THIS JOURNAL IS PRODUCED WITH THE SUPPORT OF THE PARLIAMENTARY SCIENCE AND TECHNOLOGY INFORMATION FOUNDATION

The Journal of the Parliamentary and Scientific Committee – All-Party Parliamentary Group

SCIENCE IN PARLIAMENT

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SUMMER 2022

INNOVATION AT THE FULCRUM OF SUSTAINABILITY & DIGITAL FUTURES

Parliamentary and Scientific Committee

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Coastal Waters

Water systems are a key area of focus with regards to climate change, because of both our reliance on them and the changes we've seen in recent decades. This evening, we heard from three expert speakers about issues relating to our coastal waters and river systems. Matthew Parr, Director of Strategy and Regulation at Tideway, discussed the Tideway project which is crucial to London's sewage system. Dr Helen Findlay, Biological Oceanographer at Plymouth Marine Laboratory, spoke about ocean acidification and the impact this has on coastal regions. Lastly, Dr Richard Thompson OBE, Professor of Marine Biology and Director of the Marine Institute at the University of Plymouth, discussed the impact of microplastics on our water systems and the best ways to mitigate against this. Our Q&A session at the end of the talk largely revolved around ways to reduce our impact on water systems and how we can push to make the necessary changes.

Our major cities are heavily reliant on water systems, and this may be no clearer than when one looks at the Tideway project. Mr Parr pointed out that London's current sewage system was established when London's population was around two million. Now with a population of around ten million it only takes two millilitres of rains to result in sewage discharge into the river Thames, polluting the water system. The Tideway project aims to prevent this through the construction of a deep shaft system such that when heavy rainfall occurs the sewage is drained away, reducing the strain on the river system. Mr Parr discussed how this was vital to keep the river system healthy, and how the whole project had reducing environmental impact as a key aim. After years of work, 78% of the construction is complete and it's expected to be operational by 2025.

It's not just water systems in our cities that we're having an impact on. Ocean acidification is a major problem caused by our carbon emissions. Dr Findlay described how oceans have become 43% more acidic since the industrial revolution. This has an impact on marine ecology as it erodes calcium carbonate structures, such as shells. This leads to economic impacts in our coastal regions as the resources we can retrieve from the ocean are diminished. More work is being done on the exact impact on coastal regions, but studies indicate that acidification rates are faster near coastal regions than in the mid-ocean. Dr Findlay described how reducing emissions and investing in carbon removal technologies are key in slowing this process. Assessing vulnerable regions in order to know where is most at risk from this acidification trend will also help mitigate against the adverse effects.

Plastic pollution also has a major impact on ocean waters. Dr Thompson discussed how there is proof that microplastics are having a direct impact on human and ecosystem health. Dr Thompson outlined that a solution to such a problem needs to be holistic. Microplastics are only one source of plastic pollution and our attitude towards plastic hasn't changed substantially in decades. Plastic is a vital resource in minimising food waste and reducing our impact on the environment in some areas, and all of this needs to be taken into account for good policy. Dr Thompson outlined in some cases banning is appropriate, like with cosmetic microbeads where a single container had three million plastic particles. However, in other cases a push to reduce use or recycle a product through education and incentive would be more effective. Such policies will be vital if we wish to keep our coastal systems healthy.

Alfie Hoar
P&SC Discussion Meeting, 'Coastal Waters'
6th June 2022

Stephen Metcalfe MP
Chairman, Parliamentary & Scientific Committee (All-Party Parliamentary Group)

A warm welcome to our Summer edition which coincides with the Parliamentary & Scientific Committee's long awaited return to the Palace of Westminster for our discussion meetings programme.

On the 4th July I chaired for the first time in over two years an excellent in-person panel discussion on the subject of Quantum Technologies in which we were partnered by Imperial College London. This was followed by the traditional reception and dinner. It was good to be back!

Our distinguished speakers have kindly agreed to contribute articles to the Autumn issue.

We plan to hold the majority of these events in Parliament and a number online. It is hoped that the day will come when the House authorities permit a hybrid approach to our meetings.

I was delighted to welcome guests to our Annual Lunch in the Cholmondeley Room, House of Lords, on the 5th July, and thank our Vice Chair, Chi Onwurah MP, for her excellent speech.

Beyond the Summer Recess, we look forward to the Autumn and early Winter programme meetings and on the 14th December the Christmas Parliamentary Science Reception, which will be organised by P&SC, for the first time, in conjunction with the Learned Societies.

I was very pleased to sponsor the Annual Parliamentary Links Day on its return to the Palace of Westminster on the 28thJune. As always a superb event, organised by the Royal Society of Biology on behalf of the STEM community.

Preparations are in place for the 26th annual STEM for BRITAIN which takes place on the 6th March. We will launch the 2023 event in Parliament on 12th September, when the application process will open to early-career researchers across the country. The closing date for submissions is Monday 28th November.

I am delighted that three of our STEM for BRITAIN 2021 Gold Medal Winners are contributing to this issue: Dr Ben Fernando (Physics and The Westminster Medal); Dr Scott Harper (Mathematics) and Dr Nikita Mayur Patel (Biosciences and The Physiological Society Prize). My thanks to all our excellent contributors.

I am sad to report that Karen Smith, our wonderful Administrator for the past seven years, has decided to retire. Along with her husband John, who has over the past 18 months organised an excellent speaker programme, Karen has been instrumental in the success of P&SC.

My thanks to Karen and John for their tremendous hard working contribution to our Committee and for their support to me and the team led by Leigh Jeffes. We wish them well for the future.

I am delighted to welcome David Youdan as Administration and Programme Manager. David has been associated with P&SC for a number of years, including serving on the Advisory Committee of the Council.

An engineer by profession, David recently retired after 19 years as Executive Director of the Institute of Mathematics and its Applications, and therefore brings a wealth of experience to his new role.

Finally a very warm welcome to our newest member, the Isaac Newton Institute.

With best wishes for an enjoyable Summer.

SCIENCE IN PARLIAMENT
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The Journal of the Parliamentary and Scientific Committee (All-Party Parliamentary Group).

Science in Parliament has two main objectives:

1. to inform the scientific and industrial communities of activities within Parliament of a scientific nature and of the progress of relevant legislation;
2. to keep Members of Parliament abreast of scientific affairs.

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INNOVATION AT THE FULCRUM OF SUSTAINABILITY AND DIGITAL FUTURES

Professor Sa'ad Sam Medhat
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Innovation continues to morph new relationships between the growing opportunities presented by the data-led digital capabilities and the desire to meet the global aspirations for a sustainable future. Managing such a balancing act requires a fresh approach to curating the way in which innovation is initiated developed, deployed and scaled, and it postulates a need for developing a better understanding of some of the common challenges that face sustainability and digital futures.

INTRODUCTION

When diagnosing their strategic directions, many organisations are now increasingly reprioritising their business goals and innovating their strategies in order to leverage both the digital capabilities and meet the sustainability imperative, in terms of its key pillars of environmental, economic and social (McKinsey, 2021). More and more organisations are using sustainability as a business driver, and exploring ways to ascertain where sustainability can make the biggest impact (IBM Institute for Business Value, 2022). In addition, organisations are also investigating how to eliminate the vast amounts of dark data (data generated but unused for any useful purpose). Furthermore, progressive organisations are also pursuing educational and awareness programmes to inform their customers and stakeholders on their plans and roadmaps to cut carbon emissions intensity and achieve net zero emissions. However, within the 'shared space' of digital and sustainability there are many challenges that go on to impede the pace of digital and sustainability transformation, and require a more of a collective approach to creating shared principles to tackle them.

THE CHALLENGES

Over the past three years, the Innovation Council of the Institute of Innovation and Knowledge Exchange, which brings together over 60 c-suite executives from multinational corporations, has identified the following pertinent challenges, amongst many others:

- Agreement on the types of common knowledge, skills and competencies needed by both digital engineering and green engineering.
- Coherent standards that can demonstrate through Use Cases how sustainability and digital transformation can be interlocked and balanced effectively to yield better value, particularly, when it comes to addressing issues of accountability, transparency and responsibility together with those of ethics, safety, bias and fairness.
- Agreed practices of applying digital to an organisation's sustainability strategy to enable it to meet its Environmental, Social and Governance (ESG) goals through shared approaches for gathering and analysing ESG-related data from own operations, and across the entire value chain.
- Applying a consistent approach when managing integration complexities, particularly when it comes to data interoperating across multiple public and private infrastructure platforms (e.g. data traversing public cloud, private cloud and hybrid cloud systems in a trusted, sovereign, safe and secured manner).
- Collecting quality data to support and accelerate sustainable sourcing (e.g. wearable devices detecting health issues), reusability (e.g. materials informatics can identify ways to reduce packaging), traceability (e.g. sensors and RFID tags can trace a product's origins, while a circular economy-platform can signal when to refurbish a product), and product lifecycle management (e.g. Artificial Intelligence interacting with Internet of Things' devices can indicate the need for preventive maintenance, while ubiquitous connectivity allows remote diagnostics).

THE INNOVATION RESPONSE

Evidence demonstrates that when investing in digital and sustainability solutions, more sociotechnical innovations are required in order to mandate a more collaborative and coherent approach to greening of the industrial ecosystems, whilst ensuring consumer affordability, inclusivity and value differentiation is accomplished (EY 2021) (Nambisan et el., 2019). Sociotechnical innovations can help to assess and understand in detail the extent of what and how these innovative digital technologies are effectively contributing to the improvement of sustainability performance. For example, the role of digitally enabled services and the expansive move by many businesses towards 'Servitization' – *where customers pay for a service outcome instead of buying an equipment* – has started to offer some actionable insights into how digital can positively impact productivity, and improve transparency and standards in governance, thus future proofing sustainability integration within the organisation and across its wider ecosystem.

Undoubtedly, advancements in digital applications are transforming people's interactions and engagements (Checchinato, 2021). Data, information, and knowledge are key factors of success that organisations must handle to open new opportunities and adopt their business and operating models. People's engagement is also becoming more amplified by the adoption of artificial intelligence and virtual reality-powered tools that combine physical and digital dimensions in a unique multi-sensorial experience (Bolton et al., 2018).

Many contemporary entrepreneurs are now embracing tightly the "Thinking Digitally" mantra to help them address some of the challenges, including those of migrating from legacy systems and infrastructures, and seize the opportunities offered by the digital technologies to secure their competitive advantage (Jacobides, 2019; Soltanifar et al., 2021; Cutolo and Kenney, 2020). These contextual sociotechnical innovative changes are increasingly attracting interests from policymakers, as well as practitioners, and academics alike to examine how these challenges could, and, should be addressed.

In addition, more disruptive innovations in the field of new climate technologies are desperately needed to generate the game changing capabilities in such fields as materials for providing higher density energy batteries; alternative materials in cement-binding (or "clinkers"); efficient, affordable and scalable green hydrogen with better membranes and catalyst electrolysers; green ammonia production using nitrogenase to minimise the use of energy and thus cost in the bioelectrocatalysis process; metal organic frameworks (MOFs) that use adsorbents and act as a sponge to suck CO_2 from the air directly and cost effectively; and, quantum computing and quantum-enabled technologies that allow for precise molecular-level simulation and deeper understanding of some of the challenges of how to abate or eliminate CO_2 emissions. With the estimated annual spending of $3 to $5 trillion in sustainability climate investment, according to McKinsey research (McKinsey, 2022), the opportunity for big companies to drive the transition net-zero is significant.

Furthermore, governments have an important role to play in incentivising and orchestrating the development of programmes and interventions that bring together business and industry more closely with academic and educational institutions, professional bodies, research organisations, and other stakeholder networks to tap into the intellectual collective, remove roadblocks and create the much needed solutions and associated use cases that deliver on the economics of decarbonization.

THE RESEARCH STUDY

In an attempt to unearth responses to the aforementioned sustainability and digital futures challenges, my professional body, the Institution of Engineering and Technology (The IET) in partnership with my organisation, the IKE Institute are jointly conducting a landscape research study. The primary aims of the research are to help to foster and support innovation within the drive to net zero emissions, and leverage the confluence of digitalisation to achieve the climate change targets, whilst unlocking new economic opportunities. Over 120 firms have already taken part in an extensive survey, the findings from which will be reported in a future article.

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2071 - THE WORLD WE'LL LEAVE OUR GRANDCHILDREN

Professor Chris Rapley CBE
Professor of Climate Science
University College London

"I have been thinking about the future.

As a climate scientist it is part of my job to explore what it might bring".

Thus opens the play '2071', written in 2014 by myself and the playwright Duncan Macmillan. The performance was a 'fireside chat', describing my journey as a scientist, my involvement in climate science, the evidence that disturbing the Earth's energy balance is a big mistake, and the steps being taken globally to tackle it. It closed with some reflections on where we (humanity) are heading.

