to Environmentally-Positive Infrastructure (EPI), so infrastructure that looks beyond carbon in order to improve the overall quality of the environment and

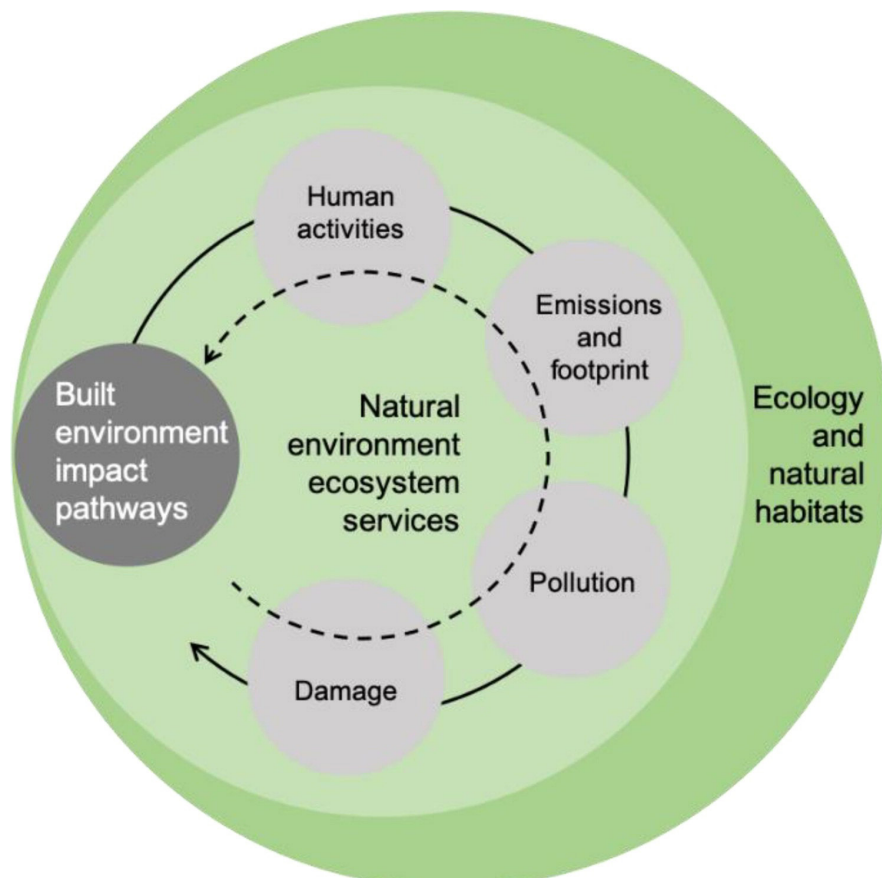


Figure 1: Visualisation of the EPI concept

provide social, ecological, and economic benefits, certainly presents challenges, but also affords enormous opportunities.

As a starting point, we need to answer three main questions:

- How do we **envision** future built-natural environment systems?
- How do we **evaluate** the performance of our existing systems and redesign them in the context of the future vision?
- How do we **integrate** decisions on how to regulate, operate, design and build for the future using systems approaches?

Since the purpose of infrastructure is human flourishing and that infrastructure is a system of systems, we must envision and manage infrastructure accordingly.

Figure 1 above shows a high-level visualisation of the EPI concept. The figure reminds us about the complexity of the problem we are trying to solve, which is a problem of a system boundary. Above all, Figure 1 communicates three key messages. Firstly, when we analyse options for pollution management, it is important not only to understand the level of pollution, which is typical analytical focus, but also to propagate that influence to assess the

damage that pollution imposes on both people and the natural environment. The ability to quantify the ultimate impact of our activities will enable us to make a stronger case for action and potentially explore a wider range of options for pollution management. Secondly, Figure 1 visualises what we mean by the EPI concept. Two aspects are important here. If we aim to eliminate (all) pollution sources, for which multiple technologies are available (breaking the link between emission/footprint and pollution in Figure 1), there is still a key question to answer when it comes to managing human activities: can we ensure that the notion of 'clean technology' will not increase system use? This implies that pollution management options should also include resources (water, food, energy, materials) demand management and integrated land use planning. If we, however, decide to try to develop an EPI system by removal of pollution once it is emitted to minimise the damage (e.g., net zero carbon), issues such as water quality due to diffuse pollution, air pollution and impacts on health as well the challenge of embodied resources should be considered as well.

Finally, the EPI agenda needs to be closely linked with the ecosystem services analysis. Our reliance on natural resources for the functioning of the human system will become an ultimate constraint on future development, and we are all at the same time part of the problem and part of the solution. A key point to make here is around system responsibility and who is to make decisions on integrating the natural environment into our

FEATURES

infrastructure decision analysis. In this respect, there is much more that could be done with regulation and policy change, which is one of the highest leverage points in the systems analysis. This would take the responsibility from individual actors and the market and ensure implementation at a wider scale.

So, in order to fully understand and manage the link between natural and built environments, a systems approach is necessary. This will allow for solutions that go:

- Beyond cities, as we need to understand the **wider environment** and how our infrastructure decisions contribute to the pollution which causes environmental damage;
- Beyond carbon, looking at **direct pollution** as any substance or any form of energy emitted to the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled, or stored in some harmless form;
- Beyond direct pollution, understanding the **embodied pollution** associated with infrastructure materials, and water and land footprint.

Moreover, the concept of Environmentally-Positive Infrastructure (EPI) as an adaptive system of systems intrinsically linked to people and the natural environment will help to:

- Better understand targets for offsetting environmental impacts;
- Set development goals within the capacity of natural systems;
- Improve resilience, safety and sustainability through policy, technology and behavioural change options for future-proofing.

In order to achieve EPI, there is a need for enhanced coordination and integration, and this is where part of the value of a systems approach lies. An example of this type of integrated approach is our EPSRC-funded VENTURA project, a collaborative piece of research with the British Geological Survey (BGS), and University College London (UCL) led by CSEI's Director Dr Ana Mijic. The VENTURA team will help end-users explore housing and water system planning options using new virtual and digital engagement methods.

The way in which the built environment can work with the natural environment to avoid degrading it is an important challenge for a range of stakeholders, not only engineers and geologists, but planners, landowners, local government and policy makers. The project will investigate how models of the natural and built environment can be applied to improve water management decisions in the context of local urban planning.

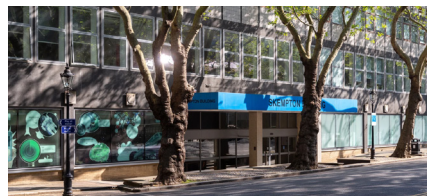
VENTURA includes the creation of a novel web-based virtual decision room (VDR) and digital tools for project stakeholders and end-users to explore the impact of different planning and decision scenarios and make decisions accordingly.

The VDR will be co-created with local

government, the local community, regulators and water utility companies to collaboratively plan and evaluate the environmental sustainability of urban growth planning scenarios using water consumption and wastewater treatment and reuse.

Conclusion

To conclude, at a time of system shocks, significant underlying challenges are revealed in current approaches to delivering infrastructure: these include the need for holistic assessment and that infrastructure-users in some societies feel distant from nature. In response to these challenges, we advocate for an approach that sees the natural environment as all-pervasive, where the built infrastructure is inseparable from it and an adaptation of the natural environment to suit societal needs, using its materials and resources. We refer to this concept as the Infrastructure-Environment Nexus. The concept of Infrastructure-Environment Nexus in the context, for instance, of water management can help us address two long-standing scientific and practical challenges of broadening the scope of water management from an engineering to a sociotechnical process: (1) integrated assessment and (2) collaborative decisions. In cities, the biggest challenge for future water planning is the impact of housing development on water sustainability. The concept of water neutrality holistically addresses this challenge as it promotes developments designed to offset adverse impacts on water resources, water quality and flood risk by promoting solutions such as water efficiency and green infrastructure. Current state-of-the-art approaches to strategic land use planning are based on spatial optimisation or indicator-based assessments. These approaches, however, cannot assess feedbacks between water and land use systems (e.g., impact of housing on water quality and implications for wider ecosystems), which have to be evaluated to develop truly water-neutral solutions. Tools that can deliver holistic water-neutral planning are still to be developed.



More information about CSEI can be found on the Imperial website at: <https://bit.ly/IE35-CSEI>

To join us and help us make our research vision come to life, see our **Get Involved** page⁴ or email our Research and Engagement Manager Jeni Giambona, j.giambona@imperial.ac.uk.

Follow us on Twitter @csei_imperial

Sign up for our Newsletter⁵ to be notified of our future events and research highlights.

Carbon neutral to net zero pollution



Research lead: Dr Ana Mijic, Dr Marc Stettler, Dr Rupert J. Myers

What is the problem?

Infrastructure is vital to society and provides us with energy, water, transport, telecommunications, and waste management. For most of human development, infrastructure was separated from environment. However, as the scope of human activities changed, creating significant environmental impacts, the role of infrastructure has transitioned from supporting human systems to also managing natural environment. This raises a question of addressing systemic impacts of infrastructure projects and the role of civil and environmental engineering in creating and maintaining the built environment.

Global focus is currently on reducing greenhouse gas (GHG) emissions through setting the Net Zero Carbon targets at national levels and science-based targets for companies. This is of course beneficial to tackling global climate change. However, systemic impacts that refer to both direct and indirect long-term impacts extend beyond carbon footprint and spatial boundaries of an infrastructure project. These impacts, which cause the environmental damage – including biodiversity loss, and severe air, water, and soil pollution – are due, at least in part, to direct environmental pollution in some form or another. In addition, indirect environmental impacts due to infrastructure in the form of embodied pollution associated with infrastructure materials, and water and land footprints pose additional strain on the natural environment and affect its ecosystem services. The data portrays devastating impacts of pollution at a global scale, with annual number of cases of premature death linked to the use of natural resource and environmental damage currently reaching 19 million.

Our infrastructure decisions contribute to the pollution that our society generates; however, they can also determine how we manage the trends of population growth, urbanisation, and growing consumption. Within that context, infrastructure is critical in shaping the set of viable routes to reducing environmental pollution in the future. We argue that civil and environmental engineers must play a crucial role in creating solutions that will promote sustainable development. This raises the question: how can we continue to improve quality of life through infrastructure provision, while minimising our impacts of pollution on the natural environment in the world that we have already created?

Transforming Construction



Research lead: Professor Jennifer Whyte and Dr Luigi Mosca

What is the problem?

If the key to transforming the construction sector lies with a move towards increased use of digital engineering capabilities, DfMA and offsite manufacturing, then there is a risk that a significant proportion of the supply chain will be left behind. The UK government has placed the importance of ensuring the SME supply chain stays connected with changes in the sector through a variety of guidance documents and funded programmes, one of these is Transforming Construction Network Plus (N+) programme.

Infrastructure Lifecycles



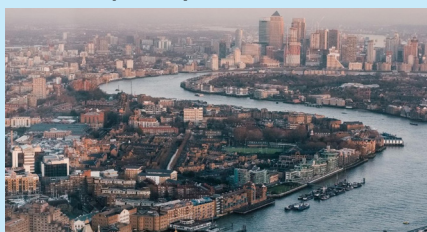
Research lead: Dr Rupert Myers

What is the problem?

Infrastructure systems are essential to society and underpin the nature of the built environment (spatial distribution, type, etc.), since they provide numerous basic services, e.g.: transport (road, rail, etc.); energy (electricity distribution and transformation, etc.); water (sewerage, water treatment, etc.). Their high social importance, and characteristically long lifetimes and high initial investments, are key reasons why infrastructure systems are usually both constructed and operated by an organisation. E.g., the London Underground, initially constructed and operated by the Metropolitan Railway in the mid-1800s, is currently operated by Transport for London.

These key aspects distinguish the 'product' life cycles of an infrastructure system (Kia, Wong, and Cheeseman 2020), i.e., including construction, use, and end-of-life stages, as 'service-oriented' rather than 'production-oriented', whereas the latter is common to most other products, e.g., clothes and fast-moving consumer goods. Therefore, infrastructure systems already embody the core 'service-oriented' element of the circular economy. The key for a sustainable infrastructure system is thus to reliably deliver its social service(s) without excess cost(s) (to the managing organisation and society) and environmental impacts.