The project originated from an introduction to the theatre Director, Katie Mitchell. Katie was already convinced of the significance of the issue, was practicing a low-carbon personal and professional lifestyle, and was keen to use theatre to spread the word. After years of public lectures and private briefings on the subject, I was searching for a way to reach new audiences. The agreement to collaborate was immediate. We soon had a commission from the Royal Court Theatre and the Deutsches Schauspielhaus in Hamburg. Duncan and I were introduced, and we started weekly meetings to create the script.

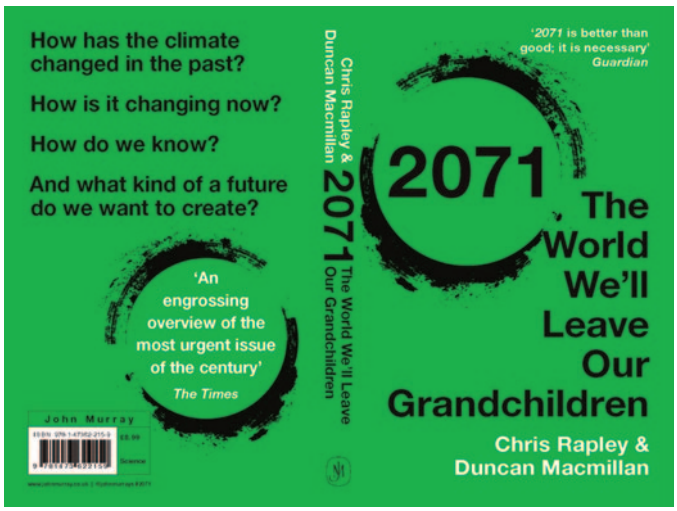
Climate change is a subject of great complexity. Its communication requires the delivery of a lot of information. We aimed to tell the story in language for non-specialists, but without compromising core detail. A key issue was what we wanted as an outcome. The audience would be traditional West End theatregoers, with a likely additional group drawn by interest in the topic. From investigations carried out in preparation for the Science Museum's 'atmosphere' gallery, for which I was responsible as Director, we knew that many people who accept the reality of climate change are very hazy about the evidence. We aimed for a sufficiently clear exposition to equip the audience to engage with confidence in social discussions on the topic. Duncan's skills as a storyteller, and Katie's ability to craft a theatrical experience were crucial to capture attention and achieve impact.

The show opened in Nov 2014 with an initial run of 13 performances. It split the critics, who ranged from dismissal to a variety of positives. A five-star rating from the Guardian's Michael Billington ensured a sell-out. He commented *"This talk, which deserves wide dissemination, is better than good: it is necessary"*. He subsequently rated it 4th out of his top 10 London productions for 2014. There followed a run of 3 performances at the Deutsches Schauspielhaus in Hamburg, and a 'reprise' of 3 performances at the Royal Court in early 2015.

The final performance took place at the Palais des Beaux Arts in Brussels in late June 2015. It was a single 'invitation only' event for a guest audience, sponsored by the European Climate Foundation (ECF). Later in the year, the ECF CEO commented:

> *"Several months after your superb performance "2071" we would like to let you know that we are still receiving very positive feedback from the influential audience – Senior players in EU public policy arena with a particular but non-exclusive focus on climate change policy-makers as well as EU business, NGO, think tank and media leaders were all present. The timing was perfect to be of support to the EU's leadership role in the run-up to the COP 21 in Paris in December 2015. This was confirmed in particular by the Director-General of DG Climate Action, who was one of the guests present."*

The performances played to a cumulative audience of ~10,000. A book of the script was published by John Murray with a print run of 10,000. It was accompanied by a German translation published by Droemer. Licenced performances have since been



delivered in Australia, Wales (in Welsh), the USA and Italy. It resulted in a lengthy OpEd in the Observer (https://www.theguardian.com/science/2014/nov/22/-sp-climate-change-special-report), coverage at the Hay Festival, Cheltenham Festival, Edinburgh Festival, Words by the Water and numerous scientific conferences. The book featured on BBC's NewsNight (https://www.youtube.com/watch?v=gmysGrBlqHE).

Was it a success? Messages received from audience members, and conversations in the bar following performances, were encouraging. Confidence had apparently been generated to talk about the subject socially, and to spread the message. A typical reaction was; *"It suddenly all made sense!"*. The reported impact on EU preparations for COP21 was a pleasing bonus.

In 2019 Duncan and I published an 'Epilogue' to 2071, to bring the material up to date. In March this year, with atmospheric CO_2 concentrations still rising and climate impacts accelerating, we posted a revised version as follows:

2071' was written and first performed nearly eight years ago.

Since that time, the carbon dioxide content of the atmosphere has increased to 415ppm, a level unprecedented in 2 million years. The concentrations of methane and other greenhouse gasses have also increased significantly. The global mean temperature is now 1.2°C above pre-industrial levels. Sea level rise has accelerated to 4.4mm/y. Droughts, floods, wildfires and storms have increased disproportionately. It is estimated that economic losses from weather, climate and water extremes are now running at some $3.6 trillion per year. The number of climate refugees has increased.

The cost of electricity generation by renewables has tumbled. But renewables still account for only ~11% of primary energy production. 90% of all known coal reserves and 60% of all oil and gas reserves need to be left in the ground. We need to Abolish Fossil Fuels.

Despite the supposed 'diplomatic triumph' of the 21st Conference of the Parties (COP21) of the United Nations Framework Convention on Climate Change, at which 195 nations committed to "limiting the global temperature rise to well below 2°C above pre-industrial levels, and to pursue efforts to limit the rise to 1.5°C", real world action based on current policies will only limit warming to 2.7°C, with a 50% chance of that figure being exceeded. Only the most optimistic assessments give an outcome under 2°C.

In its latest reports the Intergovernmental Panel on Climate Change states: "It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred", and "Climate Change is a threat to human wellbeing and the health of the planet. Any further delay in concerted global action will miss the brief, rapidly closing window to secure a liveable future". The UN Secretary General has declared a "Code Red for Humanity".

We are running out of time. Achieving the COP21 guardrails may still just be possible within the laws of nature. But it won't happen without a synchronised and determined transformation of politics, technology, economy and society at a scale and pace unprecedented in human history. We are primed for action yet success is slipping away.

Is there hope? Possibly. Greta Thunburg, the Swedish teenager, has understood the climate challenge and is not afraid to speak her mind. Having shot to fame as a result of her 'Skolstrejk för Klimatet', she has followed up with forthright speeches to the powerful, such as to the delegates at COP24 in Katowice: "I will not beg the world's leaders for change. I will tell them that change is coming whether they like it or not. We have to realise what the older generations have done to us – what a mess they have created – (and) we have to make our voices heard". Participation in school strikes globally has been in the millions. Greta is an inspiration and example. We all have a voice. We can only hope that world leaders will rise to the occasion. Young people form a powerful constituency. The Future is theirs after all!

Studies of human behaviour have shown that, contrary to common belief, 'Actions drive Beliefs' and not vice versa. This and other insights from the mind sciences underpin the work of the UCL Climate Action Unit (CAU) (https://www.ucl.ac.uk/climate-action-unit/sites/climate_action_unit/files/science_in_parliament_-_roberts_et_al_2021.pdf). If the 2071 project were to be repeated, it's apparent that an 'action' rather than 'problem' framing would have greater potential for accelerating the scale and pace of progress.

For the moment, the closing words of the original script still apply:

"Science can't say what is right and what is wrong.

Science can inform, but it cannot arbitrate, it cannot decide.

Science can say that if we burn another half-trillion tons of carbon the atmospheric content of CO_2 will go up by another 100 parts per million, and that will almost certainly lead to a warming of the planet greater than two degrees, with major disruption of the climate system, and huge risks for the natural world and human wellbeing.

But it can't answer moral questions, value questions.

Do we care about the world's poor? Do we care about future generations? Do we see the environment as part of the economy, or the economy as part of the environment?

The whole point about climate change is that, despite having been revealed by science, it is not really an issue about science, it is an issue about what sort of world we want to live in.

What kind of future do we want to create?" □

IS THE FUTURE OF HEALTHCARE DIGITAL?

The NHS Long Term Plan, published in January 2019, sets out a vision to transform the health service using digital technologies. In theory, this could reduce burdens on staff, increase resource efficiency, and result in more accessible services for patients. But how well do these work in practice? Here Dr Caroline Wood discusses the evidence for and against digital technologies within healthcare, focusing on video consultations and apps.

Dr Caroline Wood, Oxford Population Health

Professor Trish Greenhalgh, Nuffield Department of Primary Care Health Sciences, Oxford University.

Dr David Morley, Health Services Research Unit, Oxford Population Health

Associate Professor Angeliki Kerasidou, Ethox Centre, Oxford Population Health.

Professor Susan Jebb, Nuffield Department of Primary Care Health Sciences, Oxford University.

Dr Federica Lucivero, Ethox Centre, Oxford Population Health.

THE VIRTUAL DOCTOR WILL SEE YOU NOW

Digitising outpatient appointments is a core theme of the Long Term Plan, which promises that by 2024, 'every patient will have the right to online 'digital' GP consultations.' Yet the use of online consultations in primary care services remains low, despite a temporary surge during the height of the COVID-19 pandemic. In England, for instance, video and e-consultations combined accounted for fewer than 0.5% of general practice consultations in December 2021, whilst telephone appointments made up 35%.

The arguments in favour of online appointments include that these save patients time/money that would be spent on travelling and parking, and that they can be more accessible for certain patients (for instance, those with mobility issues). Digital appointments could also enable more flexible working for healthcare professionals, lessen the likelihood of cancelled appointments, and even reduce carbon emissions.

However, relying on high-speed internet connections to deliver consultations could potentially exclude certain patients, for instance those in isolated rural areas and low-income families. Other groups who could be disadvantaged by online consulting include people less comfortable with information technologies (particularly older adults), those with a hearing impairment, and those with limited English. In addition, providing online consultations can increase burdens on health services, through the need to train staff, provide 'how-to' resources for patients, and trouble-shoot technical issues.

Ultimately, the key deciding factor should be how digital technologies impact patient outcomes. In a systematic review carried out by the Cochrane Collaboration, Sasha Shepperd, Professor of Health Services Research at Oxford Population Health, and colleagues assessed data from over 90 clinical trials which compared online conferencing (either alone or in combination with remote-monitoring technologies) against face-to-face or telephone appointments for a range of different conditions [1]. Overall, they concluded that online consulting can be just as safe and effective in treating chronic (but stable) health conditions as face-to-face or telephone appointments. "Our results found evidence that consulting and monitoring patients via remote methods improved blood pressure control in people with hypertension, and improved glucose control for people with diabetes" she said. Nevertheless, for certain conditions, face-to-face appointments may still be more appropriate. These include mental health conditions, since the lack of non-verbal cues in remote appointments can make it more challenging for clinicians to identify changes in a patient's status.

A PHONE CALL CAN BE JUST AS GOOD

It should be borne in mind, however, that in many cases the benefits of online consultations

also apply to telephone consultations. Trish Greenhalgh, a Professor in Oxford University's Nuffield Department of Primary Care Health Sciences, believes this is a key reason why the number of online consultations has plummeted since the height of the COVID-19 pandemic. "In a recent qualitative study where we interviewed both patients and clinical staff, a recurring theme was that, in most cases, video consultations offered no relative advantage" she said [2]. "Problems could generally be sorted adequately and safely by telephone and an in-person assessment was considered necessary for the remainder. Both staff and patients also felt that the clinical relationship was more easily initiated and maintained face-to-face." She noted, however, that in some distinct scenarios online consultations can offer a definite advantage, for instance in enabling GPs to assess emergency patients out-of-hours, to determine if they need to be immediately transferred to hospital.

general health and comorbidities, their digital literacy and home set-up, the strength of the clinical relationship, and, where relevant, the capabilities and confidence of healthcare staff in using these technologies."

THERE'S AN APP FOR THAT

Another recurring theme of the Long Term Plan is the integration of apps into NHS services. In particular, the plan proposes that a central NHS App will provide a single gateway for people to access their patient data, find health information, and register to use NHS services. Potentially, this could speed up referrals, enable easier data sharing between NHS services, and reduce inefficient paper trails. For instance, new 'maternity digital records' are already allowing new mothers to access all the notes and information related to their pregnancy via their smart phone.

Beyond accessing information and services, complementary apps integrated into the NHS

Video consultations may help increase access to healthcare services, but could also affect the doctor-patient relationship. Photo credit: Pixabay.

"Even when the underpinning infrastructure is established, the question of whether digital technologies are appropriate for an individual patient requires a case-by-case assessment" she added. "This should take into account the specific health issue being addressed, the patient's

system could also empower patients to more effectively manage health conditions. One that could particularly benefit from digital technologies is diabetes, which already accounts for 10% of the NHS budget and could affect one in ten UK adults by 2030. According to a study led by the Health Services Research Unit (HSRU) at Oxford Population Health, web-based and mobile technologies can help improve the wellbeing of individuals with diabetes, and prevent diabetes-related health complications from arising [3]. One of the lead authors Dr David Morley (HSRU) said: "Our studies found that web-based and mobile technologies

yet in places where CPR and defibrillator use occurs quickly (for instance Heathrow Airport) it is over 80%.

HEALTH IN OUR HANDS

Besides helping us to manage illnesses, apps could support all of us to achieve healthier lifestyles. The NHS has already launched a range of custom apps for specific health goals

Research suggests that apps could enable people to better manager certain chronic conditions, such as diabetes. Photo credit: Pixabay.

enabled users to get an in-depth sense of how their body reacted to both lifestyle and medication factors, encouraging problem-solving through making changes to their diet and/or activity levels after identifying reasons for blood sugar highs and lows."

Apps could even help support emergency services, as demonstrated by the GoodSAM App [4]. The app is directly integrated into ambulance dispatch systems, and automatically alerts local volunteer responders trained in CPR when there is an emergency call for a cardiac arrest. GoodSAM includes a crowd-sourced map showing the location of nearby defibrillators, allowing responders to deliver basic life support whilst the ambulance is on the way. These precious minutes have a dramatic impact on survival: national survival rates from cardiac arrests are less than 9%,

including stopping smoking (Smokefree), cutting down on alcohol (Drink Free Days), and being more active (Couch to 5K). Diet-related apps, however, have proved particularly popular, which may reflect the widespread confusion studies have found among consumers over how to eat healthily. Through the Livestock Environment and People (LEAP) project, Oxford University researchers have contributed important evidence about the health and environmental benefits of plant-based diets, and is now exploring how this information can be used to drive behaviour change.

In 2021, the LEAP team launched an online programme called OPTIMISE (Online Programme to Tackle Individuals' Meat Intake through SElf-regulation) to help people self-monitor their meat consumption, learn about the

health and environmental impacts of their meat intake, and set personal meat reduction goals. Professor Susan Jebb, Director of LEAP, said: "A controlled trial found that OPTIMISE users more than halved their meat consumption after two months, from a daily intake of 221g to 107g (a 52% reduction) [5]. Since then, a real-world test of the programme with a larger cohort found similar results, suggesting that online tools can be effective in supporting motivated individuals to make dietary changes."

AN ISSUE OF TRUST

Since digital technologies within healthcare depend on collecting, storing, and transferring individual data, a key challenge facing its wider adoption is gaining confidence and acceptance from the public. According to Angeliki Kerasidou, Associate Professor in Bioethics at Oxford Population Health's Ethox Centre, the increasing number of partnerships between healthcare services and private, profit-driven companies that supply digital technologies could potentially undermine public trust. "In the UK, the public's concern with and apprehension regarding the sharing of their health data with bodies outside the NHS, and particularly with commercial entities, is well documented" she said. "What is needed are clear guidelines to assist health services to set governance arrangements that place the common good at the core of the partnership. This is particularly important given the extremely sensitive nature of health data, and the fact that once such data are obtained they could be used for additional purposes, such as analysing the app performance, or sold to third parties for marketing."

Digital health could also transform doctor-patient relationships. As Dr Federica Lucivero, a Senior Researcher in Ethics and Data also at the Ethox Centre, said: "By placing more distance in the doctor-patient interaction and giving patients tools to control their health, digital technologies could introduce new interactions between care providers and patients. This raises questions on how these relationships will take shape, whether valuable features of traditional relationships will get lost, and whether medical training needs to be rethought or patient expectations redirected [6]."

Hopefully, these issues will be explored fully during the Health and Social Care Committee's current inquiry on digital transformation in the NHS. As Dr Lucivero concluded: "If we want to achieve the fullest benefit from digital technologies, and implement them in an ethically sound way, ethical reflection and engaging with end-users should be involved from the early development stages. This would allow us to learn step by step from mistakes, identify gaps between intended and actual use, and ensure these deliver both health and economic benefits."

Oxford Population Health, based at Oxford University, is a world-leading research institute that uses large-scale studies to investigate the causes of disease and the most effective treatments. https://www.ndph.ox.ac.uk/

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BIOTECHNOLOGY: THE NEW ENABLING TECHNOLOGY

Nick Challoner, Group Chief Scientific Officer, Croda International PLC

Biotech is lauded for its sustainability benefits. Yet its ability to stimulate a new wave of innovation could be an even bigger prize for the UK.

The biotechnology industry is booming. Since 2010 an index of biotech firms listed on the Nasdaq has quintupled in value and the number of companies within it has more than doubled. Between 2011 and 2020 the money that biotech startups raised from IPOs ballooned from $4bn to $65bn. This pace of expansion was unforeseeable a decade ago. Today the sky is the limit. Why?

Biotechnology is the use of cellular and biomolecular processes to develop products for industrial use. It takes advantage of the ability of certain living organisms to take in a substance or substances and, via their inbuilt biological processes, convert them into a useful industrial product or products. It opens the possibility for a wide range of new ingredients to be derived from biological feedstocks, that could replace

ones that require chemical manufacturing processes or are derived from petrochemical feedstocks.

The primary discussion driving the growth of biotechnology is about sustainability. Today's consumers want more sustainable products in all aspects of their lives. From drugs to cosmetics, they are far more interested in learning about what goes into making their products than previous generations, leading to a growing demand for better safety and transparency and much closer interrogation of upstream raw materials. For example, Croda's use of biotechnology is helping replace petrochemical feedstocks in the surfactants supply chain. Surfactants are used within a variety of products from detergents and dyes to cosmetics and many are manufactured using a petrochemical derivative called ethylene oxide. It is highly effective but not the most sustainable option for production, so companies are seeking biobased alternatives. At our US facility we have invested in a manufacturing site that can utilise biotech produced biobased ethanol to make biobased ethylene oxide. That, in turn, is used to create bio-based surfactants without using petrochemical feedstocks.

Sustainability goes much further than just environmental impact. Consumer attitudes and concerns around sustainability are evolving and now span a much wider definition, encompassing more social elements such as ethical supply chains; diversity and inclusion; gender equality; and the equitable sharing of benefits. Where once the question was "is this ingredient plant based?" it is now frequently "where does that plant-based raw material come from? Which country? Which region? How is it farmed? Is there an equitable sharing of benefit in the supply chain through which you receive it?". The use of controlled processes limits the complexity of the supply chain and the number of points where threats to sustainability and equality could materialise. As the demand for greater transparency grows, greater control over the source of bio-based raw materials and the processes by which they become ingredients for products will have a vital role to play, biotechnology is a way in which that control can be increased.

PUSHING INNOVATION UP THE AGENDA

But limiting the biotechnology discussion only to enabling sustainability goals, misses its additional potential for sustainable innovation – a significant reason why so many companies and investors are piling into the sector. Biotechnology can enable a new wave of innovation that will change the products and services we use, and the way in which they are produced. Whilst biotechnology is not new it remains one of the most innovative ways in which to create novel products.

Companies have been using bio-based feedstocks for decades but they have been limited by what can be derived from them using traditional chemistry. Biotechnology changes that significantly in three ways.

Firstly, it provides a completely different toolkit with which to explore the products that can be obtained from living organisms. We know that traditional chemistry already provides a way to manufacture certain products but it can require the use of catalysts, solvents and raw materials that are not sustainable. The number of those products that can be delivered through biotechnology processes such as fermentation and plant cell culture (which avoid many of these chemical processes) is growing. It is fast becoming a new and effective way to create these sustainably-sourced ingredients. Today, there is considerable potential for more bio-based products to be created than ever before. Biotechnology is the key to finding and producing them.

Secondly, it provides a way to discover brand new bio-based ingredients. Replacing existing petrochemical-derived ingredients with biotechnology-derived alternatives is only part of the story. The opportunity biotechnology provides to answer questions that have never been addressed through chemistry is the other. This is because biotechnology expands the number of living raw materials, produced by living micro-organisms that could become the starting point for brand new products with novel capabilities. With so many species of plants and microorganisms available for use in biotechnology processes, the opportunity for this approach to uncover both replacements for fossil-fuel derived ingredients or new molecules that enable entirely new product properties is significant. Biotechnology even has the potential to change the entire manufacturing process – making it considerably more sustainable. Some companies are already powering their own manufacturing sites using the gas created by enzymes used in their biotechnology processes.

And thirdly, biotechnology-derived bio-based molecules can be modified to be more potent and therefore more effective. Personal care is a good example where this is having an impact. One of the most recent bio-hyaluronic acids now dissolves in both water and oil, so it penetrates better through oily skin and is absorbed deeper for more intense hydration. This was achieved purely through laboratory research and development to tailor ingredients at the molecular level. Similar processes can be used to allow new product delivery systems to be created, by tailoring ingredients so with specific functions in mind – for example, growth factors or peptides for anti-ageing.

Biotechnology barriers

Whilst the benefits of biotechnology are becoming more widely recognised, incorporating this approach into multiple industries is not without its hurdles. There are some specific issues preventing companies from fully exploiting biotechnology's potential to improve innovation – businesses are struggling to find the right mix of skills to build a workforce that can unlock the opportunity biotechnology presents; the sector needs to expand biobased feedstocks beyond the primary agricultural crops on which it predominantly relies today, to secondary or waste feedstocks; and the negative perceptions of biotechnology at a consumer level need to be better explained. But the most difficult challenge to solve is unfortunately the most expensive too – the creation of an industrial-scale infrastructure through which the sector can grow and flourish.

Giving industry a way to access an entirely new set of innovative products depends on biotechnology processes being implemented on an industrial scale. Without that in place today, biotechnology is being held back.

This is hard to address due to a combination of both cost and complexity. The process of

moving from lab to production is extremely challenging and as volume increases it becomes harder to manufacture products this way. Even for the largest businesses, which have significant manufacturing experience, it can be very difficult to go past certain volume thresholds when it comes to some biotechnology-derived ingredients.

In addition, to support product scale-up and technology development, pilot/demonstration plant operation is often the most reliable way to generate the data needed to design equipment and scale it up to an industrial level.

Once successfully trialled/modelled in laboratory conditions, the finances and expertise required to scale to industrial production are very significant, limiting access to only the few larger companies with the resources to commit. It will naturally therefore limit the technology options selected, which will ultimately restrain levels of innovation in the sector.

GOVERNMENT'S GLORY

This is where governments can play a vital role – unlocking the potential of biotechnology to improve national economic prospects through planned, targeted investment and an integrated strategy to guide where funding is focused. Without sufficient public sector support, moving biotechnology to an industrial scale will be a slow fragmented process that could become a significant barrier to realising true economic impact.

So although biotechnology is becoming the poster child of sustainable products and services, we must not lose sight of the considerable benefit it can offer the UK economy beyond that, by stimulating new innovation. There is no doubt that it has the capacity to increase the variety of innovative new products the UK produces and the amounts of each that can be created.

Biotechnology's contribution to the sustainability debate must continue to be promoted. But there needs to be more attention given to how it also represents a source of national economic growth as an underpin for the next phase of industry innovation on these shores. □

APPLYING BIG DATA TECHNOLOGY TO DETECT INFECTIOUS DISEASE: CYSTIC FIBROSIS IS LEADING THE WAY

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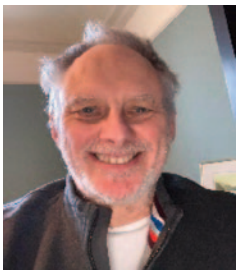

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INFECTIOUS DISEASE AND CYSTIC FIBROSIS

In Paragraph 30 of their May 2022 communique, the G7 Health Ministers acknowledged the gravity of infectious disease, stating: "We therefore highlight the importance of accelerating the early and late-stage development of urgently needed new antimicrobial drugs, vaccines, alternative therapeutics and diagnostics".[1]

Infectious disease and especially lung infection is pertinent to people with Cystic Fibrosis (CF) who, even with the development and use of disease correcting modulators, will always require antibiotic treatments for lung infections. CF is one of the most severe and life-limiting recessively inherited genetic disorders affecting more than 90.000 people globally and more than 10.000 people in the UK. [2] Chronic lung infections are a key feature of CF which are suppressed by the use of daily prophylactic inhaled antibiotics. However, acute exacerbations (or flare-ups) of symptoms as a result of an infection become more frequent as the disease progresses. These are a significant cause of morbidity and premature mortality. Exacerbations are treated with intensive courses of intravenous antibiotics. The cause or trigger of these exacerbations is poorly understood. Cystic Fibrosis Trust established the UK CF

Innovation Hub based at the University of Cambridge which is targeted at research using novel data technologies to understand better the factors that trigger these exacerbations, develop novel ways for their earlier identification and create new antimicrobial therapies to treat them.

DATA TECHNOLOGIES AND INFECTIOUS DISEASE

Data technologies including, but not limited to, Artificial Intelligence (AI), Machine Learning and Big Data analysis are advancing rapidly and are now commonly used in biomedical research and everyday healthcare. The COVID-19 pandemic was in part a catalyst for the development, adoption and regulatory approval of new data driven approaches to healthcare when conventional methods were no longer sufficient. However, they still have not made a significant impact on the treatment of most infectious diseases. With the ongoing creation of large-scale, standardised and detailed datasets on infectious agents, data technologies will become an essential part of any analysis and subsequent treatment.