Complexity and Resilience



Research lead: Professor David Fisk, Dr Panagiotis Angeloudis, Professor Washington Ochieng

What is the problem?

In a conventional approach to building a system, the whole design is tested only when construction is complete. This approach works for simple projects but becomes unreliable as the system complexity increases. The tried and tested systems engineering solution breaks the design task down into layers of ever smaller blocks until they correspond to identifiable components. The design is then realised by assembling the layers of blocks, testing realised performance against the design at each level of assembly. However, as the complexity of the design increases further, even this approach incurs problems. Controlling growing complexity is the issue.

Systems Integration

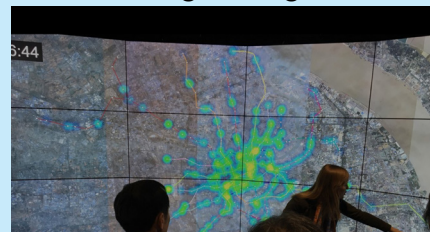


Research lead: Professor Jennifer Whyte

What is the problem?

Infrastructure systems are interdependent open systems of systems. Approaches to project delivery that focus only on the management of contracts have not been effective, leading to delays and cost over-runs in delivery, but also not delivering the best outcomes for society. Projects are interventions into existing infrastructure systems of systems. Their construction and maintenance involves many different types of engineering knowledge. There are many forms of complexity and uncertainty spanning the technological, ecological, and socio-political, both within and across project boundaries.

Data-Driven Systems Engineering



Research lead: Professor Julie McCann, Dr Ivan Stoianov

What is the problem?

Climate change, the Covid-19 pandemic and the urgent need for a sustainable co-existence between humans and the environment is likely to accelerate the digital transformation for complex critical infrastructures such as water, food, transport and electricity.

The resilience and sustainability of these complex infrastructures relies upon the acquisition and analysis of data with unprecedented spatial and temporal resolution, the application of advanced modelling, optimisation and control methods, and the integration of multiple disciplines and expertise to develop solutions.

Recent advances in data analytics are impacting the way we engineer systems, creating unique challenges and unmatched opportunities, advancing theory, methods, tools and practice of data-driven design. Data, typically from networks of distributed sensors and actuators, can help enhance designs, optimise performance, provide timely warnings of failures, support automation and make better use of resources. Yet current SCADA (Supervisory Control and Data Acquisition), IoT (Internet of Things) and IT systems, key to the timely, reliable and secure delivery and access to data, are not designed with the rigour, reliability and agility to meet the needs of multiple applications and users in order to maximise investment returns. This gap brings many research challenges, the most important of which is the co-design of both the computing (SCADA/IoT/IT) and engineering infrastructures.

- 1 See the blue boxes (left and above) or for more detail visit: <https://bit.ly/IE35-CSEI-Themes>
- 2 The Research Agenda is available here: <https://bit.ly/IE35-CSEI-Agenda>
- 3 <https://bit.ly/IE35-Systems-Research>
- 4 <https://bit.ly/IE35-CSEI-Get-Involved>
- 5 <https://bit.ly/IE35-CSEI-Newsletter>



Dr Jeni Giambona is the CSEI Research and Engagement Manager. She has substantial experience of university research engagement, including as Research Manager for the £6.23m EPSRC-funded Innovative Construction Research Centre at University of Reading, and as Deputy Director of Oxford University's Centre for Corporate Reputation where she managed a research programme worth in excess £10m. Jeni has engaged with high-profile external and internal stakeholders, both in the UK and internationally, and managed the full life-cycle of University research from horizon-scanning through to bid development, project delivery, reporting, dissemination and impact. Jeni got her Doctorate from the University of Reading, has herself carried out research and has a track record of publications. Jeni has a passion for researching, and applying, how to build identities through narrative and is a humanist with a penchant for infrastructure and NBS. When not working you can find her, without fail, going through muddy fields with her dogs.

Imposter syndrome

Imposter syndrome can be especially prevalent among students from under-represented groups in a world-class institution like Imperial. The SIDUS research project in Imperial's Centre for Higher Education Research and Scholarship has been looking at the problem and what can be done to help those students.

As Imperial alumni, we are well aware that we have benefitted from studying at one of the leading educational and research institutions in the world. This perhaps becomes more keenly felt each year as Imperial consistently places better and better in many Higher Education league tables (for example, in September *The Times* and *Sunday Times Good University Guide* named Imperial College London as University of the Year 2022; while *The Guardian* ranked Imperial first for Mechanical Engineering in their 'The best UK universities 2022' guide). Those of us who remember the level of competition to gain a place at Imperial in 'our day' can only watch in awe at the ever greater standard of entry now, with the brightest students from around the world vying to study here, with courses having 10 or more applicants for each place.

Joining such an intelligent and high-performing community is, of course, a great thrill and can engender a sense of achievement on arrival. But it can also have the opposite effect. Coming from a good grammar school

in a small town, to a world-class university in one of the world's great cities where I had classmates from six continents, I remember very quickly realising that despite having been the top of my classes at school, I was now in a cohort comprising students all of whom had also been the high-performers in their own schools and as a result I was suddenly relatively average. Too often the result of this perceived change in status can be what is now termed 'Imposter syndrome'. It can be especially difficult for students to deal with if they also feel that they are in an under-represented group (e.g. minority ethnic, first-generation, mature, LGBTQ, disabled students, women, etc.).

SIDUS project

Imperial's Centre for Higher Education Research and Scholarship (CHERS) is conducting a two-year study (2020-2022) aimed at promoting inclusion and supporting success for Science, Technology, Engineering, Mathematics and Medicine (STEMM) students from under-represented groups at

the university: the Supporting the Identity Development of Underrepresented Students (SIDUS) project.

Building on earlier work, they have explored the lived experiences of STEMM students from under-represented groups. They also intend to work with under-represented students and develop case-studies and other relevant resources for staff and students to enhance an inclusive and supportive learning environment that maximises the participation, strengths and potential of the current and prospective under-represented STEMM students. Understanding how these groups of students navigate their way through university life contributes to the knowledge of their successes, challenges and opportunities. Thus allowing for better support of academic and professional identity and a sense of belonging, which are central to the wellbeing of students.

Based on 110 interviews with undergraduate students across departments at both Imperial and the University of Reading, SIDUS explored students' lived experiences. Areas

The amount of information I am getting is overwhelming...

How is the Union structured?

I am not sure which College services to turn to for support.

I feel like I don't belong and sometimes it just gets a bit too much.

What are the Constituent Unions?

Make the most of your time at Imperial!

Find answers in 'A Student's Guide to Imperial'

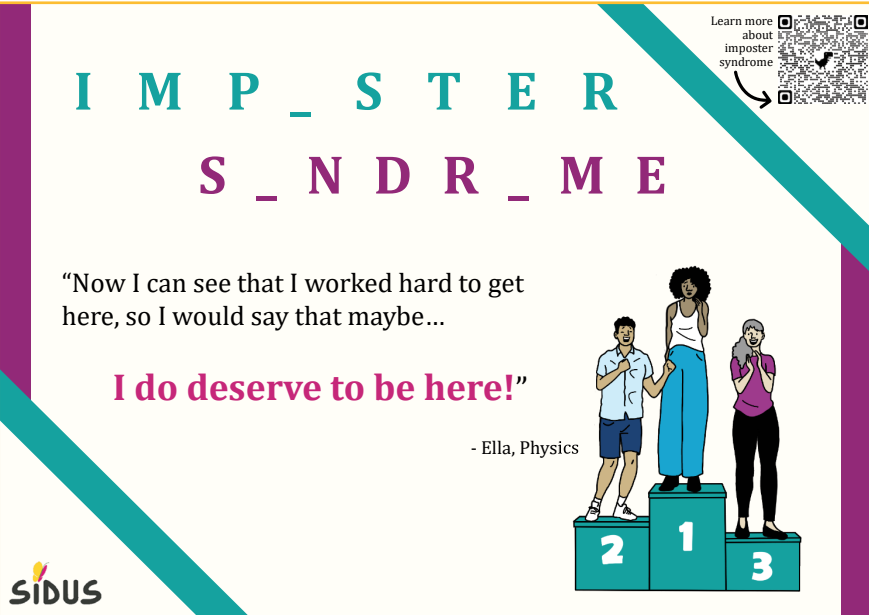
made by students, for students

Download the handbook now

SIDUS

Posters courtesy of SIDUS project, artwork by Raquel Durán

covered in the interviews addressed: a sense of belonging in general; notion of 'typical or ideal' students; future career planning and future professional selves; and experiences of being 'under-represented'. Analysis of the interviews (Chiu & Murray, 2021; Murray et al., 2021) revealed that 'imposter syndrome' was present in 37 of 110 interviews; 10 students discussed imposter syndrome explicitly in the interviews; 27 students discussed feelings that the researchers defined as imposter feelings; imposter feelings can impede the development of a sense of belonging. From this, SIDUS has developed suggestions for how the university can foster a diverse and inclusive learning environment for all, especially amongst under-represented groups. Students experience imposter syndrome differently depending on their intersecting structural identities and how under-represented they are in particular spaces. Imposter syndrome can be a diversity and inclusion issue. Collective 'spaces of belonging' helped manage imposter syndrome,



**I M P _ S T E R
S _ N D R _ M E**

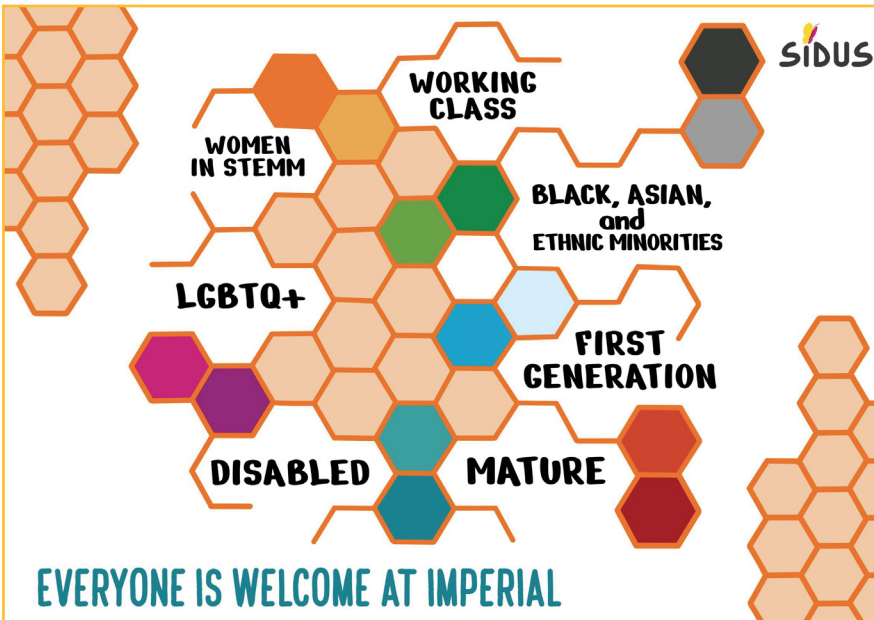
"Now I can see that I worked hard to get here, so I would say that maybe..."

I do deserve to be here!"