Many data technologies, especially those used for diagnostics and decision support algorithms, aim to solve a "classification" problem. This has been described as *"Given a particular set of (clinical or other) measurements on a number of patients with known diagnosis, infer a pattern that can reliably predict the correct diagnosis from the measurements"*.[3] The aim is that when faced with a patient of unknown diagnosis, where a part or all of the clinical (or other) measurements are available the algorithm will be able to predict a possible diagnosis.

The use of data technology in infectious disease has been classified into five areas, namely: surveillance, prevention, diagnosis, treatment and implementation.[4] Of these, prevention, diagnosis, and treatment are of greatest relevance and value to CF.

Infectious disease surveillance entails the systematic collection, aggregation, analysis and timely dissemination of data on incidence and prevalence of infections and, where relevant, the use of antimicrobials. The systems used for surveillance are essential for decision-making based on reliable data and to monitor and adjust, where necessary, the impact of interventions made on the basis of that data. This includes tracking the incidence of infectious disease, developing an understanding of the source of the infections, tracking any antibiotic resistance linked to the incidence, and finally monitoring the prevalence of the disease in the population as a whole or in particularly susceptible sub-groups including rare-disease patients, the elderly and immune-compromised.

Diagnosis of infectious diseases has relied almost exclusively on conventional microbiology and still relies significantly on these tried and tested methods. To develop a diagnostic to what was always a lab-based discipline, two components are necessary: firstly, a sufficiently large set of laboratory and clinical input data and secondly the outcome data, i.e. the diagnosis made by the physician based on the laboratory and clinical input data. The combination of these two data sets is what is used to train an AI algorithm to make diagnoses in the absence of one or the other set of data. "Training" requires the algorithm to be able to extract patterns from the data relevant to a specific infection, whilst being able to differentiate between this and subtly different patterns which may represent a different infection. Training is an iterative process where the model used is refined to improve sensitivity and specificity of the diagnosis and then validated with previously unseen data.

By 2020, 222 AI-based medical devices were registered in the USA, with 64 of them specifically FDA-approved. In the EU, where the approval of medical devices is more decentralised, 240 AI-based medical devices were CE-marked. The majority of these devices were developed for diagnosis and use pattern recognition-based algorithms. These algorithms process large volumes of data quickly and identify subtle patterns in the data to detect disease, including infectious disease. Of these medical devices only four are specific to infectious diseases. Two were approved both in the USA and Europe (sepsis and automated plate reading) and a further two were approved only in the USA (sepsis and syphilis).

THE CHALLENGE OF DATA AVAILABILITY

The increasing availability of data in healthcare is creating opportunities for the use of such data for public health, epidemiology, surveillance and clinical research, along with several unique challenges. The key challenge for the development of any model using data technologies is the requirement to create a sufficiently large and diverse database which is representative of the whole population. Whilst some data is available, in many cases databases are kept secret and proprietary for competitive reasons.

Privacy and data protection requirements also constrain data availability. Machine learning diagnostic systems could leverage a patient's electronic health record to assess their individual risk of a resistant infection and recommend the narrowest-spectrum antibiotic likely to successfully treat the infection. However, use of personal data in healthcare must

be done under the auspices of data protection and privacy laws aimed at protecting the privacy of the individual. This includes but is not limited to individuals' identity, personal characteristics and health status. Processing of this data is forbidden by default, unless the patient has given explicit consent to process this data. To facilitate innovation, privacy laws generally include mechanisms to anonymise data and to protect patients from retrospective identification. These mechanisms should always be considered when collating electronic patient data when developing new technologies.

MANAGING CYSTIC FIBROSIS WITH AI – PROJECT BREATHE

Project Breathe[5] is a case in point. It is a ground-breaking approach to managing CF that allows people with CF to monitor their health parameters such as lung function, blood oxygen levels, daily activity, how much and how often they are coughing, and store these data in the cloud. The data can then be interrogated using AI technology to create a predictive algorithm that identifies the earliest signals for an impending exacerbation and is able to provide advance warning - up to 10 days in advance of current approaches. By pinpointing these early changes, people with CF can act earlier on changes in their health parameters and potentially prevent infections that could lead to hospitalisation. In addition, the data is a valuable tool to help our understanding of the triggers of these exacerbations and potentially could lead to novel treatments to abort their onset.

Project Breathe was conceptualised by the parents of a young boy with CF whilst sitting at his bedside in hospital over Christmas, when he was receiving lifesaving antibiotic treatment for a bacterial lung infection. Their social enterprise company, Magic Bullet built on a very successful feasibility study called SmartCare funded by Cystic Fibrosis Trust. [6]

Funded by the Cystic Fibrosis Foundation, the Project Breathe consortium, including Cystic Fibrosis Trust, Microsoft Research, the University of Cambridge, Royal Papworth Hospital and Magic Bullet, is currently running an extended trial to validate the technology in a clinical setting.[7]

A "Project Breathe kit", is provided to study participants. This includes a smartphone app, wearable tech to track activity and sleep, an oximeter and a spirometer. Data from the devices is automatically uploaded to the app, and patients can also enter self-reported data on how much they are coughing and how they are feeling overall.

The data is analysed using supervised machine learning to apply a predictive algorithm model developed in the SmartCareCF study by Andres Floto, a Professor of Infectious Diseases at the University of Cambridge, and John Winn, a principal researcher at Microsoft Research who has CF. The model looks for patterns, and changes in patterns, which are contained in the data to predict when a patient may become ill.

The final outcome of the work is still in the future. Project Breathe is nevertheless already demonstrating how effective and safe home monitoring of a debilitating disease can be. The project is already benefitting people with CF, with early results showing that the model predicts lung infection up to 11 days earlier than when antibiotic treatment would usually be started. Data from the smartphone app has circumvented in-person clinic visits, saving time, reducing patient stress and decreasing the impact on an already stretched NHS.

As with any innovative healthcare provision, digital health technologies in the NHS such as remote monitoring of long-term conditions requiring a high burden of treatment like cystic fibrosis, should be accessible to all who could benefit. There should not be a postcode lottery created by exciting new technologies that have the potential to prevent unnecessary hospital treatment and enable people with life-long conditions to feel empowered to manage their own condition more easily.

Professor Floto says: *"We think Project Breathe may be a great solution to realize the widespread rolling out of virtual clinics. If we can intervene earlier, we should be able to protect the lungs from long-term, ongoing damage".*[8]

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WHY CIRCULAR CARBON IS CRITICAL IN THE RACE TO NET ZERO

Andreea Sapunaru
Global Marketing Director
Sustainability at Unilever

It seems there's not a day that passes where we're not faced with the latest, most damning climate report to remind us how perilously close we are to catastrophic events. The next few years are undoubtedly critical for the future of humanity, with the world literally in the race of a lifetime to get to net-zero. Many countries now have national pledges in place and a growing number of businesses have set targets to reduce their energy dependence and switch to clean energy sources. Despite the progress made, we still urgently need to limit the global temperature rise to 1,5, which requires an immediate peak in global greenhouse gas emissions and a reduction of 43 percent this decade.[1]

While the world's focus remains largely on energy use, there is another cause of climate change that urgently needs addressing too: embedded carbon.

AN INDUSTRY UNDER THE RADAR

The chemical industry is one of the largest industrial energy users in the world. It is the backbone of modern manufacturing on which the vast majority of industries depend - from clothing to technology, to construction, to household products. Yet, it's an industry still heavily reliant on fossil fuels.

Research from the Nova Institute calculates, for the first time, the amount of embedded carbon in chemical and derived materials sector, which is a staggering 450 megatons every year. This carbon will make its way into the atmosphere as CO_2 in one way or another, either through incineration or biodegradation, which is the equivalent to the emissions of over 355m cars each year.[2] Of this demand, 85% is generated from fossil-based resources, 10% from biomass and only 5% by recycling.[3] No matter how fast they can transition to cleaner energy sources to power the plants, this blind-spot will prevent many nations from becoming net-zero.

THE FUTURE IS GOING CIRCULAR

As Unilever is one of the world's largest cleaning and laundry businesses, which is highly reliant on chemicals, this is a major challenge we are working to address. Upon evaluating the full lifecycle of our products, we found that 51 percent of lifecycle emissions were related to the raw materials we use. That's why, in 2020 we published our Clean Future strategy, in which we have committed to eliminate the use of virgin fossil-derived carbon from our cleaning and laundry formulations, a move which we estimate will reduce our products emissions, arguably the hardest to abate, by up to 20 percent.

A new future needs to be created. One that uses less carbon and better sources of carbon, like those from renewable and recycled sources above the ground, to stop drilling for more from under the ground. We call this the Carbon Rainbow. A business like ours needs carbon to make our products, and so cannot decarbonise completely. However, we can choose where our carbon comes from. After all, you can't make cleaning products without chemicals, but you can make chemicals without fossil carbon.

SUPERIOR, SUSTAINABLE AND AFFORDABLE FOR THE MANY

Beyond the obligation to achieve national pledges, we also know that consumers believe it's governments' and manufacturers' joint responsibility to drive change when it comes to environmental damage.

Data shows that climate change is the number one

concern for consumers, ahead of water pollution, plastic waste, air pollution and deforestation.[4] There is also a growing number of consumers making purchasing decisions based on sustainability criteria - over half of shoppers have already stopped buying a product/service because of its negative impact on the environment, or switched their product for one making a positive impact. However, we also know that while people won't buy a product that's not sustainable, they are also not willing to pay more or compromise on product performance, with two in three shoppers stating the biggest purchase barrier is that sustainable products are harder to find or more expensive.

Today, sustainable choices cannot come with a trade-off – they need to deliver on performance and affordability. This is where both governments and manufacturers need to work together. At Unilever, we are committed to producing products that are superior in performance, made from sustainable sources, and are affordable for the many.

CREATING A CLEANER FUTURE FOR ALL

At Unilever, we have been putting this ambition to the test using cutting-edge technology. For example, in China we launched OMO (also known as Persil) laundry capsules made with captured industrial emissions, or 'purple carbon' as we refer to it. Together with our partners LanzaTech and India Glycols, we are able to convert these waste gases into key cleaning ingredients called surfactants. We've since piloted the innovation in our Coral laundry liquid in Germany and our Sunlight hand-dishwash liquid in South Africa. The process LanzaTech is using cuts the greenhouse gas emissions by 82% compared to the traditional fossil-fuel process, and yet produces the same end ingredient, which we can then use to create the same superior cleaning that is kinder to the planet.

Unilever has also invested in a new $120m venture with biotechnology specialists, Geno. The venture aims to commercialise and scale biotech plant-based alternatives to feedstocks like palm oil, or fossil fuels, to make key ingredients used in everyday cleaning and personal care products. An alternative that can be offered to the combined $625bn[5] home and personal care markets. Again, the unique aspect of the technology is that it creates the same ingredient we currently get from palm kernel oil, therefore the same superior clean.

We have also relaunched our biggest laundry brand – Persil – in the UK and around the world with its cleanest and greenest formulation yet, using plant-based stain removers. And we are also working to develop new ingredients that improve the performance of our products. For example, our partnership with Evonik to launch rhamnolipids in our hand dishwash products in Vietnam and Chile. This biosurfactant is 100% biodegradable, renewable and ultra-mild on hands, a key benefit for consumers.

However, as with all ground-breaking innovations, they need significant investment to scale to the levels needed for commercialisation.

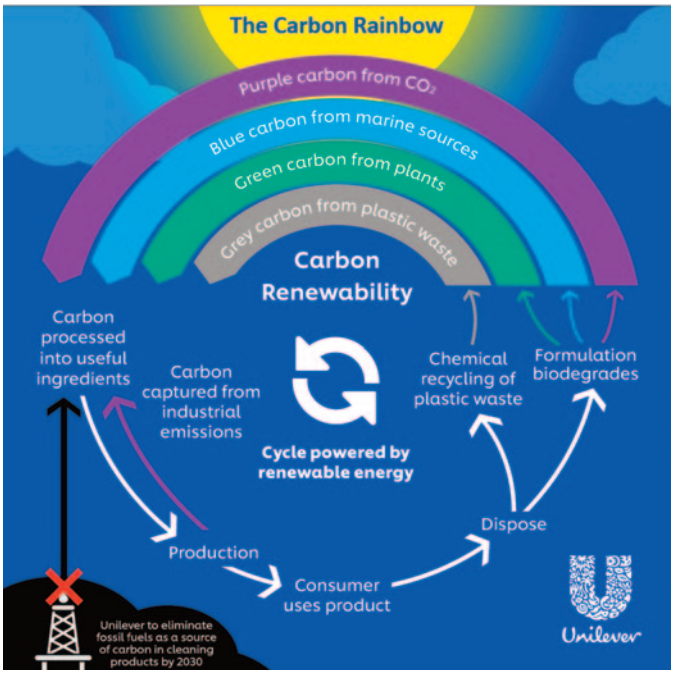
MAKING THE SYSTEM CHANGE FOR GOOD

We cannot achieve this agenda only with an industry push. As a downstream user of chemicals, Unilever is a small part of the chemical industry. We need chemical suppliers to transform their supply chains, we need chemicals users to help drive the scale and demand, and we need policymakers to help create an enabling environment. We need suitable policies to bolster new technologies of renewable carbon, but also to enable these technologies to compete on an even playing field with black carbon.

On the supply side, we need policies that support research into technologies that enable carbon circularity, to make them more efficient, and thus cost-effective. Then once the technologies being researched are ready for scale-up, we need policies that de-risk the investment required to move from pilot stage to industrial production.

And on the demand side, we need a clear policy signal in the UK that the transition to non-fossil carbon chemicals is the way to go. There are a lot of companies waiting for this policy signal to make the required investments.

Technologies that underpin the Carbon Rainbow will be a staple of the low carbon economy and the time to gain technological sovereignty is now.



THE DECADE OF ACTION

This decade marks the years for action, and we all have a role to play. We are at the tipping point for the future of humanity and species everywhere and this means turning off the tap on fossil fuels for good. The UK is in a strong position to offer investment into these new technologies and working together we can be on the right side of history.

For the first time since the industrial revolution, we now have a choice and together we must make better choices for people, the planet, and for businesses to thrive.

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VALUE CHAIN IMPLICATIONS OF A POST-FOSSIL WORLD

Thomas Birk, Vice-President, UK and Ireland/Managing Director BASF UK

Event 28 March 2022 P&SC in cooperation with SCI

Awareness of climate change has climbed the public agenda and demand from consumers for action has accelerated over the past two or three years. This pressure feeds through to industry, with customers demanding manufacturers address how products are made. It finds its way to companies like BASF, at the start of the value chain, via brand owners and we accept that change is necessary.

The chemical industry has a huge climate change impact - total emissions attributable to the industry are 5.8% of all global greenhouse gases (2.2% production process emissions and 3.6% from the energy used to power those processes). To put that into context, chemical industry emissions are equal to that of all livestock farming, or three times global aviation. So, the consumer pressure for change is quite justified. Although the chemical industry accepts the need for change, it also recognises the scale and complexity of the challenges – such a transformation will not come easily, or quickly.

WHY FOSSIL-BASED?

Since the Industrial Revolution, humankind has extracted fossil-based fuels from the earth, using these materials as fuels and feedstocks that have driven the development of our society. It has brought many benefits, including increased longevity and improvements to quality of life but this has come at a cost. Fossil fuels were created when the carbon that was extracted by plants 300 million years ago, using energy from the sun, was trapped deep beneath the earth's surface in sedimentary rocks. This is now being extracted and burned in the form of oil and gas and is finding its way back into the atmosphere as CO_2, a gas that increases the tendency of the earth's atmosphere to trap the energy of the sun - known as the greenhouse effect. This has led to global warming and causes increasingly extreme and dangerous weather patterns that threaten our very existence.

The chemical industry developed alongside the extraction and refining of fossil fuels and the rise of the automobile. Since the 1950s there has been rapid growth, with the industry developing synthetic alternatives that were cheaper and stronger than many previously existing products and materials. These materials are produced by complex value chains – multi-stage processes in which chemical building blocks are built to create the desired functionality.

INTEGRATED CHEMICAL MANUFACTURE

BASF operates six world-scale chemical manufacturing sites, including the world's largest integrated chemical manufacturing site in Ludwigshafen. These sites operate on a 'Verbund' system ('Verbund' being German for 'connected') and are best thought of as a collection of independent manufacturing facilities grouped together on one complex. The connected nature of these facilities means that the output of one facility becomes the feedstock of another. It is a super-efficient, optimised but highly complex manufacturing operation and is also one that originates with a small number of processes and raw material feedstocks that feed everything that flows downstream of them. An example of such a process is the steam cracker, which uses temperature and pressure to break naphtha (a component of oil that comes directly from the refinery) into 7 chemical building blocks (ethylene, propylene, C4-stream, benzene, toluene, xylene and methane) that can then be modified and reassembled to make the 60,000 products that the company produces today.

BASF produces just over 20 million tonnes of CO_2e/yr

directly attributable to processes and the energy to power those processes. These emissions are 'within our gates', under BASF's control and are described as Scope 1 and 2 in the greenhouse gas protocol. In addition to those emissions directly attributable to the company, there are further greenhouse gas emissions both upstream of BASF, through the extraction and supply of its raw material feedstocks, and downstream through the use of the products and their disposal at end of life. These are described as Scope 3 emissions. BASF estimates its Scope 3 emissions to be around five times the Scope 1 and 2 emissions and this situation is not untypical within large scale chemical manufacture.

MOVE TO RENEWABLE ENERGY FOR PROCESSING

BASF is dealing with this climate impact burden by setting ambitious targets for emissions reduction and plotting a pathway to achieve these. The company has committed to having net zero emissions by 2050 and has set an emissions reduction target of 25% by 2030, despite predicting a 50% production capacity increase over the same period. It will identify and re-engineer processes with the largest emissions to reduce these as much as possible. One example is the proposed electrification of the steam crackers. At present, BASF operates seven steam crackers, each emitting 0.5 million tonnes of CO_2e/yr, currently powered by gas generated within the cracking process, so the company aims to change the energy source from fossil fuel to electricity. Reducing the carbon footprint of this process will have a knock-on effect of reducing the impact of all cracker downstream products. This requires electrification, so access to renewable energy is a key component of the company's future plans.

CONSIDER ALTERNATIVE SOURCES OF CARBON

So, assuming BASF, and the chemical industry more widely, is successful in reducing Scope 1 and 2 emissions to zero by 2050, there still remains a sizable impact of Scope 3 emissions. The upstream issue is fossil fuel extraction, with leakage, flaring and refinery processing contributing to the upstream Scope 3 emissions. Downstream, product disposal through incineration, landfill or direct release to the environment means that fossil derived CO_2 will inevitably end up in the atmosphere, contributing to climate change. Therefore to ensure net zero targets are met, the industry must consider alternative sources of carbon – but these are limited and come with problems. Notwithstanding that, the existing system which has evolved over decades to become highly optimised and energy efficient uses cheap, readily available and consistent feedstocks - the alternatives are not any of those things - yet.

ALTERNATIVES TO FOSSIL FUELS

One alternative to fossil derived carbon is biomass. Plants can be grown and used by the chemical industry, for example specific extracts can be used as a reactant or ingredient in dedicated processes that address individual chemicals. Alternatively, biobased materials can be converted to biogas, bioethanol or bionaptha and be used in existing infrastructure. In both cases, CO_2 is being captured by plants to be converted into chemicals, which largely removes the upstream emissions related to fossil fuel extraction and processing, while any end-of-life fate simply returns the atmospheric CO_2 back from where it came, adding no additional climate burden. Both approaches have issues with scale and the potential impact of dedicating land to the production of feedstock, rather than food. In addition, biobased routes are less efficient – where the chemical industry wants mostly carbon and hydrogen, biomaterials contain other elements, such as oxygen and nitrogen and may entail additional processing steps.

Waste carbon is another alternative - keeping existing carbon in the loop, rather than digging more out of the ground. Waste plastics, textiles and tyres can be processed and returned to their original building blocks and then rebuilt into useful molecules. Here, we are at the dawn of new technology and invariably some way away from being able to process material at scale and to be economically viable.

BASF believes the industry does not need to start again. Using alternative feedstocks through existing infrastructure would mean production at the hundreds of millions of tonnes scale that is the order of magnitude of current and future chemical production. To achieve this, the company uses a mass balance approach to transition from fossil feedstocks to renewable and waste derived materials. A mix of feedstocks is used as the input and a blended material is produced as the output. The biobased or waste derived feedstock can then be allocated to the products and customers charged accordingly. It is through this kind of mechanism that the gradual transition away from fossil technology can be achieved because scale and volume cannot be achieved overnight.

I have highlighted the challenge that in order to reduce emissions the chemical industry must move away from fossil fuel and yet a viable alternative at scale must be integrated to ensure we can produce sustainably in all senses of the word. At BASF, we accept the challenge and yet neither we nor the chemical industry as a whole can achieve this alone. There is not one single action that will successfully address this challenge completely – we need to work together as consumers, as industry, as policy makers for this shift to turn into a reality.

#WeCreateChemistry for a sustainable future. □

TRAINING TALENT – REFORM OF PHD PROCESSES

Dr Benjamin Fernando
Access Fellow
Christ Church College and
Department of Physics
University of Oxford
STEM 2021 Physics Gold Medal
and The Westminster Medal

It is sometimes said that undergraduates are the lifeblood of a university - if that is the case, then PhD students are surely its workhorses. It is hard to think of a major scientific research project which does not involve at its core a group of committed doctoral students, often undertaking much of the grinding and monotonous work required to see progress through. The challenges of study at this advanced level are also a formative step in the academic pipeline, in which the key research skills that define a scientific career are set.

Given the importance of this group of young scientists to both societal and scientific productivity, it is surprising the way in which PhD students are recruited in the UK remains as under-regulated as it is. Whilst undergraduate admissions procedures are tightly moderated and the system itself centralised, many parts of the postgraduate procedure resemble more of a 'wild west' way of doing recruitment. This has signifiant implications for who is chosen, especially at the most selective universities, to undertake research - and in turn, who has the best chance of going on to be a scientific leader of tomorrow.

The crux of the problem is that there is effectively no standardisation anywhere in the doctoral application cycle. A lack of centralised resources or a system comparable to UCAS, wildly varying procedures (sometimes even within a given university), and an opaque ranking system have combined to yield a process in which enormous biases exist.

Take for example my own field, the geosciences. Whilst the journey to gender parity at doctoral level in my subject (at a statistical level) is nearly complete, the breakdown of the demographic by ethnicity is truly dire: the proportion of students funded by the main research council who are from ethnic minority backgrounds is around 6%, versus a population average of nearly 20%.[1] This is only one example, but the trend repeats (albeit with different minority demographics) across STEM fields.

There are of course many reasons for this, some of which may be cultural or historical, whilst others are clearly procedural. The most obvious way to illustrate this - and to demonstrate that it need not be this way - is to compare the application procedures to the same university for an undergraduate and a postgraduate student.

All undergraduate applications are handled through UCAS, and have been since 1992. Here, a candidate pays a standard fee and uploads one personal statement as part of an application to up to five universities. Each candidate sees the same UCAS website, which holds centralised guidance on the processes and procedures involved. Each university gets the same information on each candidate, including valuable contextual information on school type, deprivation indicators, and adjustments needed at interview.

At doctoral level, the picture is wildly different. Some courses require a fee, but some only require that fee from certain (external) candidates. Some personal statements are a page in length, some might be three. Students are expected to contact potential supervisors in advance of a formal application, but there is no guarantee of getting a reply. Some institutions require a research proposal, others simply a copy of previously submitted work. Sometimes places on a course come with funding, sometimes the funding is separate…

The list goes on. Funding bodies (including those sponsored by the UK Government) require reporting on demographics, but fail to provide a centralised set of resources for applicants or a standardised set of reporting metrics. In a sector struggling with over-work and staff shortages, this inevitably results in wildly varying standards, and a hodgepodge of reporting metrics which make it challenging to even develop a clear picture of the state of the field.

All of these factors combine to make doctoral applications far less equitable or transparent than their undergraduate equivalent, and far more open to manipulation from those 'in the know' - who more often than not are those from 'traditional' scholarly backgrounds. It is unsurprising therefore that many of the biases and under-representions we work so hard to eliminate at undergraduate application reappear or become even more apparent later in the academic pipeline.

There appears to be only one route to addressing this issue: a top-down standardisation of procedures; which places an emphasis on fair delivery for all applicants regardless of background, and which minimises unfairly privileged access or connections. The challenges involved in setting up a system like this are not to be underestimated, but if it works at undergraduate level it can work at postgraduate level too. The Government is the main funder of doctoral study in the UK, and as such they must be the ones who take the decision to drive forward the agenda on this.

1 Dowey et al, Nature Geoscience (2021): https://doi.org/10.1038/s41561-021-00737-w □

THE SWITCH FROM TACKLING TRAUMA TO COMBATING CLIMATE CHANGE

Nikita Mayur Patel

Trauma is one of the leading causes of death and disability in those aged under 44 and exceeds the number of deaths caused by HIV, tuberculosis and malaria combined. Globally, there are approximately 6 million trauma related deaths each year which is equal to someone dying every six seconds. Trauma in its widest sense is a disease caused by physical injury to the body which may be blunt such as road traffic accidents or penetrating through stabbings and shootings. In contrast to most other diseases, instances of trauma and the accompanying mortality rates are rising.

The trauma-associated blood loss or haemorrhage accounts for almost 40% of all trauma mortalities and is frequently considered the biggest cause of preventable deaths in the world. The term 'haemorrhagic shock' describes a condition whereby the extent of blood loss primarily produces a state of severe hypotension (low blood pressure) which leads to poor tissue perfusion and hypoxia (low levels of oxygen in the body).