- Ella, Physics

SIDUS

Learn more about imposter syndrome



EVERYONE IS WELCOME AT IMPERIAL

WOMEN IN STEMM

WORKING CLASS

BLACK, ASIAN, and ETHNIC MINORITIES

LGBTQ+

FIRST GENERATION

DISABLED

MATURE

SIDUS

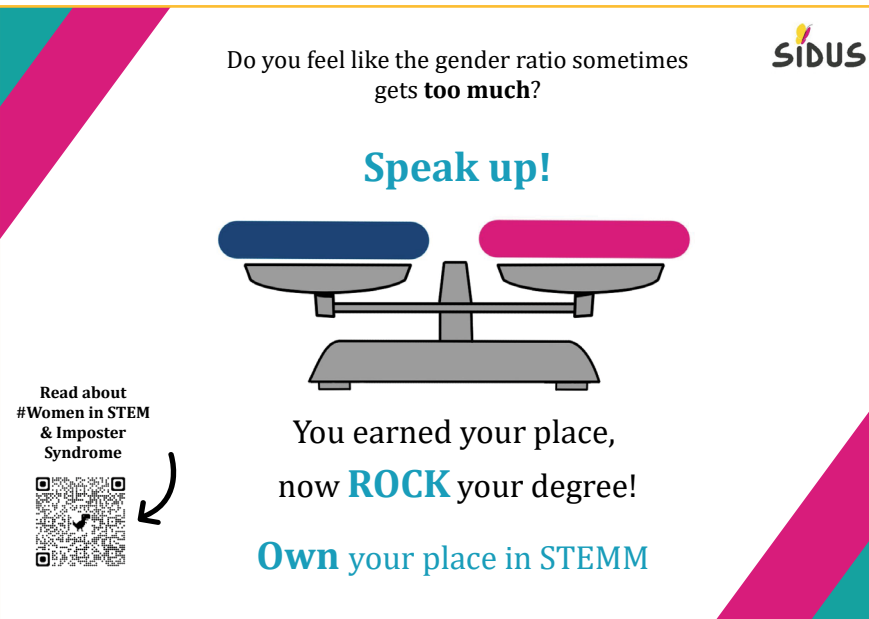
"I didn't feel like I fitted in because a lot of the events in the first few weeks of Freshers' Weeks were very drink heavy or going out. I just think it's not where I found myself. Later on, when I began to meet other people who had similar interests to me in the way that they have fun. I think that's when I started feeling a bit more like I fit in or belonged."

including friendship groups and student societies where they could meet students that were 'like them' or with an inclusive group identity. The university should be managing student expectations and understanding of what it means to be a university student (e.g. not to be afraid of making mistakes/asking questions; imposter feelings can be very common). Transparency in expectations plays a key role in reducing inequalities caused by assumptions.

A Student's Guide to Imperial

The SIDUS project has produced a handbook 'A Student's Guide to Imperial' based on the results of the interviews with students and intended to help new students fit in, feel at home and cope with the stresses of being in a new and possibly strange environment. SIDUS research data has informed the Handbook in collaboration with StudentShapers.

StudentShapers is a programme that offers Imperial undergraduate students



Do you feel like the gender ratio sometimes gets **too much**?

Speak up!

You earned your place, now **ROCK** your degree!

Own your place in STEMM

Read about #Women in STEMM & Imposter Syndrome

SIDUS

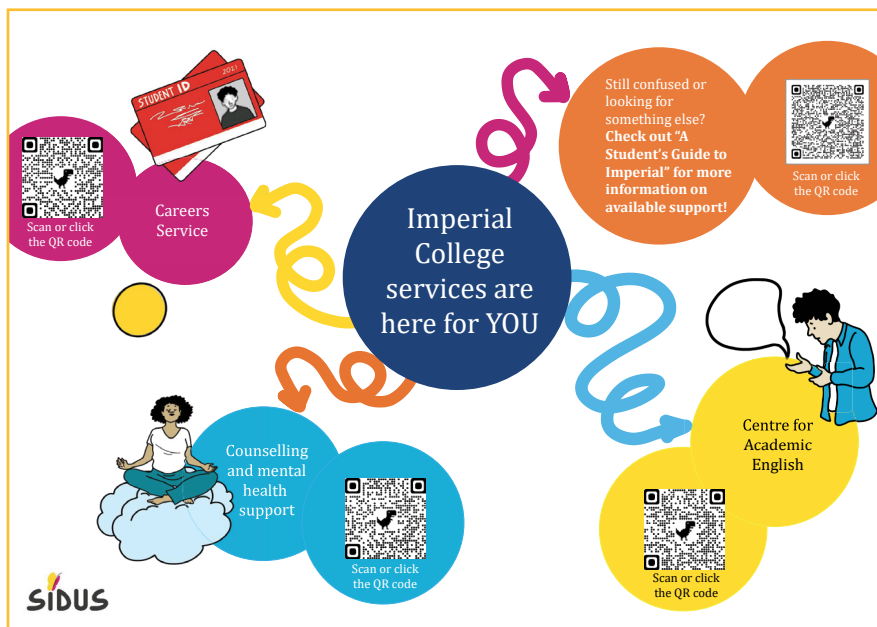
FEATURES

the opportunity to undertake projects in partnership with staff to enhance curricula, develop innovative teaching practices and make positive change to the student experience. The Handbook has been produced by three student partners: Danai Bili from Physics, Marine Coispeau from Life Sciences and Katarzyna Zukowska from Electrical and Electronic Engineering, with illustrations by professional illustrator Raquel Durán. The content is based on and inspired by the rich interview data collected in the SIDUS Project.

As well as the handbook, there is also a set of 21 bookmarks, with quotes from students, advice and links for helpful resources, and a set of 8 posters (shown here).

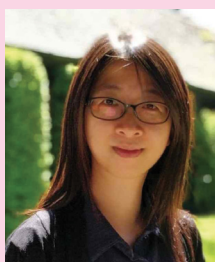
It's great news that students today are being given this sort of support and, after 45 years, I finally know that it wasn't just me!

Editor



Have you got all the bookmarks yet? Check out the SIDUS website!

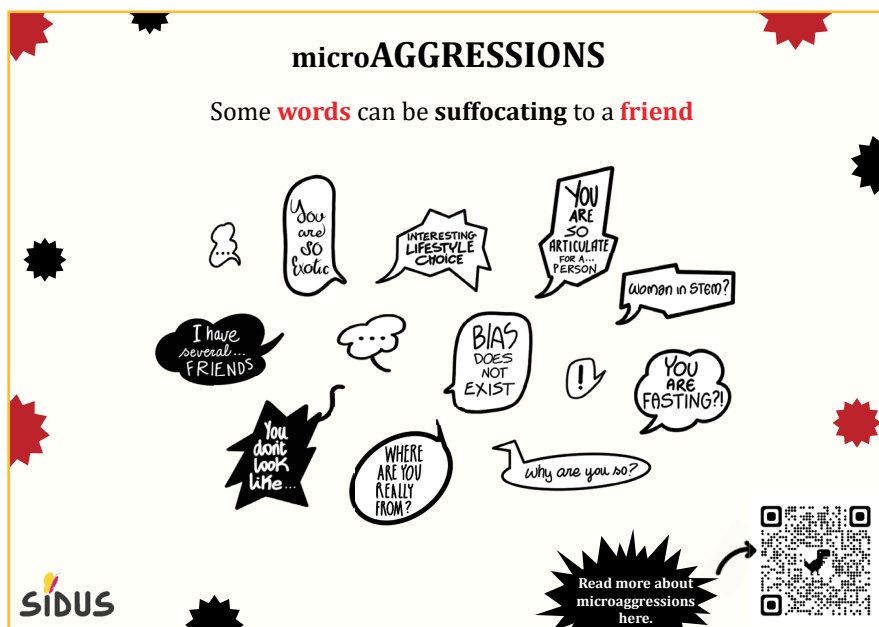
The project team



L to R: Dr Jo Horsburgh (CHERS), Prof Martyn Kingsbury (CHERS), Dr Tiffany Chiu – Principal Investigator (CHERS), Dr Órla Murray (CHERS) and Dr Billy Wong (University of Reading)

Photos courtesy of Imperial College, London

“Microaggressions are the everyday slights, indignities, put downs and insults that people of colour, women, LGBTQ+ populations or those who are marginalised experience in their day-to-day interactions with people.”



“I felt almost as though ‘you don’t deserve to be here’ or ‘you’re here by fluke’. But I think I’ve been able to shake that feeling off bit by bit to where I am now.”

For more details...

To find out more about the SIDUS project, and for full references, visit the project pages on the Imperial website at <https://bit.ly/IE35-SIDUS-project>

You can also download the handbook, bookmarks and posters as pdf files from <https://bit.ly/IE35-SIDUS-material>

Let the SIDUS team know what you think about these materials at <https://bit.ly/3A1ep90>

The student partners



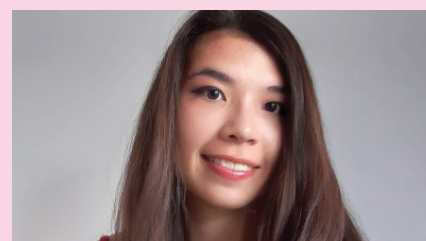
Danai Bili, Physics

“Hello, I am Danai and I just graduated from the Department of Physics! In my natural habitat I enjoy reading about Medical Physics applications and going for long runs.”



Katarzyna Zukowska, Electrical and Electronic Engineering

“I am a third-year EEE student with a passion for film and education, currently working as an Outreach STEM Ambassador at Imperial.”



Marine Coispeau, Life Sciences

“I just graduated with a Biotechnology degree from Imperial College this year (2021). Some of my hobbies include running, drama and traveling! It has been an honour to work on this project during the summer and I can’t wait to see how this may benefit the incoming students!”

The Invisible Matter: Nanomaterials

This year's RSMA Trust Essay Prize was won by Disha Bandyopadhyay, a 3rd year MEng Materials with Nuclear Engineering student, for this essay delving into the fascinating world of nanomaterials.

Despite a nanometre being just a billionth of a metre, materials with features on this scale are much more reactive and dynamic than their bulk counterparts. Just the basic components of matter – elements and their electronic densities are fused in together in a smaller area in a nanomaterial such that most of the electron density spews on the surface, ready to react with other materials. Their widespread use in industry allows nanoparticles to be either engineered with a specific purpose or be an incidental by-product that could cause multitudes of problems. Therefore, the study of nanomaterials has two great benefits: understanding the pollutants and toxins and using the same science to trap and reduce pollution. Although their high reactivity and small size makes them unpredictable and difficult to control, the Department of Materials at Imperial College London studies them so that their properties can be harnessed for the good: healthcare, sporting goods, cosmetics, food, consumer electronics, computing, environmental remediation among others in various forms of unique particles or thin films.

There have been growing concerns since the early 2000s about nanotoxicity, leading up to the much-debated nanomaterial paradox. What gives nanomaterials their huge potential benefits, (their large surface area to volume ratio) is also the same property that makes nanomaterials so dangerous.

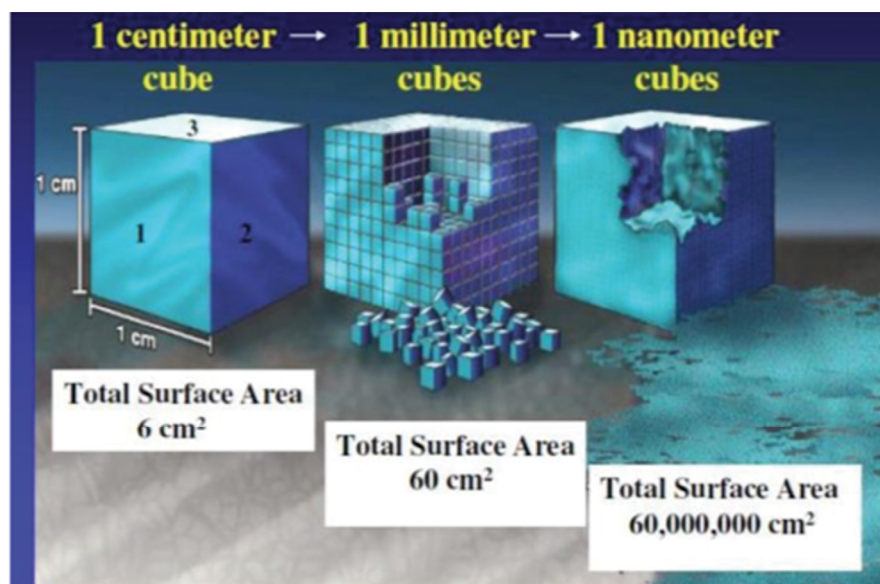


Figure 1: How nanoscale features result in increased surface area. From [1]

Owing to their small size, not a lot of material is required to make these structures, but typical nanoparticles are made of inorganic materials such as cadmium selenide and tellurium which are mostly toxic. They are also capable of entering animal and plant systems easily. Zinc oxide nanoparticles from cosmetics enter through oral or dermal routes, nanoparticles from cigarette smoke enter the system via inhalation while some nanoparticles are intentionally injected intravenously for medical treatments. When these particles enter any living species, they cause an inflammatory biological and ecological response. They produce reactive oxygen species which alter cell potential, causing acidification, killing, and compromising healthy cells. Even inert nanoparticles can interact with the environment by forming physical coatings around organisms, interfering with their growth and natural behaviour. In the third-