Trauma patients who survive the initial injury often develop multiple organ failure at a later stage owing to the vast physiological damage exerted on the body. There is a need to identify therapeutic interventions which can lower or prevent the decline in organ injury and dysfunction to better manage trauma patients and ultimately improve their prognosis; as currently only the secondary effects of multiorgan failure are treated (e.g. using a ventilator for lung damage or dialysis for kidney dysfunction).

I had the great opportunity to present and discuss my research investigating new treatment strategies for trauma-associated organ dysfunction at the STEM for Britain 2021 competition to Members of Parliament. The competition allowed a greater engagement and dialogue between early career researchers and constituent members and raise awareness of the ongoing research which is taking place behind the scenes.

I was absolutely delighted to not only receive The Physiological Society Prize but also the Gold Medal in the Biological and Biomedical Sciences category! I entered STEM for Britain as I thought the competition was a fantastic opportunity to disseminate my research and increase awareness in the trauma and haemorrhagic

shock fields, given its high prevalence in society. The ability to communicate and discuss science with a lay audience is a valuable skill to have, just as key as the research quality and integrity.

As a result of my achievements at STEM for Britain, I was invited to co-host a youth panel event at the United Nations Climate Change Conference (COP26). A recent survey conducted by the University of Bath found that 60% of young people felt overwhelmed by climate anxiety and frustrated by the lack to action to tackle climate change.

However, all hope is not lost. Science and business can go hand in hand to offer innovative climate change solutions. The Society of Chemical Industry organised a Next Generation Debate (Countdown to Planet Zero: Combatting Climate Change with Chemistry) to give today's scientists the opportunity to discuss the work they have been involved in to fight against the climate emergency and answer questions from the live audience. The three themes explored were Fuels of the Future, Turning Waste into Gold, and Engineering Nature.

I was both nervous and excited at the same time to co-chair this event as I recognised how important it was to educate members of the audience, whether they were the scientists or non-scientists, on how science is vital in battling the climate crisis. As part of my role as a co-host, I had to ensure the questions and comments posed by the audience were understood by everyone, given that a mixed audience was attending. This highlighted how crucial good science communication is to prevent any misunderstandings and the spread of false information.

We also opened a poll with the question 'Do you think that science is pivotal in providing climate change solutions?', with 100% of the audience answering yes! This was a notable outcome from the debate and demonstrated that there is hope in science.

I hope the youth panel event has inspired the future generation of scientists and innovators and displayed some of the exciting research which is currently taking place. On a personal level, I valued being able to use the transferable skills I gained and developed as part of the STEM for Britain competition at COP26, despite the two being very different events in terms of topic and format. I would definitely recommend other early career researchers to enter STEM for Britain to assess their science communication and presentation skills, in addition to having the chance to find out more about the research conducted by other participants.

□

THE ART OF MEASURING SYMMETRY

Scott Harper

Heilbronn Research Fellow at the University of Bristol
Gold Medal winner in Mathematical Sciences at STEM for Britain 2021

Have you ever marvelled at the stunning symmetry of a butterfly? Or been frustrated by a photograph taken off-centre? As humans we're attracted to symmetry, and we encounter it daily in nature. So it's no surprise that symmetry plays a fundamental role across science. For instance, it's symmetry that explains the tragic side-effects of the drug thalidomide seen in the 1950s. However, there are some seemingly simple questions about symmetry that have remained unanswered for decades. We recently answered one of them.

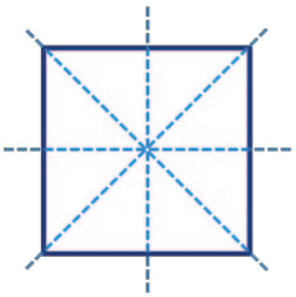
THE LANGUAGE OF SYMMETRY

Galileo famously said that the laws of nature are written in the language of mathematics; indeed, the Standard Model, fundamental to modern physics, is written in the mathematical language of symmetry. But what is symmetry? And why do we need mathematics to understand it?

WHAT IS SYMMETRY?

What is it about a butterfly that makes it symmetrical? Well, it looks the same on both sides, so it looks the same if you reflect it in a mirror. This gets to the heart of what is symmetry is all about: we should not think of shapes as simply having symmetry but rather having *symmetries*. A symmetry of a shape is something you can do to it after which it looks the same. Reflecting a butterfly in the vertical line is a symmetry since the butterfly looks the same afterwards.

Like a butterfly, the square can be reflected in the vertical line, but reflecting the square in the horizontal or diagonal lines also leaves the square arranged exactly as it was. However, reflections are not the only things we can do: rotating the square by 90° clockwise is also a symmetry of the square, as is doing this two or three times (rotating by 180° or 270°). (Mathematicians normally point out that we should also include "doing nothing" (rotating by 0°) as a symmetry, but for the sake of exposition, we will break with this tradition and ignore this trivial and uninteresting symmetry in this article.)



Symmetries of a square

A square, therefore, has seven nontrivial symmetries, but the butterfly has only one. In this sense, a square is more symmetrical than a butterfly. (Until the very end of the article we are focussing only on objects that have a finite number of symmetries, so we can count them. We are ignoring things like a circle which have an infinite number of symmetries.)

This suggests that to "measure the symmetry" of an object we should consider the *group* of all its symmetries. Indeed, this is a fruitful way to study any object. In 1800s, Évariste Galois was the first mathematician to adopt this approach, solving equations via their groups of symmetries. Today this perspective is ubiquitous in mathematics and science.

WHAT IS NEW TO DO?

Throughout history, humans have not only used numbers for practical purposes such as measuring and accounting: we have also asked interesting questions about the numbers themselves, some of which still occupy mathematicians today.

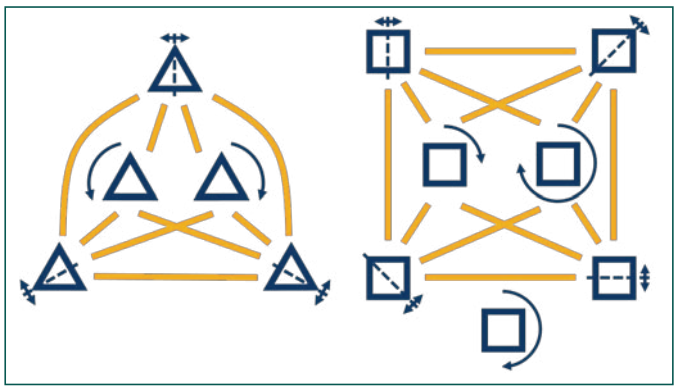
Just consider the example of prime numbers. A whole number (bigger than one) is a *prime number* if the only whole numbers dividing it are one and itself. The mathematicians of ancient Greece knew that there are infinitely many prime numbers, but we still do not know whether there are infinitely many pairs of prime numbers that just two apart! This highlights how quickly in mathematics we stumble across questions that are easy to ask but difficult to answer.

In the same way, you don't have to think about groups of symmetries very long before you start asking yourself natural questions that are not easy to answer. *Group theory* is the field dedicated to tackling these questions, not because there is an immediate application to science in mind, but simply out of curiosity. However, as we will see, applications often follow. Let's consider one such question.

ISOLATED SYMMETRIES & THE 1975 QUESTION

We join two symmetries by a line if by carrying out combinations of these two symmetries, one after the next, we can obtain all the symmetries of the shape (see the figure for the triangle and square).

One of the first things you might notice is that the square has an *isolated symmetry* (a symmetry not joined to any others) but the triangle does not. In fact, a regular polygon has no isolated symmetries if and only if it has a prime number of corners. What about isolated symmetries in more general contexts?



Symmetries of a triangle (left) and square (right)

In 1975, Brenner and Wiegold naturally asked: "which groups of symmetries have an isolated symmetry?" In a paper with Tim Burness and Robert Guralnick published in the *Annals of Mathematics* in 2021 [doi:10.4007/annals.2021.193.2.5], we answered this longstanding question. In fact, we showed that a group of symmetries has an isolated symmetry exactly when it has a noncyclic quotient, and these latter groups are easy to classify.

COMPUTING RANDOM SYMMETRIES

We pursued this question for its own interest, but there is scope for interesting applications. Researchers who exploit symmetry, from chemists to cryptographers, use computer algorithms to carry out massive calculations involving groups of symmetries. Knowing that all the

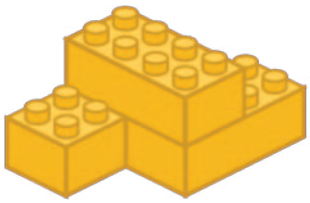
(possibly billions of) symmetries of an object can be obtained by combining just two of them can lead to significant efficiencies in algorithms. In particular, our answer to the 1975 Question sheds light on the mystery of why the random symmetry generator (the product replacement algorithm) built into numerous computer programs works as effectively as it does.

THE BUILDING BLOCKS OF SYMMETRY

How did we make this breakthrough? Just as lego constructions can be broken into lego bricks, as molecules can be broken into atoms and as whole numbers can be broken into prime numbers, groups of symmetries can be broken into smaller indivisible groups called *simple groups*.

This leads us to the *Lego Principle*: if all your lego bricks are yellow, then anything you build from those bricks will also be yellow. (And you know this without having to build all possible constructions and checking them!) Similarly, you can deduce facts about a group of symmetries from facts about the simple groups it is built up from.

Classifying all the finite simple groups, the atoms of symmetry,



was one of the greatest mathematical achievements of the last century. This effort by hundreds of mathematicians across the world, writing thousands of pages of mathematics, goes by the name of *The Classification of Finite Simple Groups* and is akin to a Periodic Table of Symmetry.

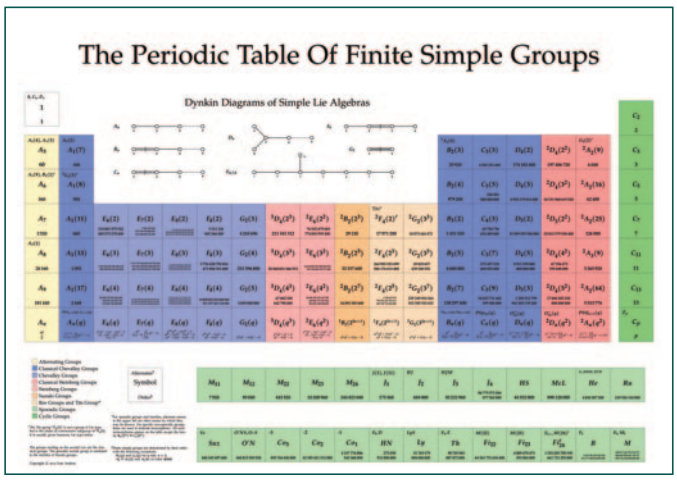
We managed to answer the 1975 Question by applying the Lego Principle to reason that we could focus our attention on the building-block simple groups, then we undertook a very careful study of these fundamental simple groups using the Classification of Finite Simple Groups. Along the way we developed several new techniques that promise to invigorate several branches of research.

TO INFINITY AND BEYOND

This research only concerns objects with a finite number of symmetries, but some of the most natural objects have an infinite number. For example, you can reflect a circle in any of the infinitely many lines that go through its centre. Addressing these sorts of questions for objects with an infinite number of symmetries is both a tantalising and daunting prospect: we have nothing like a Periodic Table of Symmetry for infinite groups of symmetries but some parallels between the finite and infinite worlds seem to be emerging. Addressing problems like the 1975 Question in this fertile field is my next exciting venture.

In October, Scott will begin a Leverhulme Early Career Fellowship on "Group generation: from finite to infinite" at the University of St Andrews. □

Scott receiving a Gold Medal, for his work on symmetry, from Prof Martin Bridson at STEM for Britain 2021 (image credit: John Deehan Photography & the Parliamentary & Scientific Committee)



The Periodic Table of Finite Simple Groups (image credit: Ivan Andrus)

RISING SEAS – BARRIERS TO MONITORING AND COMMUNICATING THE RISKS

Angela Hibbert
National Oceanography Centre (NOC), UK

Ed Hill
National Oceanography Centre (NOC), UK

The publication in August 2021 of the report of Working Group 1 of the Intergovernmental Panel on Climate Change (IPCC) bolstered evidence that global mean sea level continues to rise, accelerating from an average increase of around 1.3 mm y^{-1} in the early 20th Century, to roughly 3.7 mm y^{-1} between 2006 and 2018 (IPCC, 2021). Such increases were ascribed in almost equal measure to thermal expansion of the oceans (50%) and the melting of land-based ice sheets and glaciers (43%), both of which are a consequence of climate change, with a smaller contribution due to changes in water storage on land. Importantly, the report highlighted that sea level will continue to rise, because of the slow ocean response time to climatic warming, with estimated likely increases of between 0.38m and 0.77m by 2100, depending on which combination of future greenhouse gas emissions, pollution controls and socio-economic assumptions is used.

WHAT DOES THIS MEAN FOR THE UK?

Whilst assessments such as those of the IPCC tend to report one rate of sea level rise globally, the reality is that sea level change is not uniform geographically, simply because the uptake of heat by the ocean and the input of meltwater is not uniform and neither are the processes by which they are redistributed around the global ocean. Consequently, sea levels have risen more slowly that the global average in some regions (e.g. the eastern Pacific) and more rapidly in others (e.g. the Indian Ocean). In the UK, the mean rate of sea level rise is broadly consistent with the mean global trend, increasing by an average of ~1.5 mm y^{-1} since 1901, with an acceleration to ~3.6 mm y^{-1} since 1993 [Kendon et al., 2021]. However, in response to the last deglaciation, land levels in northern parts of the British Isles are uplifting, whilst southern England is subsiding, which leads to lower observed rates of sea level rise in the northern UK than in the south.

WHY SHOULD I WORRY ABOUT MM-SCALE CHANGES IN SEA LEVEL?

The UK experiences some of the largest tidal ranges in the world (as high as 12m in the Bristol Channel), so when a high tide and a large storm surge event co-occur, sea defences may be overtopped resulting in coastal flooding. Such events are compounded if the base level (i.e. mean sea level) is higher, meaning that overtopping becomes increasingly likely as sea level rises. An aggravating factor is that tidal ranges can themselves be modified in response to sea level rise, increasing the risk of flooding even further. Indeed, the UK Climate Change Risk Assessment Evidence Report [2017] identified more severe and widespread coastal flooding to be one of the primary Climate Change-related risks to the UK. This was illustrated in December 2013 when high tides and a large storm surge in the North Sea resulted in major flooding on the east coast of England, impacting the Humber region particularly badly. Significantly, the maximum sea level heights observed during the storm were of similar magnitude to those seen during the famous 1953 North Sea storm surge, which had resulted in the loss of over 300 lives on the east coast. The 1953 storm was considered to have been a 1 in ~300 year event, yet here was another similar-sized event occurring only 60 years later [Spencer et al. 2015], illustrating how sea level rise can lead to more frequent and severe coastal flooding.

HOW IS UK SEA LEVEL MONITORED?

UK resilience to storm surges has improved since 1953, when it was recognised that a co-ordinated monitoring system was required for coastal defence. A UK Tide Gauge Network (UKTGN) was formally created in 1980 and evolved from a collection of existing tide gauges that were operated by different authorities and for a variety of purposes, to the current group of 43 tide gauges. Today, the UKTGN delivers sea level observations in near-real time to the UK Coastal Flood Forecasting (UKCFF) Service, which operates across government agencies and incorporates a suite of tidal, surge and wave forecasting models, alongside the tide gauge observations.

Tide gauges can capture the full extent of sea level variability and are therefore a valuable tool for multiple uses including scientific applications, operational monitoring of coastal hazards and quantifying the associated risks for stakeholders, such as local authorities, port operators and structural design engineers. However, tide gauge systems can be costly to maintain, particularly if they are to meet the +/-0.01m accuracy standard for long-term monitoring of sea level trends for climate resilience, as required by the Intergovernmental Oceanographic Commission's (IOC) Global Sea Level Observing System (GLOSS) Programme [IOC, 2016]. In recent years, the UK Tide Gauge Network (UKTGN) has been used primarily for short-term operational forecasting with an associated accuracy tolerance that is an order of magnitude lower (+/-0.1m). Consequently, since 2017 less than half of the UKTGN gauges reported data of sufficient quality to contribute data to the IOC's databank for long-term sea level observations

– the Permanent Service for Mean Sea Level. In 2020, there was no usable data from the 5 UK tide gauges that would ordinarily contribute to the annual sea level assessment contained in the State of UK Climate report [Kendon et al, 2020] and only 1 record was suitable for use in the previous report. This jeopardises the continuity and ongoing utility of some of the longest continuous sea level records in the world, undermining UK credibility as a contributor to global monitoring and, most crucially, our ability to monitor trends in national sea level. A further consequence of the deteriorating accuracy of UKTGN observations is that fewer data are available for the estimation of sea level extremes and for tidal predictions. This constrains mitigation and forecasting of coastal hazards which, ironically, is the main application of the present-day network.

The impact of the 2004 Indian Ocean Tsunami, together with technology advances in the wider sea level community, have raised the bar for tide gauge specifications. The IOC's GLOSS Programme now defines minimum standards that include high frequency sampling of 1 minute or less and the establishment of continuous Global Navigation Satellite Systems receivers (GNSS) to monitor vertical land motion [IOC,2016]. Whilst other nations have upgraded their monitoring technology over the last decade, the UKTGN presently falls short of these requirements, affording sampling (15 min) and latency of observations that has been deemed unsuitable for applications such as tsunami monitoring [ICG/NEAMTWS, 2019]. In an attempt to improve the UK sea level monitoring capability, in 2021, the National Oceanography Centre (NOC) raised one-off funding to install 3 prototype scientific-grade tide gauges at key locations (Newlyn, Sheerness and Liverpool (see figure)). These tide gauges have been designed to rigorous GLOSS standards and build upon innovative key technologies already developed at the NOC. Most importantly, they can be used for multiple applications including climate change assessments, determining design levels of coastal infrastructure and for operational forecasting including tsunami monitoring.

The new NOC tide gauge at Liverpool, Alfred Lock (courtesy of Geoff Hargreaves, NOC)

DO WE NEED TSUNAMI MONITORING IN THE UK?

Although there is a low likelihood of a tsunami impacting the UK, the possibility cannot be dismissed. A 1755 tsunami event destroyed the city of Lisbon and records show that it also impacted the southwest UK, following an earthquake along the Azores-Gibraltar plate boundary. That fault has been associated with at least 3 UK-observed tsunamis in the last 80 years [Long, 2015]. For earthquake-generated tsunamis like the Lisbon event, the UK receives advance warning from the northeastern Atlantic and Mediterranean Tsunami Warning System (NEAMTWS) to facilitate an emergency response, but for other sources of tsunamis, such as landslides, there is currently no warning system in place and the observations of tsunami-capable tide gauges could provide their only means of detection. UK geological records provide evidence of major tsunami strikes - one to the coast of Scotland and northeast England following a submarine landslide off Norway about 8,200 years ago (the Storegga slide), with 2 further large events affecting Shetland in the last 10,000 years [Bodevik et al., 2005]. More recently, the landslide-related tsunami risk to the UK was brought into sharp focus by the eruption of Cumbre Vieja, La Palma in September 2021 - a volcano that has been the subject of press attention since assessments of its structural evolution suggested there was potential for a trans-oceanic 'megatsunami' if the flank of the volcano was to suddenly collapse (e.g. Ward and Day, 2001). That danger appears to have passed, for the time being at least, as the eruption has come to an end, but an assessment of the risk posed to the UK by tsunamis is long overdue, as tsunami modelling has developed considerably since the last evaluation was commissioned by DEFRA in 2005 [Kerridge, 2005].

If the sea-level risks to the UK are to be understood fully and mitigated, investment is required to ensure that the UKTGN is suitable for a full range of sea level monitoring and assessment applications and that the interests of all stakeholders are preserved in future.

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HOUSE OF COMMONS SELECT COMMITTEES

BUSINESS, ENERGY AND INDUSTRIAL STRATEGY COMMITTEE

The Business, Energy and Industrial Strategy Committee scrutinises the policy, spending and administration of the Department for Business, Energy and Industrial Strategy and its public bodies, including Ofgem, the Financial Reporting Council and the Committee on Climate Change.

The Committee regularly holds accountability evidence hearings with Government Ministers and with bodies such as the Financial Reporting Council, the Committee on Climate Change and Ofgem. The BEIS Committee also hears from a range of stakeholders in the course of its work, receiving evidence from academics, business groups, NGOs and charities to its inquiries.

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Inquiries:

- Net zero and UN climate summits - Opened 6 March 2020. Government response published 17th May 2021.
- The impact of coronavirus on businesses and workers - Opened 13 March 2020. Government response published 19th May 2021.
- Delivering audit reform - Opened 18 March 2020.
- Work of the Department and Government Response to coronavirus - Opened 14 April 2020
- Post-pandemic economic growth - Opened 3 June 2020.
- Post-pandemic economic growth: Industrial Strategy – Opened 23rd July 2020. Government response published 24th September 2021.
- Post-pandemic economic growth: Levelling up local and regional structures and the delivery of economic growth – Opened 24th July 2020. Report published 3rd December 2021.
- Forced Labour in UK value chains – Opened 18th September 2020. Government response published 8th July 2021.
- Decarbonising heat in homes – Opened 2nd October 2020. Published 18th May 2022.
- Business and Brexit preparedness – Opened 17th November 2020.
- Mineworkers' Pension Scheme – Opened 18th March 2021. Government response published 5th July.
- Findings of the Report of Climate Change Assembly UK – Opened 19th April 2021. Government response published 9th September.
- Liberty Steel and the Future of the UK Steel Industry – Opened 27th April 2021. Report published 20th January 2022.
- Net Zero Governance: Opened 23rd June 2021.
- Post-pandemic economic growth: State Aid and Post Brexit Competition Policy. Opened 23rd September.
- Energy National Policy Statements – Opened 3rd November 2021. Published 25th February 2022.
- Energy Pricing and the future of the Energy Market – Opened 8th December 2021. Written evidence. Deadline 31st January 2022.
- Decarbonisation of the power sector. Opened 20th May. Deadline 30th June 2022
- The semiconductor industry in the UK. Opened 25th May 2022.
- Post-pandemic economic growth: UK labour markets. Opened 27th May 2022.
- The work of the Investment Security Unit. Opened 15th June 2022.

For further details: Tel: 020 7219 5777
Email: beiscom@parliament.uk

ENVIRONMENTAL AUDIT COMMITTEE

The remit of the Environmental Audit Committee is to consider the extent to which the policies and programmes of government departments and non-departmental public bodies contribute to environmental protection and sustainable development, and to audit their performance against sustainable development and environmental protection targets.

Unlike most select committees, the Committee's remit cuts across government rather than focuses on the work of a particular department.

From its beginning in 1997, in carrying out its environmental 'audit' role the Committee has had extensive support from the National Audit Office, providing seconded staff and research and briefing papers.

Membership:

Rt Hon Philip Dunne MP, Conservative, Chair
Duncan Baker MP, Conservative
Sir Christopher Chope MP, Conservative
Barry Gardiner MP, Labour
Rt Hon Sir Robert Goodwill MP, Conservative
James Gray MP, Conservative
Helen Hayes MP, Labour

Ian Levy MP, Conservative
Clive Lewis MP, Labour
Caroline Lucas MP, Green Party

Cherilyn Mackrory, Conservative
Jerome Mayhew MP, Conservative
Anna McMorrin MP, Labour
John McNally MP, Scottish National Party
Dr Matthew Offord MP, Conservative
Claudia Webbe MP, Independent

Inquiries

- Preparation for COP26 - Opened 17 March 2020.
- Greening the post-Covid Recovery - Opened 13 May 2020. Government response published 22nd June 2021.
- Energy Efficiency of Existing Homes - Opened 18 May 2020. Government response published 13th May 2021.
- Biodiversity and Ecosystems – Opened 13th July 2020. Report published 30th September 2021.
- Fixing Fashion follow up – Opened 6th October 2020
- Technological Innovations and Climate Change: Tidal Power – Opened 9th November 2020
- Green Jobs – Opened 17th November 2020. Report published 25th October 2021.
- Water Quality in Rivers – Opened 8th December 2020. Published 13th January 2022.
- Next Steps for deposit return schemes. Opened 15th February 2021.
- Technological Innovations and Climate Change: Community Energy – Opened 19th February
- Sustainability of the built environment – Opened 25th March 2021. Published 26th May 2022.
- Technological Innovations and Climate Change: Supply chain for Battery Electric Vehicles – opened 4th May 2021
- Mapping the path to net zero: Opened 25th June 2021.
- Net zero aviation and shipping: Opened 20th July 2021.
- Carbon border adjustment mechanism: Opened 24th September 2021.Published 4th April 2022.
- Technological Innovations and Climate Change: Negative emissions and Technologies – Opened 28th September 2021.
- Aligning the UK's economic goals with environmental sustainability – Opened 29th November 2021.
- Technological Innovations and Climate Change: Green Steel. Opened 3rd February 2021.
- Accelerating the transition from fossil fuels and securing energy supplies. Opened 31st March 2022.
- The financial sector and the UK's net zero transition. Opened 30th May 2022. Deadline 30th June 2022.
- Technological innovations and Climate Change: Geothermal Technologies. Opened 16th June 2022. Deadline 21st July 2022.

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SCIENCE AND TECHNOLOGY COMMITTEE

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Email: scitechcom@parliament.uk

The work of many Government departments makes use of — or has implications for — science, engineering, technology and research. The Science and Technology Committee exists to ensure that Government policies and decision-making are based on solid scientific evidence and advice. It is chaired by Greg Clark MP.

The Committee has a similarly broad remit and can examine the activities of government departments that make use of science, engineering, technology and research (otherwise known as science for policy). In addition, the Committee scrutinises policies that affect the science and technology sectors, such as research funding and skills (often referred to policy for science).