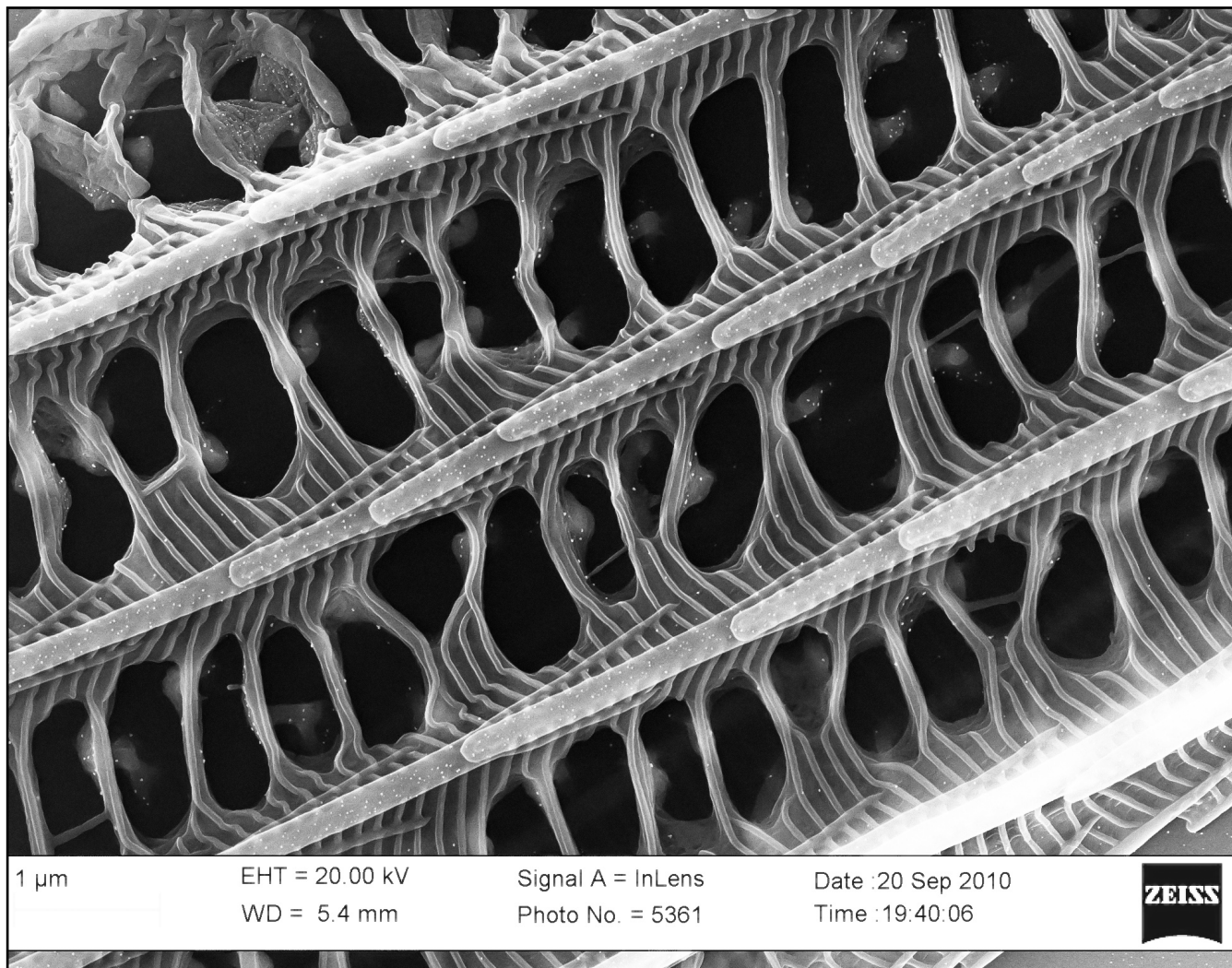


Figure 2: SEM image of the fibrils on a morpho moth wing. The spacing of the fibrils allow constructive interference of about 450nm waves resulting in the blue colour of the wings. From [2]

year nanomaterials option, we study this phenomenon, particularly how the core and surface structures affect nanomaterial properties. Stability of any suspension of nanoparticles is achieved by controlling basic parameters such as pH, temperature, dissolution/redox behaviour, and surface agitation. The ability to translocate barriers and intoxicate flora and fauna is controlled by the effective dose or the concentration of the particles, clearance time and how easily accessible cells and organelles are in the ecosystem. All of this is ultimately a function of materials processing, which controls the shape, size, surface area and surface reactivity. Due to their tiny size, synthesising a batch of nanoparticles to be monodisperse and homogenous can be challenging, albeit not impossible.

Man-made nanoparticles often end up in landfills, wastewater systems and biosolids, as they emerge from the production of raw materials, manufacture of products and the end of product lifecycles through wear and tear and corrosion. Naturally occurring nanomaterials exist and are randomly structured and distributed. They're formed by volcanic ash, ocean spray, bacteria, mineral composites and much more. Whether these

nanoparticles attack or protect species depends on whether the particles are stable in their tiny form or if they deposit themselves onto surfaces, or aggregate and transform themselves into more complex arrangements. Some of these nanoparticles set themselves into useful arrangements such as the sharp conical spikes on a cicada wing which gives them antimicrobial properties, nanoscale fibrils in the wings of the morpho moth which give it a brilliant blue colour, or into thin films on aquatic plants like water lilies which make them superhydrophobic and an inspiration for artists like Monet.

Nanoparticles are small enough such that the bulk material properties do not apply to them. And they aren't singular particles either, so quantum mechanics doesn't define them. Hence, nanomaterials form a bridge between modern and classical physics, expanding our understanding of what matter is and all it's capable of. The confinement of electron densities results in smaller nanoparticles being good absorbers, while the larger ones are better scatterers of light.

Due to their highly sensitive surfaces, nanomaterials work as effective gas sensors. This works on the basis of how the interaction with specific gas molecules can rearrange the

surface electron densities, affecting the overall conductivity of the material. Each type of nanoparticle changes its conductivity in a set way in the presence of the gas molecule, which is documented. For example, a graphene coated with a polymer nanoparticle has high sensitivity to nitrogen dioxide levels and is used as a gas sensor for the same. In environmental applications, the presence of hydrogen peroxide is a good indicator of whether a degradation process is taking place and, judging by the rate of change of conductivity, the rate of the degradation process can be determined. The same principle can be used to synthesise various other sensors which can be used to efficiently detect when air toxicity is increasing, or if there has been any leak in manufacturing processes, particularly when hazardous gases are used in synthesis routes. These particles also double as buffers to help maintain healthy compositions.

Nanomaterials allow for another great sensing application which works with solvents. Specialised functional groups attached to nanoparticles bind with the target molecule that is wished to be detected. Once this bonding happens, the size of the particle changes and, therefore, so does its absorbance capability, which can easily be



Figure 3: The Lycurgus cup, currently in the British museum, that changes colour depending on direction of incident light. From [4]

detected by UV-vis spectroscopy and dark field microscopy. This makes it a quick and relatively easy testing technique for detecting toxin levels in rivers and lakes. The same idea is also used when nanoscale zero valent iron is used to immobilise metals, detoxify pesticides, and transform fertilisers. The use of magnetic nanoparticles in this way also helps clean-up carcinogenic dyes released from the textile industry [3]. Furthermore, since nanoparticles are typically inorganic substances they don't bleach over time and it's a lot easier to use them than their organic competitors. Both the detector and marker can be made of the same material, just a different size/morphology, so they're easier to make. Essentially, just the processing time can be changed and the product changes from one function to another.

The primary challenge with dealing with nanoparticles is how tiny they are. It isn't possible to have a wide beach clean-up with them as we do with plastics (instead, they're used for the clean-up), so targeted and specific solutions must be engineered. This is where nanoporous structures are making headlines as saviours where one nanoscale structure immobilises the more harmful nanostructure. The tailoring of pore number, size, and charge in a nanoporous material aids the removal of organic solvents, heavy metals, bacteria, and aerosols from the environment and so environmental remediation remains an immense arc of applications. Nanomaterials have been used in water filtration where a bottle with two necks and a membrane in the middle is manufactured. The inlet water contains many particulates and pollutants. The

other side of the membrane creates an osmotic pressure by the presence of nanoparticles. The nanoparticles help segregate the pollutants to one side of the membrane so clean water can be poured out. Add a nifty magnet at the top and none of the nanoparticles can enter the useful water stream.

Nanoscience is not a new field. In fact, historic artefacts such as the Lycurgus cup made by the Romans in the fifth century AD harnessed orientation dependent scattering effects of nanoparticles to produce luminescence in different colours. It is likely they didn't understand the science behind this colour change, but pairing known applications with our current technological advancements, we can engineer better and highly functional structures with nanotechnology. It is becoming easier to synthesise nanoparticles now whether this be by modelling them with greater accuracy or synthesising the modelled structures via sputtering techniques or sol gel processing. We can ultimately visualise them with advanced microscopy techniques such as SEM and TEM, as well as FIB which allows in situ imaging to potentially show the reaction taking place in real-time. With these possibilities, even more permutations and combinations of materials and structures can be studied, combined, and implemented for applications with a greater impact and chance of success.

Evidently, nanoparticles have a variety of applications and their contribution to advanced sensing technologies have brought breakthroughs in efficient detection systems. The challenge for the scientific community

now lies in making safe nanomaterials and harnessing the power of their unique properties to address the challenges of ecological disaster. The question of whether nanomaterials are safe in their current form for the ecosystem remains largely unanswered, and with lots of inconclusive results. However, it can't be denied that their widespread use and successful integration has been an indispensable tool, making it clear that nanomaterials need to be further explored. They have the potential to change and revolutionise our world, but in which direction exactly is yet unknown. So, there's only one way to find out – continual research and study!

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- [1] Ryan, MP 2020, Lecture 4: Nanotoxicology, lecture notes, MATE96007 Nanomaterials 1, Imperial College London, delivered December 2020.
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Seismic 2021 Conference

The Society of Petroleum Engineers' annual Seismic Conference, normally held in Aberdeen, once again became a Virtual Event in 2021. The RSMA Trust was pleased to sponsor the conference attendance for Elim Wong, a Geophysics second year undergraduate student. Here, Elim tells us what the conference was like and why it was a valuable learning experience.

I was privileged to have received a subsidy from the RSMA to attend the five day Seismic 2021 Conference by SPE Aberdeen on 17–21 May. This is the second year Seismic 2021 has been held virtually instead of in Aberdeen, due to COVID-19. Similar to the previous year, the theme of this year was about energy transition, the role of seismic in unlocking value in the energy mix. The conference was presented by numerous experts from different universities, energy and seismic companies on topics around seismology. Seismology plays a significant role in exploration, development and production of energy and can also be applied in other fields at the same time. Apart from oil & gas and carbon capture & storage, seismic analysis is used in other fields including wind farm construction, geothermal energy, and fibre optic monitoring. Many of these topics were presented over the five days. In addition a number of speakers also introduced and discussed the progress that has been made in technology like 4D time-lapsed seismic imaging, ocean bottom seismology, machine learning on fault identification. All speakers included industrial examples.

There was an interesting talk by Jagat Deo from Seismic Image Processing on a newly developed seismic processing method. He introduced a brand new established One-Way Wave equation, the Guided Wave Migration eGWM, and then compared it to the traditional Kirchhoff method using field data. Jagat presented the conclusion that the new method is more accurate with a lower signal-to-noise ratio, and it is also more efficient and hence can result in a reduction of 700% CO₂ emissions by using lower computing requirements. He emphasised the importance of choosing a green processing method. Rather than using processing methods that take days or months to execute, by choosing a much faster computational method that takes less time while being able to produce similar results, we can save energy. This then reduces the carbon footprint of seismic processing, which is an important step in helping reach a net zero target. I found this talk very interesting as I never related seismic processing with carbon footprint before, but I completely agree it is a meaningful perspective to consider, and we should pay more attention to this characteristic.

As a second year geophysics undergraduate student, to be honest, I have to admit that the discussion in the conference sometimes went beyond my understanding. The speakers in



Elim Wong, 2nd year Geophysics student

the event are all professionals with many years of studies and experience in the subject, thus it is sometimes a little bit hard to understand and follow the abstract technical discussion. However, I do believe the conference is worth attending as an undergraduate. I have expanded my seismic knowledge and skills in these five days which I believe can help with my seismology project and lectures in the coming years. The conference also triggered my curiosity to research deeper in seismology, like searching the terminologies and principles behind the concept in the presentations and discussions. Furthermore, it was a great experience to join the discussion with many specialists in the field and to experience how the industry works. The industry environment is challenging and keeps changing with the advance in technology and computing power, a lot of difficulties are encountered during the work and people have to work as a team to solve them together. It is also really pleasing to

hear opinions on topics like the future of the oil & gas and seismic industry from a professional perspective from the field. As a geophysics student, it is great to know that even with the net zero target and the decline in Oil & Gas Sector, seismic skills and techniques are also applicable to other fields for utilisation and that seismologists remain in demand. I have learnt a lot from the conference on seismic processing and also learnt to think about seismology from a different perspective, it has built up my enthusiasm for seismic studies and I am considering to do a postgraduate degree in relevant field in the future.

Overall, Seismic 2021 was a fantastic event and I really enjoyed it. I would recommend every geophysics student interested in seismology attend the conference in the future. Finally, I would like to express my gratitude to RSMA for subsidising my entrance fees to the conference.

Imperial fund leads investments in Electric Vehicle 'super app' and eTanker energy storage

Bonnet, a startup founded by two Imperial alumni, focused on improving the experience of electric vehicle drivers, has raised a £920k pre-seed round from investors including the Imperial College Innovation Fund (ICIF).

Bonnet has launched a mobile app that aims to eliminate range anxiety for electric vehicle drivers by granting access to EV charging points away from home. It combines locating, routing and paying for EV charging across the range of available charging infrastructure – public, semi-public and even private.

Launched in January 2021, Bonnet offers customers confidence in accessing chargers along their journey, transparent pricing and reliable real-time information on charger availability. Over 30,000 charging locations are listed on the app and the company has launched partnerships with fleet and rideshare companies including FreeNow, Porsche and Green Tomato Cars.

ICIF has invested £300,000 in Bonnet Electric as part of a £920k pre-seed round from investors including Ascension Ventures, Axel Springer Porsche and Business Angels.

ICIF invests in startup companies with a strong connection to Imperial College London, such as those founded by students, members of staff or alumni, or companies which have engaged extensively with Imperial's entrepreneurial ecosystem.

Bonnet was founded in 2020 by Imperial alumni Patrick Reich and Eliot Makabu (MEng Electrical and



Eliot Makabu and Patrick Reich

Electronic Engineering). Following the completion of their studies, focussing on electricity balancing and storage, Patrick and Eliot took part in the Venture Catalyst Challenge and worked closely with the Enterprise Lab and mentoring services to develop their business.

Drawing on expertise from across Imperial and industry, Bonnet's advisors include Professor Goran Strbac, Professor of Power Engineering at Imperial, Jochen Rudat, a former director of Tesla Europe, and Dr Harveen Chugh, Associate Professor of Entrepreneurship at the University of Warwick.

Patrick Reich, CEO and Co-founder of Bonnet, said: "Our vision for Bonnet is to develop a super app that supports electric vehicle users to do everything they need to make EV ownership better. Securing access to charging away from home is the first step. Our focus following

this funding round is to grow our userbase and bring on board more Charging Point Operators, in order to continue validating with customers."

Brijesh Roy, Seed Investment Manager at Imperial, said: "Patrick and Eliot are young entrepreneurs who have built successfully on their scientific training and the entrepreneurial support available across Imperial College London. As well as supporting EV owners, Bonnet's vision of improving access to EV infrastructure supports Imperial's sustainability goals, and we are delighted to support this exciting business through its seed funding round."

Bonnet is available for download on both App Store and Google Play Store. You can use the code "HELLO" when registering to get a month of free charging!

<https://www.joinbonnet.com/>

The Imperial College Innovation Fund (ICIF) has also led a £1M seed investment round for UK energy storage startup, Cheesecake Energy Ltd (CEL). This will fund the development of CEL's manufacturing capabilities and its lead eTanker storage system.

CEL was founded by Imperial PhD Mike Simpson (Chemical Engineering), and is developing a green energy storage technology known as eTanker that stores electricity in the form of compressed air and heat. eTanker is deployed in a modular, containerised package, making it suitable for a range of terrains and applications in industry including local renewable microgrids, electric vehicle fleet charging and heavy industry.

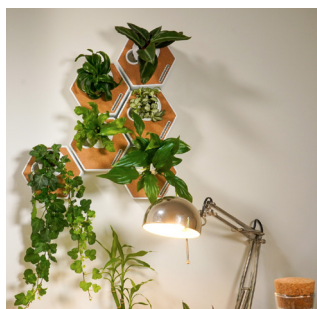
CEL's patented technology revolutionises current compressed air energy storage by storing two-thirds of the electricity as heat, at a lower cost. CEL believes its innovation will lead to 30-40% cost reductions for energy storage, coupled with portability and flexibility that will make it attractive for many applications. It uses ex-service truck engines, converted into zero-emission electrical power conversion machines for energy storage. These drive compressors, which deliver high pressure air and heat into storage units. When electricity is required, the air and heat pass back through the converted truck engines, now acting as turbines, to turn a generator and produce electricity.

<https://cheesecakeenergy.com/>

Design Engineering alumni develop mini green wall for home use – reach Kickstarter goal in 4 hours!

Four Imperial alumni are reimagining the way houseplants are displayed by developing a self-watering mini green wall for the home.

The team behind Shirinoku have created the Noku Canvas, a new way to display houseplants as part of a modular system that would be self-watering, wall-mounted, and display plants like art. The Canvas is specially designed to give those in even the smallest of homes a way to bring nature into their living space, by opening up the walls as a place



to put plants.

Shirinoku's four founders say that they experienced the mental health benefits of houseplants first-hand, which inspired them to create the Noku Canvas. The team lived together during the pandemic's lockdowns and often felt trapped indoors, with little access to green space.

After buying several houseplants they felt a noticeable change in their mood and happiness. The team recognised the benefits of houseplants but saw several issues with keeping them – namely remembering to water them and

the plants taking up space or being forgotten in the corner of a room.

With the Noku Canvas, plants can be displayed vertically, and the modular system allows the green wall to be built and customised by its owner. The wall-mounted canvas means that shelf space is saved and a 3-week water supply can be stored in the canvas' water basin, making it self-watering through a hydroponic wicking system. The Canvas is made from recycled plastic and natural cork, and one of their key values is to be carbon neutral.

Shirinoku was named after the Japanese art of forest bathing, or *shinrin-yoku* – the act of visiting a forest to soothe oneself mentally.

They launched a Kickstarter project to fund development of Noku Canvas and reached their goal of £10K in 4 hours! The Kickstarter is now closed and they raised over £139K in funding.

<https://www.shirinoku.com>



Photos courtesy of Shirinoku

Shirinoku was founded by four graduates from Imperial's Dyson School for Design Engineering: (L to R) Ben Collis, Marcus Melconian, Luke Holland and Elvis Lee.

Electrical Engineering class of 1978

The Electrical Engineering class of 1978 to 1981 met on Saturday 4th September 2021 for the 40th anniversary of their graduation. They had planned a much bigger event, but Covid travel restrictions for those who live abroad meant that it had to be scaled back to a drink and dinner in the FiveSixEight bar in Beit Quadrangle. Nevertheless, 13 attended, and were pleased when the manager of the FiveSixEight bar invited them into the Union Bar which brought back many happy memories. They are planning a bigger reunion once Covid is behind us, either in 2022 or 2023. Some of the class are looking forward to the decade reunion lunch on Saturday 13th November. To get in touch with the class, please email

alan.r.higginson@btinternet.com

Alan Higginson (Electrical Engineering 1978-81)



Beit Quadrangle (left to right): John Johnson, Andrew Hall, Marek Stuczynski, Krishna Thakrar, Simon Milner, Alan Higginson, Mike Casey, Shaun Byrne, Sunil Morzaria, Arthur Jordan, Mauro Cordani, Trevor Hall. Not in the photo – Henry Szyzsko.

News From South Africa

The CGCA South African branch was once again able to hold a quarterly lunch in May this year. Richard Gundersen, Chair of the branch, sent pictures of the lunch held in Johannesburg. Sadly, on this occasion the group paid tribute to two recently deceased members, Pat Frampton and Roger Loveland.

ALUMNI
We want your news!
See page 2 for
contact details



L to R: Charles Lewis, Rod Milne, Richard Gundersen, Andrew Smith, Colin Batchelor, John Baker

Imperial alumnus Maggie Aderin-Pocock announced as President of the British Science Association

The British Science Association (BSA) has announced that Imperial alumnus Dr Margaret Ebonulwa Aderin-Pocock MBE will take over as its President.

Dr Maggie Aderin-Pocock is an innovator and space scientist who, after an undergraduate degree in Physics, completed a PhD in the Department of Mechanical Engineering in 1994, both at Imperial.

Not only is she a science communicator, presenting the BBC's *The Sky at Night*, but she is also Managing Director of Science Innovation Ltd. This aligns with her long-term goal to expose children and adults to the wonders of space.

To officially mark her role, Maggie will host a Presidential Address at the British Science Festival on her vision for space travel's future as well as developing humanity's knowledge of the galaxy.

Maggie takes on the role of

President from Imperial's Lord Darzi, who is currently Co-Director of one of Imperial's six Global Challenge Institutes, the Institute of Global Health Innovation.

When deciding where to pursue her further education, Maggie said: "Imperial seemed like a magical place to me. When I was a child, I used to go to the Science Museum with my sister. Walking past Imperial, I used to think, 'That's where the clever people and scientists go!'"

As the first black female President, Maggie is keen to overcome the poor representation of racial diversity within the STEM industries. On race, talking to the BSA, Maggie added: "Racism is too important an issue not to be talked about and dealt with publicly; we cannot hide from it and must take it on – despite these often being uncomfortable conversations." She also expressed her support of the

BSA's mission to 'transform the diversity and inclusivity of science'. This coincides with Maggie's identification as neurodiverse, and her desire to bring awareness to disabilities expressed through the #Wethe15 Campaign.

Striving to also combat racism at an institutional level, Maggie has joined the Commission on Race and Ethnic Disparities (CRED) and will discuss its subsequent Report published earlier this year at her Presidential Address.



Photo courtesy of British Science Festival

‘A Guildsman, first and foremost’

Prof PETER GROOTENHUIS
(Mech Eng 1941-44, 47-49,
49-57)

Peter was born on 31 July, 1924 and came to England from Holland with his parents in 1940.

By the time his parents returned home, in 1946, Peter had graduated with a BSc in Mechanical Engineering at Imperial and was already working on his PhD research which was undertaken partly in the Mechanical Engineering Department (MED) at Imperial and also as a Graduate Apprentice at the Bristol Aeroengines Co.

Peter was to spend the great majority of his professional life based in the MED.

He was appointed as Assistant Lecturer in the MED in 1946 and then, following his PhD and DIC, as Lecturer in 1949.

Peter was one of a small group of young staff who participated during the 1950s in the planning and development of the new Imperial College MED, which resulted in the opening of the current buildings in 1963.

In the decade leading up to that transformation, new courses were designed as part of a general goal to develop Imperial to be the UK's equivalent of MIT. Much of the new course structure was led by Sir Owen Saunders, with whom Peter had undertaken his PhD research. Allegedly, Saunders said that Peter was 'good with mathematics' and so he would be the ideal person to take on the subject of Dynamics and Vibrations, for which role there was no immediate candidate. Peter did just that and remained Head of the Dynamics Section throughout the rest of his career, becoming Professor in 1972.

Early in the 1960s, Peter spent a sabbatical year at Cornell University in the USA, where he developed contacts with several notable US colleagues and brought many up-to-date ideas, such as Random Vibration, to the new courses at Imperial. He designed two of the laboratories in the new MED building and these remained fully operational for over 50 years. One was the Vibrations Lab on level 5, which today houses the RR Vibration UTC, and the other was the Noise Lab in 123, which contained the necessary facilities for noise measurements, one of Peter's specific interests within Dynamics.

Peter was an inspirational teacher, and a skilled user of chalk



and board. Although he had poor eyesight throughout his career, he had an uncanny knack of being able to point to exactly the right spot on the blackboard when referring to a specific equation – a skill which unnerved some students.

In addition to the mainstream UG Dynamics and Vibrations courses, Peter also developed an MSc course on Sound and Vibration in collaboration with the Physics Department. This proved a very popular course.

Peter had many interests and connections with the industrial world where most of his students would go on graduation. As a result, his teaching was heavily infused with the realities of the outside world.

His early industrial connections were strongest with situations where vibration was mostly a problem because of the noise that ensued.

One of his earliest and grandest projects was in the 1960s. The challenge was to ensure that the concert halls and other buildings of the new Barbican development were isolated from the vibration and noise generated by trains on the Metropolitan line which ran directly below the complex. The project led to the development of new and imaginative vibration isolation designs involving the use of constrained layer damping in concrete structures, to improve absorption of dynamic inputs.

Several other building projects, including the London Underground extension to Heathrow many years later, followed the same approach.

Alongside these civil engineering applications, Peter also had strong

links with a number of defence research groups, including with the Admiralty and the RARDE, again focussing on new experimental and testing techniques. Several of these were developed by PhD students. The later generations of those research studies still contribute to some of the most advanced technologies in the world.

Peter was an active participant in the industries growing up with the new post-WW2 technologies. He had a small consultancy partnership for many years with Peter Allaway (Grootenhuus Allaway Associates) as a basis for his activities when advising on the design of the new generation of quiet buildings, including the Wellington Hospital, the Guildhall School of Music and Drama, the British Library and many other buildings in London.

For many years, Peter was a Director of Derritron Electronics, one of the first companies to manufacture vibration excitation devices designed for testing various machines, vehicles and structures. His contribution to this business lives on in the still widely-used VP series of exciters: P being for Peter, and V for his fellow director at Derritron, Victor.

To complete the wide range of professional activities Peter was a founding member in 1959 of the Society of Environmental Engineers (SEE), and its President from 1964-1967.

This Society performed an invaluable role in providing and ensuring that the highest standards be maintained in Environmental Engineering. The SEE was based at Imperial College at its outset and

retained close links with the College throughout most of its 60 years of activity before closing, in 2019.

Peter promoted the technology he developed throughout this career in a number of publications.

He also presented his many applications on a series of overseas lecture tours – to Russia, China, Singapore, Hong Kong. These lecture tours were mostly in the 1980s, in an era when such travel was much more arduous than is the case today; in particular, he went to China in 1980 – very early in the reopening of the country.

Peter met Sally in 1953. They married in 1954 and lived within easy walking distance of the Department. This proximity meant that

Peter was closely associated with the College's interface with its neighbours.

He was a Churchwarden of Holy Trinity Church in Prince Consort Road for 18 years and was also a member of the Parochial Church Council for a span of 53 continuous years, from 1957 to 2010.

In the early days, Peter was active in various sports including rowing and sailing – both of which he pursued at the College – and also Ice Skating, a legacy from his home country, which proved invaluable in the winter of 1962/3, when Peter was spotted skating somewhat expertly on the Serpentine, towing a small child in an upturned dustbin lid.

Peter was a member of the Council of Imperial College from 1974-79, reflecting his keen interest with the internal running of the College.

A Guildsman, first and foremost, Peter's election as a Fellow of the City and Guilds of London Institute (FCGI) in 1976, was perhaps his most apposite honour.

He was elected to the Fellowship of the Royal Academy of Engineering, in 1982, was a Life Member of the Old Centralians and served as the CGCA President in 1987-88.

Peter passed away just before Christmas – on 19 December – 2020, at the age of 96. He is survived by Sally and their two children, Felicity and Hugh.

Peter left a bequest to the Old Centralians Trust to be used for student welfare.

With thanks to Prof David Ewins

Changing attitudes to women in science & engineering

KATHLEEN (MARJORIE) DE REUCK (née Gratwick)
(Physics 1948-52, Chem Eng 51-56)

Marjorie Gratwick was born on 5 July, 1929. She came to Imperial in 1948 to study for a degree in Physics, graduating in 1951, and followed this with an MSc in 1956, concurrent with a DIC in Chemical Engineering, her tutor for both being Professor D M Newitt. Marjorie became a Life Member of CGCA.

Coming to Imperial, Marjorie was shocked to find there were so few women students, but as she had four brothers, she soon managed to fit in, holding her own and getting into the swing of combining work with student social affairs. She became secretary of the IC Women's Association, being elected President for the session 1951-52.

Marjorie was also involved in Imperial College Women's Sports Club (ICWSC) and, in June 1952, she was elected its Vice President & Junior Treasurer.

Marjorie also met her husband, Tony De Reuck, very early on in her time at Imperial.

Marjorie's career at Imperial was, to say the least, unusual in that she worked for some of the time unpaid! Between 1958 and 1960, she wrote a history of the Chemical Engineering Department, as part of the series of departmental histories commissioned by the then Rector, Sir Patrick Linstead. And, in partnership with Dr E Glaister, she also co-wrote that for the Mechanical Engineering Department, from 1960 to 1963.

In 1966, Marjorie joined the Thermodynamic Tables Project Centre Group in Chemical Engineering, under the auspices of the International Union of Pure and Applied Chemistry (IUPAC), where she worked with Dr Selby Angus. The centre had been started only in 1965, so Marjorie was at the forefront of its development. She was responsible for supplying data on the thermophysical properties of industrially important fluids, used in industries such as natural gas power generation, and the chemical and refrigeration industries. This IUPAC work involved travelling widely worldwide to meet colleagues, and has been of great value to many aspects of science, including the environment.

In 1998, Marjorie submitted extensive evidence to the Parliamentary Select Committee on Science and Technology. She argued that there needed to be government investment in Thermophysical Properties Data in the UK.

During her career, Marjorie worked her way up to senior

academic level, retiring as a Professorial Research Fellow and, for a while, she also worked part-time in the IUPAC Centre.

A very significant aspect of Marjorie's life was that she played a large part in the positive development of attitudes towards women in science – not only at Imperial – and retained an interest in the way women work in science throughout her life.

Having experienced life as a young woman undergraduate, in what seemed to be a man's world, she was keen to redress the balance, and became part of the group of women determined to ensure that family life should be a feature of the development of Imperial College. She worked with like-minded people such as Lady Anne Thorne, Sandra Dawson and Dot Griffiths in setting up the College Tutor system and the Day Nursery. Besides being early proponents of the work-life balance, they did not see that being a woman at Imperial should be a problem, but recognised that others perhaps saw women scientists and engineers as a special case.

Being involved in Imperial's women's groups meant that Marjorie saw and heard first-hand how women felt and how they saw their roles. Marjorie and her colleagues worked to instil a feeling of equality within College; life at Imperial was to be about getting on with the job, as equals, in the lab and in the research field.

For academic women, Marjorie was involved in AWISE, the Daphne Jackson Trust, and Portia, the women scientists' advocacy body founded in 1997 by a group of women at Imperial, including Marjorie, and of which dynamic organisation she was a Trustee. Other interests included the Athena movement and the Elsie Widdowson Trust.

Marjorie was involved in Imperial College Women's Club which was (and is still) for all women employees, those retired, and the spouses of visiting academics. With her husband, Tony, she had been a generous donor to the College, and to the University of Surrey, where they instituted a scholarship for Masters students in 2015 to mark their 18 year connection there.

Tony, also a member of the Old Centralians, pre-deceased her by three years (his obituary was included in the Spring 2017 Issue of IE) and Marjorie died on 28 January 2020, at the age of 90.

*With thanks to Anne Barrett,
from her book,
'Women at Imperial College'*

'Brilliantly analytical but also delightfully silly and playful'



Prof SAMUEL EILON
(Mech Eng 1952-55)

Sam was born in Jaffa, in Mandate Palestine, on 13 October, 1923. He was educated at the Reali School and the Technion (the Israel Institute of Technology) in Haifa, graduating in Electrical Engineering in 1945.

Sam was not at all religious, but was a lifelong committed Zionist and had a fierce belief in the importance of his Jewish identity and in the importance and rights of the State of Israel. He fought in the War of Independence as a member of the Haganah and, by 1948, was in charge of supplies and logistics for the Israel Defence Forces (IDF) in the Sfat area. This set of challenges started him on the road from mechanical engineering to the application of scientific method and mathematical tools to management, decision-making and the control of complex systems and procedures. He spent some 6 years in the IDF, achieving the rank of Major.

When the time came to adjust his focus back to his career, Sam decided on Imperial College, London as the place to study.

His studies resulted in a DIC and a PhD in 1955, after which he stayed on to become a lecturer in the Department of Mechanical Engineering. He won two Whitworth Prizes and, in 1963, was awarded a DSc (Eng). In 1964, he became Professor of Production Engineering, and in 1971, he was appointed head of the newly created Department of Management Science.

In 1961, Prof Eilon established the one-year advanced course in Operational Research & Management Studies, a programme which laid the foundations of the School of Management, later the Imperial College Business School.

Prof Eilon's main research interest lay in the areas of production and inventory control, behavioural models of decision processes and industrial applications of operational

research. He was active in the Institution of Production Engineers and councils for management education and, in 1976, was made a founding member of the Fellowship of Engineering (the Academy of Engineering).

His 37 year career at Imperial was not just one of research and teaching, but of collaboration and friendship, and he always pointed out that his success would not have been possible without the support and contribution of all his colleagues.

In 2019, Prof Eilon was awarded an Imperial College Medal in recognition of his outstanding contribution to the life and work of the College.

Professor Nelson Phillips Associate Dean of External Relations, Business School said, in May 2017 that Prof Eilon, "was, in effect, the founding Dean of the Business School; thanks to his vision, the Department of Management Science grew from strength to strength. Without him, ours wouldn't be the world-leading business school it is today."

Prof Francisco Veloso, Dean of the Business School said, "Professor Eilon was a key figure in the foundation of the Business School. I was very fortunate to meet him and have the chance to learn about this warm and generous man who made many significant contributions to business and society. It was an honour to get a sense of the passion he felt for Imperial. He will be greatly missed."

Sam is described by his children as being: "Kindly, mischievous, teasing, benign, brilliantly analytical but also delightfully silly and playful; a sweet and lovely man who was an example to us all how to live a full and rich and productive life."

A devoted husband to Hannah, for more than 73 years, a loving father, grandfather and great-grandfather, Sam died peacefully at home on 17 July, 2020, at the age of 96.

Very much missed

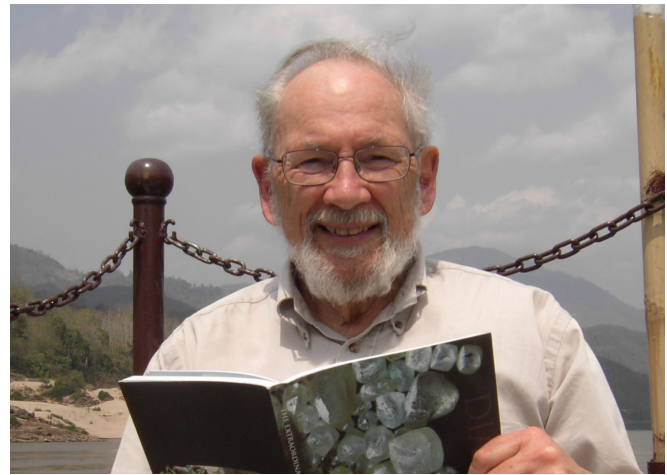
CHRISTOPHER JOHN MORRISSEY
(Mining Geology 1962-68)

Born in December, 1935 in Portsmouth, Chris was educated at Mount St Mary's College, near Sheffield. On leaving school in 1953, he was expected to follow the family tradition of a career as a Naval Officer but failed entry to Dartmouth Naval College on the grounds of poor eyesight.

He made a complete U-turn and, acting on the suggestion from a family friend that there were openings in the gold mines in South Africa, he booked a passage on a Union Castle passenger/cargo ship and set off on his own from Southampton to Cape Town aged just eighteen. He spent a year as an Official Learner at Freddie's Consolidated Mines Ltd Orange Free State, and a further year as Sampler, Randfontein Estates Gold Mines Ltd before moving to Johannesburg to take up a place at University of Witwatersrand in the Department of Mining Engineering. Not finding engineering to his liking, he moved to what was then Southern Rhodesia and spent the next five years working as a technical journalist, writing for and editing various mining publications in Southern Africa. During this period, his increasing fascination

with geology became one of his life's passions, leading him back to England in 1962 to study at the Royal School of Mines. During this time, he met and married his wife Jackie, with whom he shared the rest of his life.

His first post in industry was as Senior Exploration Geologist with Northgate Exploration Ltd from 1970-75, managing programmes in Ireland and Canada, and as Acting Mine Geologist at Tynagh Pb-Zn-Cu-Ag mine, Ireland. This was followed by a return to Imperial for two years as a Research Fellow, investigating the exploration potential of the Phanerozoic sedimentary cover of Saudi Arabia for mineralisation of the Pb-Zn-Ba-F association. In 1977, he joined Rio Tinto as Exploration Manager, based in London. A main achievement during this time was identifying, securing and advancing to full evaluation the Morro do Ouro gold deposit in Brazil, which RTZ brought into production in 1987. In 1983, the Exploration Department was relocated to offices in Bristol, and Chris was appointed Managing Director, Riofinex North Ltd with overall responsibility for programmes in Western Europe which discovered economic gold resources in Portugal and Northern Ireland. In 1990, he



became Managing Director of the European Division of RTZ Mining and Exploration Ltd overseeing programmes in Eastern and Western Europe, Turkey and Greenland, one of which discovered the Las Cruces high-grade copper deposit near Seville, southern Spain. His final appointment in 1996 as Group Chief Geologist (Western Hemisphere) of RTZ-CRA/Rio Tinto plc marked the culmination of his distinguished career. Chris retired in 1998.

Then followed a move to live in the beautiful city of Bath, where, for the next nineteen years, he enjoyed working as an occasional freelance economic geologist and revisiting his journalistic skills writing articles

for the Rio Tinto Review, in between taking marvellous long haul holiday trips around the world (not always geologically biased!) with Jackie.

Finally, in 2017, they moved to live in the West Midlands to be near their children and grandchildren. Chris greatly enjoyed his role as full-time grandfather during these last years, but struggled increasingly against failing health.

He died on Boxing Day last year, a few days after his 85th birthday.

He is survived by Jackie, his daughter Helena, son Johnny and three grandchildren who very much miss him, as do all his family and friends.

'Great professionalism and a very strong ethical approach'

DONALD (DON) FRANCIS
LEEPER, OBE
(Maths 1957-60, Mech Eng 1962-66)



Don was born on 11 September, 1938 and attended Walsley County Grammar School.

At Imperial, he graduated with a degree in mathematics. He then became an apprentice mechanical engineer with the English Electric Company before returning to Imperial, to take an MSc in Mechanical Engineering.

Whilst at Imperial, Don took up rowing, eventually competing for the college at Henley. He maintained this connection with, and passion for the sport all his life and was a Member of the HRR Steward's Enclosure, rarely missing the chance

to invite friends and colleagues to join him over at the regatta.

Don was also an avid railway modeller. What should have been a garage at his home was turned into a spotless and very well-appointed workshop with the most exquisitely detailed reproduction landscape complete with fully controlled rolling stock. This was not just a Hornby set, but each piece turned from stock materials, perfectly made in miniature with the same engineering exactness that he also applied to his daytime job.

Don went on to have a long and distinguished career. He joined Zisman Bowyer & Partners in 1966 and rose to become a Senior Partner. Soon after Zisman Bowyer became a member of the Building Services Research and Information Association (BSRIA), in 1971, Don became a BSRIA Council member and leader of important member-facing groups, mostly associated with the then very significant research portfolio of the Association.

He remained an energetic supporter of the Association for the whole of his working life and was instrumental in the creation of BSRIA Ltd in March, 2000. A founder non-executive Director

from 1991 to 2002, he also served as Chairman from 1994 to 95.

Don always had a very strong ethical approach to business in general. With the arrival of Thatcher's era of lowest competitive tendering, he was deeply affected by the breakdown of well-established business relationships formed by mutual respect and trust, where work was won on reputation and repeat business.

Later, when Don served as President of the Chartered Institution of Building Services Engineers (CIBSE), in 2005, he took as his key presidential theme, 'Trust and Money', which sought to redress some of the worst aspects of lowest price engineering.

Don is remembered with great affection for his enthusiasm, hunger for learning and most of all for passion for all things engineering.

Andrew Eastwell, BSRIA CEO described Don as, "Always willing to spend time to help untangle both technical and business issues he gently made sure that BSRIA always kept to its core values of helping its members and the wider community improve. Later, as BSRIA's Chairman of the Board, he would spend many hours of his precious time guiding,

but never dictating progress...It was wholly appropriate that his contributions to industry through the outputs of his business and other connections would be rewarded by the Honours system with an OBE."

In 'retirement' Don became involved in the Federation of European Heating, Ventilation and Air Conditioning Associations (REHVA), serving on its Board as a vice-president, seeking to promote the engineering profession in a wider European context. He was remembered, within REHVA as showing 'great professionalism and a very strong ethical approach'.

When Don died, the industry lost not only an exemplary engineer but a major contributor to the wellbeing of the Building Services Engineering profession.

Many also lost a good friend who had provided a source of inspiration and a constant reminder that "doing the right thing" is a lasting way to a successful and happy career.

Don died in April, 2020, due to the Covid virus, leaving his wife, Pauline, and three children who can all be rightly proud of his part in creating a built environment of quality.

With thanks to Julia Evans and Andrew Eastwell of BSRIA

Visionary leader and scientist, a man of warmth and optimism



Prof Sir ERIC ASH
(Elec Eng 1945-48, 48-52)

Born in Berlin, on 31 January, 1928, Ulrich Albert Asch (Eric, as he became known) migrated to Britain with his family in 1938, to escape Nazi Germany.

His lifelong connections with Imperial began when he gained a scholarship to study his electrical engineering BSc and then his PhD, under Denis Gabor, the Nobel Prize winning inventor of holography and the flat television tube, who had also fled the Nazis. When asked of Professor Gabor's influence, speaking in 2000 Sir Eric said: "We're all children of our parents, and certainly children of the person who supervised our PhDs."

Sir Eric made significant contributions in electron optics and pioneered research on surface acoustic waves for signal processing. This technology has important uses in mobile phones, televisions and space-borne communications systems.

His research led to new techniques and improvements in the resolution of acoustic microscopes which use ultrahigh-frequency sound waves to probe the internal features of solid materials for defects. They are often used to manufacture electronic components.

Eric was a Research Fellow at Stanford University between 1952

and 1954, before returning to London and eventually becoming Head of the Department of Electrical and Electronic Engineering at University College London.

Elected a Fellow of the Royal Society in 1977, Eric later served as treasurer and vice-president of the Society, from 1997 to 2002.

He was awarded the Faraday Medal of the Institution of Electrical Engineers in 1980 and the Royal Medal of the Royal Society in 1986. He also won the 1984 Marconi Prize for his work in electron optics and ultrasonics.

"Sir Eric was an extraordinary contributor to our technology community," wrote Vint Cerf, Chairman of the Marconi Society's Board. "Another giant has left our midst."

Camilla Fritze, Marconi Society Board member, wrote of "His incredible energy to learn and understand from those around him. He always made sure young people had a voice and were considered. He has left an incredible legacy."

Becoming Rector at Imperial in 1985, Sir Eric oversaw the merger of St Mary's Hospital Medical School with Imperial in 1988. He felt this was a way for Imperial to reposition itself, but also a way to raise the number of women studying at the College which he believed was very necessary.

Imperial's Faculty of Medicine is now ranked among the world's finest. Prof Christofer Toumazou explained: 'He saw the importance of interdisciplinary way ahead of his time. He merged engineering with medicine – without that we would not be creating devices to save lives at Imperial.'

Prof Toumazou also recalled Sir Eric's encouragement after attending a talk that the young lecturer gave on cochlear implants: "After the talk, he asked me if I had published the work. I had not and panicked since my early career path relied on publishing. I was honest and said no, knowing that he would be disappointed, and I would be embarrassed. On the contrary. He said that is good news. I asked why."

"He said, 'You have created the world's first totally implantable cochlear for born-deaf children. Why publish? Patent the thing straight away'. These words stuck with me ever since and this was indeed the beginning of my entrepreneurial life. He was a great inspiration."

Prof Dame Julia Higgins, witnessed Sir Eric's strong support for women: "I first met Eric not long after he became Rector and was making exploratory visits to all the departments in the College. He came round Chemical Engineering and talked to some of the research

groups, including my own. I later got a message from my then Head of Department saying that Eric was encouraging me to apply for Professorship in the department. This was typical of Eric's very strong support for women in science, engineering and technology, which he once told me arose from the fact that he had five daughters! Certainly, from that time on, I found him a great mentor and advocate in my career, support which continued long after he left the College."

Prof Higgins continued: "Some of my most recent memories of him are from functions at the Institute of Physics. When Rector, he was notorious for using a bicycle for transport round London and he still cycled (in full evening dress) to the Annual Awards dinner in 2018."

After retiring from Imperial in 1993, Sir Eric worked on educational technology as an emeritus professor at UCL. He did consulting work for various companies, acting as a non-executive director of British Telecom from 1987 to 1993.

He also chaired the BBC's Science Advisory Committee and was a trustee of the Royal Institution and the Science Museum, as well as serving as a member of the Advisory Council of the Campaign for Science and Engineering. He was CEO of the Student Loans Company (1994-96), remaining a non-executive director of the company until 2000.

Sir Eric remained involved in College life into his 90s, and regularly attended alumni events.

A passionate violinist and appreciator of music, he also continued to attend student concerts at Imperial for decades after his retirement, and enthusiastically supported the Ash Music Scholarships with his wife, Clare.

Prof Alice Gast, President of Imperial College London, said: "Eric was a visionary leader and scientist who will always be remembered for his warmth and optimism. He gave so much to Imperial through his steady leadership, mentoring and research. He remained very active at the College, and I loved spending time with him. He and Clare also lit up when they were surrounded by their wonderful Ash Scholars. Their love of music and our musicians leaves a lasting legacy and meaningful example for philanthropists."

Sir Eric passed away peacefully at home, on 22 August, 2021, at the age of 93. Much loved husband of Clare, for 67 years, and adored father and grandfather to five daughters and eleven grandchildren.

A love of making things



ROBIN DONALD TURNER
(Elec Eng 1951-55)

Robin was born on 8 December, 1929 in North-west London and, from the age of about four, spent much/most of his childhood in Kingswood, Surrey.

As a schoolboy, he became interested in making things, spending many happy hours building radios

and radio-controlled model boats, which he and his sister, Ann, would take five miles or so by bicycle to test and sail on the Mere Pond at Walton-on-the-Hill.

This love of making things was to stay with Robin throughout his life, one of his last projects being a remote-controlled fishing boat, built and sailed – to the delight of his

children and grandchildren – when Robin was aged 80.

After secondary education as a boarder at Charterhouse, Robin carried out his National Service in Gibraltar as an Electronic Control Engineer with the Corps of Royal Electrical and Mechanical Engineers (REME).

Thus it was at the age of 21 that he took up a place to study Electrical Engineering at the City & Guilds Constituent College within Imperial. On arrival at College, Robin joined the Imperial College Boat Club, where he was able to indulge his love of boats, including rowing for the college. Robin became a Life Member of CGCA.

After graduating in 1955 with BSc(Eng) and ACGI, Robin joined Marconi in Chelmsford to undertake a graduate apprenticeship in electronics, and here he soon formed some lifelong friendships with fellow apprentices. With one of these friends he shared a caravan, and in the long winter evenings they spent hours devising schemes by which they might make their fortunes by any method other than electronic engineering – including one idea to take up fur farming based on the breeding and rearing of mink and chinchilla – but reportedly none of these ideas ever got off the drawing board!

At Marconi, Robin enjoyed a fruitful career, and in 1990 – not long before he retired – he gave his position as being a Principal Systems Engineer.

Whilst at Imperial, Robin had

sought his mother's advice on who to take to the May Ball, and was advised to take his sister's best friend from school, called Patricia

This turned out to have been excellent advice, as it led to a lasting attachment, and in 1959 Robin and Patricia were married – the start of 62 years of married life.

Not long into their marriage, Robin and Patricia bought Walter Hall, in Boreham, Chelmsford for the princely sum of £900. This property was, in estate agent terminology 'in need of refurbishment/development', as it was a condemned building with some evidence of rural sanitation, with an outside privy.

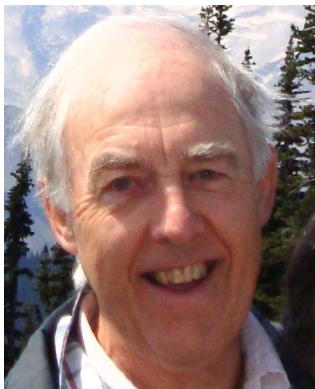
Undeterred by this, they moved in and gradually carried out the works necessary to develop it into a comfortable family home, even if at the start there was no hot water, necessitating the use of a 'tin bath' in front of the kitchen range, with water heated in the washing machine and then siphoned out for use!

All four of their children were born in Walter Hall, and on the arrival of their second child, Nicholas, there was an upstairs bathroom with hot running water.

By the time Robin and Patricia moved closer to the centre of Chelmsford, in 1997, Walter Hall had provided them with a family home for over 35 years.

Robin died in February, 2021, at the age of 91. He is survived by Patricia, their four children, Paul, Nicholas, Amanda and Katherine, and by ten grandchildren.

Regrettably, the obituary for Prof John Moore published in IE issue 34, was accompanied by a photograph of a different Prof Moore from Virginia Tech. We have apologised to John's widow, Joan, who has since provided this revised obituary and photograph.



Prof JOHN MOORE
(Mech Eng 1962-65)

John Moore, a life member of CGCA, was born on the 31st of July, 1943 on the Wirral to David Harold Moore and Dorothy Payne. He was raised in Bebington in the home of his grandparents, Samuel and Mary Payne. He went to the Birkenhead School on a County Council scholarship following the eleven-plus exam. He studied at

City & Guilds College for a degree in Mechanical Engineering; and then for his Masters and Doctorate from the Massachusetts Institute of Technology, where he met his wife, Joan, in the Gas Turbine Laboratory.

His technical passion was three-dimensional fluid flow in turbomachinery. He received the ASME Gas Turbine Power Award for his doctoral experiments and innovative computations explaining the flow in a rotating passage. He then worked on a water cooled gas turbine project and with a combustion group at the General Electric Research Lab in Niskayuna, NY.

Conscious of becoming part of the brain drain, and grateful for the government support he had for his education, John returned to England in 1973. He took a teaching position at Cambridge University and became a fellow of Christ's College. Assigned to teach Thermodynamics, he added this to his fluid flow expertise to develop computational

methods (now also with the aid of his wife Joan) that could predict performance of centrifugal impellers in the classic form of a temperature-entropy diagram. This was applied by the Rolls-Royce large engine division to significantly improve the turbine in their RB211 jet engine used by many airlines.

After another year working in combustion, this time on computations for Rolls-Royce in Bristol, John returned to the United States in 1979 to become a Professor of Mechanical Engineering at Virginia Tech. He permanently settled in Ellett Valley east of Blacksburg. Teaching and research continued, later adding analysis of rocket pumps, both for the French (SEP) and for NASA. He lectured at many professional development short courses in both Europe and the US. He received the ASME IGTI Education Committee Best Paper Award in 1996.

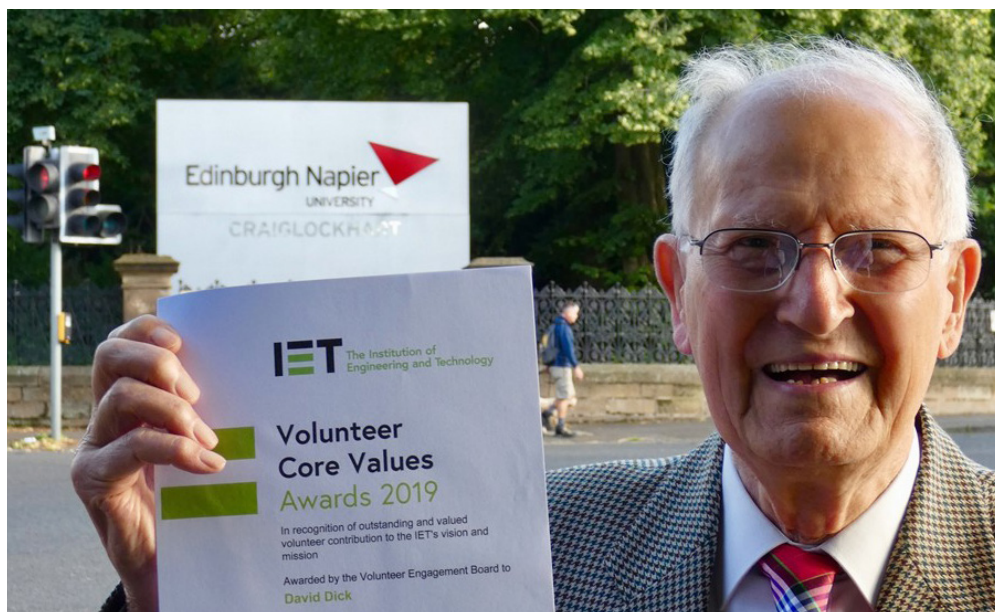
John's passion for golf started

with his grandfather shortening and giving him a 5-iron on his 4th birthday. As John would say, "golf courses are in beautiful places." John enjoyed hiking in the mountains, in Wales near where he grew up, a trip to the Pyrenees when in college, New Hampshire when at MIT, and right outside his door in Ellett Valley.

Taking early retirement from Virginia Tech in the late 1990s, John became president of the Blacksburg Country Club Homeowner's Association. He decided to research the early settlers of Ellett Valley to celebrate the year 2000. This turned into a passion for local history. He is well-known for regaling the neighbours with stories of the early settlers and the great flood that occurred in the 1700s. John and Joan also went on many family history trips, researching both his and Joan's family history.

John passed away on the 13th of November, 2021 at home in Blacksburg, Virginia.

A lifelong thirst for learning



Dr DAVID DICK, OBE
(Civil Eng 1952-53)

Dr David Dick was born in Edinburgh on 20 March, 1929.

Ill health forced him to leave Secondary school after only one year and he was employed, at the age of 14, as a Telegraph Messenger for the General Post Office in Edinburgh during the 1939-45 War.

In 1946, David gained an apprenticeship as a Telecommunications Draughtsman and attended Heriot Watt College, Edinburgh. After earning Ordinary and Higher National Certificates, the latter with an additional year of endorsements in electrical engineering, he was elected a Graduate of the Institution of Electrical Engineers (Grad IEE).

On completion of a graduate traineeship with the North of Scotland Hydro Electric Board, he was recommended and supported by the Faskally College Director of Studies, Professor Parker Smith, for post-graduate studies in hydro-electric power design at Imperial College, in 1952. He gained the post-graduate Diploma of the Imperial College (DIC) and became a Life Member of CGCA.

Before leaving Dundee, he had met a young lady, Muriel Buchanan, in Craigiebank Parish Church in 1951. They shared a hymn book and met afterwards to form a strong friendship from which love for each other soon blossomed. During his one-year course of study in London, they courted by correspondence, during which Muriel took on the enormous task of typing his dissertation (81,474 words, with mathematical equations). Muriel and David married at Craigiebank Church, Dundee, on 11 September, 1954 and honeymooned in Paris.

On successful completion of the DIC, David returned to the Highlands, to the new Gaur Power Station, as an operational engineer involved in the commissioning of electrical power plant. After a year – and wishing to live nearer Muriel's parents – David resigned his post with NSHEB and, in 1953, was appointed Assistant to the Chief Engineer of the National Coal Board in Fife. Their first house, 'The Beeches' in GlenRothes was rented from the Coal Board.

In 1954, David applied for and was appointed to a lectureship in electrical engineering at Dundee College of Science and Technology and was promoted to senior lecturer in 1958. In 1960, he was appointed Head of a new department of electrical engineering at Coatbridge Technical College. He was appointed the first Vice Principal of Napier College of Science and Technology in 1964, aged thirty-five – the youngest vice principal in Scotland.

On 1 April, 1970, he was admitted as a Fellow of the Institution of Electrical Engineers (FIEE) and, in the same year, was appointed the first Principal of the newly-built Stevenson College, Edinburgh from which he retired in 1988. He was awarded Fellowship of Stevenson College in 2009 for exceptional service.

In 1983, David was appointed an Officer of the British Empire (OBE) for his services to education and to the Fire Service of Scotland, which he served as chairman of its examination Board from 1969 to 1986 and as the Lay Inspector of Fire Services (Scotland) from 1995 to 1999. Muriel and their five daughters attended Buckingham Palace for the investiture.

After his retirement, in 1988,

David and Muriel embarked on a world tour after which he took up studies of his first love – biographical history, publishing three dozen journal articles and several books.

With a continuing love of learning, David graduated BA Hons (2003), at The Open University and MLitt (2006) at the University of Dundee. He was awarded a PhD, for his thesis on gender equality in Scottish universities, from Edinburgh's Napier University (2013), at the age of 84.

Of returning to study in later life, David said: "At first I think my fellow students were a bit surprised to see this funny, old guy sitting in their lectures. They were very kind to me though."

On being awarded his PhD, he said: "Because I missed out on so much school as a boy, I have always thought of myself as ill-educated. Now I think I can forget about that."

David was elected a Fellow of the Institution of Radio and Electronic Engineers (FIREE), a Fellow of the Institution of Engineering and Technology (FIET). He served as chairman and member of various committees of the Scottish Council for Technical Education and the Scottish Business Education Council between 1960 and 1987.

In 2007, David was invited to membership of the committee of the South East Scotland Retired Members Section (SERMS) of the Institution of Engineering & Technology (IET) and was elected its chairman in 2009.

On 30 June 2019, at the age of 90, David received the IET's Volunteer Core Values Award, for the category, 'Excellence'.

David and Muriel had five daughters and celebrated their diamond wedding in 2014.

David died on 25 January, 2021.

IN BRIEF

HARRY MORTON NEAL, CBE,
(Civil Eng 1950-53)

Morton was born in November, 1931. He was not only President of CGCA, in 1994-95, but was also a key link between College and CGCA with the City and Guilds of London Institute, of which he was the Chairman for many years, and remained on its council for many years afterwards. He worked to get the shields of the 16 founding livery companies displayed in the Mech Eng Building concourse.



Much loved husband of Cecilia, father of Michael, Camilla, Carolyn and Alexandra, grandfather and great grandfather, Morton died peacefully at home, on 8 June, 2021, aged 89.

A Service of Thanksgiving in memory of Morton is to be held at 12.00 on Monday 8 November at St Paul's Knightsbridge, followed by a reception. Those wishing to attend are asked to email Morton's son, Michael, at rsvp@st-anselm.co.uk.

BRYAN WALTON COOPER
(Civil Eng 1952-53)

Bryan, born on 5 June, 1928, sadly died, aged 92, on 17 December, 2020.

PETER M PALMER
(Civil Eng 1951-54, 56-7)

Peter died in Australia on 16 August, 2021 aged 91

ROGER LOVELAND
(Civil Eng 1956-59)

Roger, who was born on 12 July, 1938, has died at the age of 82.

DAVID MICHAEL (MIKE) LUMB
(Aero 1948-51, 51-52)

Mike was born on 28 May, 1930 and died on 22 September, 2018, at the age of 88.

BRIAN ROBERT VESEY WALKER
(Mech Eng 1950-53)

Brian Walker was born on 15 November, 1928. He graduated in Mechanical Engineering in 1953 and was a life member of CGCA.

He was Secretary of the City & Guilds College Engineering Society for 1952-53, when Philip Allsopp was C&G Union President.

Brian spent part of his career with Unilever, but latterly ran his own business: Walker Associates.

Brian died on 3 April 2021, at the age of 92.