Membership:

Rt Hon Greg Clark MP, Conservative, Chair
Aaron Bell MP, Conservative
Dawn Butler MP, Labour
Chris Clarkson MP, Conservative
Dehenna Davison MP, Conservative
Katherine Fletcher MP, Conservative
MRebecca Long-Bailey MP, Labour
Carol Monaghan MP, Scottish National Party
Graham Stringer MP, Labour
Zarah Sultana MP, Labour

Inquiries

- UK Science, Research and Technology Capability and Influence in Global Disease Outbreaks. – Opened 20 March 2020. Government response published 14th May 2021.
- The role of technology, research and innovation in the COVID-19 recovery – Opened 24th July 2020.
- Coronavirus – Lessons Learnt – Opened 6th October 2020. Report published 12th October 2021.
- The Role of Hydrogen in Achieving Net Zero – Opened 4th December 2020.
- UK space strategy and UK satellite infrastructure – Opened 23rd April 2021.
- Reproducibility and research integrity. Opened 22nd July 2021. Closed 30th September 2021.
- Diversity and inclusion in STEM – Opened 22nd November 2021.
- The right to privacy: digital data – Opened 16th December 2021.

HEALTH AND SOCIAL CARE COMMITTEE

The Committee scrutinises government and in particular the work of the Department of Health and Social Care. It is chaired by Jeremy Hunt MP.

The Committee also scrutinises the work of public bodies in the health system in England, such as NHS England and Improvement, Public Health England and the Care Quality Commission, and professional regulators such as the General Medical Council and the Nursing and Midwifery Council. They do so by holding inquiries on specific topics and accountability hearings with the Secretary of State, and Chief Executives of relevant public bodies.

Membership:

Rt Hon Jeremy Hunt MP, Conservative, Chair
Lucy Allan MP, Conservative
Rosie Cooper MP, Labour
Martyn Day MP, Scottish National Party
Dr Luke Evans MP, Conservative

Barbara Keeley MP, Labour
Marco Longhi MP, Conservative
Taiwo Owatemi MP, Labour
Sarah Owen MP, Labour
Dean Russell MP, Conservative
Laura Trott MP, Conservative

Inquiries

- Workforce burnout and resistance in the NHS and social care – Opened 30th July 2020. Published 8th June 2021.
- Coronavirus – Lessons Learnt – Opened 6th October 2020. Report published 12th October 2021.
- Children and young people's mental health – Opened 29th January 2021. Report published 9th December 2021.
- Treatment of autistic people and individuals with learning disabilities – Opened 3rd February 2021. Report published 13th July 2021.
- Department's White Paper on health and social care. Opened 25th February 2021. Report published 14th May 2022.
- Supporting those with dementia and their carers – Opened 12th May 2021. Published 29th October 2021.
- Cancer services: Opened 6th July 2021. Report published 5th April 2022.
- Clearing the backlog caused by the pandemic – Opened 20th July 2021. Report published 6th January 2022.
- NHS litigation reform: Opened 22nd September 2021. Report published 28th April 2022.
- The future of general practice – Opened 16th November 2021.
- Workforce: recruitment, training and retention in health and social care – Opened 23rd November 2021.
- The impact of body image on physical and mental health – Opened 1st December 2021.
- Omicron variant update. Opened 10th December 2021.
- Work of the Department. Opened 20th January 2022.
- Digital transformation in the NHS. Opened 13th May 2022.

For further details: Tel: 020 7219 6182
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HOUSE OF LORDS SELECT COMMITTEES

SCIENCE AND TECHNOLOGY COMMITTEE

The Science and Technology Committee has a broad remit "to consider science and technology". It is chaired by Lord Patel.

The Committee scrutinises Government policy by undertaking cross-departmental inquiries into a range of different activities. These include:

- public policy areas which ought to be informed by scientific research (for example, health effects of air travel),
- technological challenges and opportunities (for example, genomic medicine) and
- public policy towards science itself (for example, setting priorities for publicly funded research).

In addition, the Committee undertakes from time to time shorter inquiries, either taking evidence from Ministers and officials on topical issues, or following up previous work.

Members:

The Baroness Brown of Cambridge DBE FREng FRS, Crossbench, Chair
The Baroness Blackwood of North Oxford, Conservative
Viscount Hanworth, Labour
The Lord Holmes of Richmond MBE
The Lord Krebs, Crossbench
The Baroness Manningham-Buller LG DCB, Crossbench
The Lord Mitchell, Labour
The Lord Rees of Ludlow OM, Crossbench
The Baroness Rock, Conservative
The Lord Sarfraz, Conservative
The Baroness Sheehan, Liberal Democrat
The Baroness Walmsley, Liberal Democrat
The Baroness Warwick of Undercliff, Labour
The Lord Winston, Labour

Inquiries

- The science of COVID-19 Opened 7 May 2020.
- The Contribution of Innovation Catapults to Delivering the R&D Roadmap – Opened 11th November 2020. Government response published 6th April 2021.
- Role of batteries and fuel in allowing Net Zero – Opened 3rd March 2021. Report published 27th July 2021. Government response published 27th September 2021.
- Nature-based solutions for climate change: Opened 9th June 2021. Deadline 30th September 2021.
- Delivering a UK science and technology strategy. Opened 10th February 2022.

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PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (POST)

POST is a bicameral body that bridges research and policy, providing reliable and up-to-date research evidence for the UK Parliament. It is overseen by a Board of MPs, Peers and external experts.

POST briefings are impartial, non-partisan, and peer-reviewed. Timely and forward-thinking, they are designed to make scientific research accessible to the UK Parliament. POSTnotes are four-page summaries of public policy issues based on reviews of the research literature and interviews with stakeholders from across academia, industry, government and the third sector. They are peer-reviewed by external experts. POSTnotes are often produced proactively, so that parliamentarians have advance knowledge of key issues before they reach the top of the political agenda. Our research is published on our website.

POSTnotes produced since March 2022 were

673: Invasive non-native species
672: Green steel
671: Mental Health Act Reform – Race and Ethnic Inequalities
670: Innovation in adult social care
669: The impact of digital technology on arts and culture in the UK
668: Reducing peatland emissions

POSTbriefs are responsive policy briefings based on mini-literature reviews and peer reviews. Those produced since March 2022 were:

46: Geothermal energy

POST has also continued rapid response articles that summarise the research around COVID-19:

Drug Therapies for COVID-19, The future of COVID-19 vaccines

Ongoing and future projects approved by the POST Board:

BIOLOGY AND HEALTH

In production

Reform of the Mental Health Act impacts on children and young people
Disorders of consciousness
Testosterone and sports performance

ENERGY AND ENVIRONMENT

In production

Climate security
Energy security
Habitat restoration
Nature recovery, conservation and climate change adaptation
Low-carbon hydrogen use
GB Plant biosecurity

DIGITAL AND PHYSICAL SCIENCES

In production

Automation in military operations
Hypersonic missiles
Cyber warfare
Energy consumption of computing

SOCIAL SCIENCES

In production

Assisted dying
Palliative and end of life care
Invisible disabilities
The impact of remote and hybrid work on workers and organisations

KNOWLEDGE EXCHANGE

In production

Parliament-research knowledge exchange mechanisms around the world

The POST Board oversees POST's objectives, outputs and future work programme. It meets quarterly.

Officers

- Chair: Adam Afriyie MP
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- Secretary: Claire Quigley

House of Commons

- Rt Hon Greg Clark MP
- Katherine Fletcher MP
- Stephen Metcalfe MP
- Maria Miller MP
- Carol Monaghan MP
- Dr Ben Spencer MP
- Alan Whitehead MP

House of Lords

- Baroness Brown of Cambridge
- Lord Haskel
- Lord Ravensdale

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- Professor Elizabeth Fisher, FMedSci
- Paul Martynenko, FBCS
- Professor Sir Bernard Silverman, FRS, FAcSS
- Professor Dame Sarah Whatmore, FBA

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- Oliver Bennett MBE, Head of the Parliamentary Office of Science and Technology
- Penny Young, House of Commons Librarian and Managing Director of Research & Information
- Farrah Bhatti, Principal Clerk, Committee Office, House of Commons
- Xameerah Malik, Head of Science and Environment Section, House of Commons Library
- Nicolas Besly, Clerk of Select Committees, House of Lords

Head of POST

- Oliver Bennett MBE

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY

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SCIENCE DIRECTORY

UK Research and Innovation

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Website: www.ukri.org

Big challenges demand big thinkers - those who can unlock the answers and further our understanding of the important issues of our time. Our work encompasses everything from the physical, biological and social sciences, to innovation, engineering, medicine, the environment and the cultural impact of the arts and humanities. In all of these areas, our role is to bring together the people who can innovate and change the world for the better. We work with the government to invest over £7 billion a year in research and innovation by partnering with academia and industry to make the impossible, possible. Through the UK's nine leading academic and industrial funding councils, we create knowledge with impact.

Arts and Humanities Research Council

Website: www.ahrc.ukri.org

AHRC funds outstanding original research across the whole range of the arts and humanities. This research provides economic, social and cultural benefits to the UK, and contributes to the culture and welfare of societies around the globe.

Biotechnology and Biological Sciences Research Council

Website: www.bbsrc.ukri.org

BBSRC invests in world-class bioscience research and training. This research is helping society to meet major challenges, including food security, green energy and healthier, longer lives and underpinning important UK economic sectors, such as farming, food, industrial biotechnology and pharmaceuticals.

Economic and Social Research Council

Website: www.esrc.ukri.org

ESRC is the UK's largest funder of research on the social and economic questions facing us today. This research shapes public policy and contributes to making the economy more competitive, as well as giving people a better understanding of 21st century society.

Engineering and Physical Sciences Research Council

Website: www.epsrc.ukri.org

EPSRC invests in world-leading research and postgraduate training across the engineering and physical sciences. This research builds the knowledge and skills base needed to address scientific and technological challenges and provides a platform for future UK prosperity by contributing to a healthy, connected, resilient, productive nation.

Innovate UK

Website: www.gov.uk/government/organisations/innovate-uk

Innovate UK drives productivity and economic growth by supporting businesses to develop and realise the potential of new ideas, including those from the UK's world-class research base. They connect businesses to the partners, customers and investors that can help them turn these ideas into commercially successful products and services, and business growth.

Medical Research Council

Website: www.mrc.ukri.org

MRC is at the forefront of scientific discovery to improve human health. Its scientists tackle some of the greatest health problems facing humanity in the 21st century, from the rising tide of chronic diseases associated with ageing to the threats posed by rapidly mutating micro-organisms.

Natural Environment Research Council

Website: www.nerc.ukri.org

NERC is the driving force of investment in environmental science. Its leading research, skills and infrastructure help solve major issues and bring benefits to the UK, such as affordable clean energy, air pollution, and resilience of our infrastructure.

Research England

Website: www.re.ukri.org

Research England creates and sustains the conditions for a healthy and dynamic research and knowledge exchange system in English universities. Working to understand their strategies, capabilities and capacity; supporting and challenging universities to create new knowledge, strengthen the economy, and enrich society.

Science and Technology Facilities Council

Website: www.stfc.ukri.org

STFC is a world-leading multi-disciplinary science organisation. Its research seeks to understand the Universe from the largest astronomical scales to the tiniest constituents of matter, and creates impact on a very tangible, human scale.

SCIENCE DIRECTORY

Contact: Dr Jane Gate, Executive Director
AIRTO Ltd: Association of Innovation Research & Technology Organisations Ltd
c/o National Physical Laboratory
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Website: www.airto.co.uk

AIRTO, the Association of Innovation, Research and Technology Organisations, comprises approximately sixty principal organisations operating in the UK's Innovation, Research and Technology (IRT) sector. The IRT sector has a combined turnover of £6.9Bn, employs over 57,000 people and contributes £34Bn to UK GVA. AIRTO's members work at the interface between academia and industry, for both private and public sector clients. Members include independent Research and Technology Organisations, Catapult Centres, Public Sector Research Establishments, National Laboratories, some university Technology Transfer Offices and some privately held innovation companies.

Contact:
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07895 162 896 for all queries whether for membership or assistance.
Branch Office Address:
Merchant Quay,
Salford Quays, Salford
M50 3SG.

Website: www.amps-tradeunion.com

We are a Trades Union for Management and Professional Staff working in the pharmaceutical, chemical and allied industries.

We have produced a training programme funded by the EU on diversity and helping women managers remain in the workplace after a career break. This training programme is aimed at both men and women and is intended to address the shortfall in qualified personnel in the chemical and allied industries.

We are experts in performance based and field related issues and are affiliated to our counterparts in EU Professional Management Unions.

Contact:
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AWE plays a crucial role in our nation's defence by providing and maintaining warheads for the UK's nuclear deterrent and delivers advice and guidance on a 24/7 basis to UK government in the area of national security.

We are a centre of scientific, engineering and technological excellence, with some of the most advanced research, design and production facilities in the world. AWE is contracted to the Ministry of Defence (MOD) through a Government-owned-contractor-operated (GOCO) arrangement. While our sites and facilities remain in government ownership, their management, day-to-day operations and maintenance of Britain's nuclear stockpile is contracted to a private company: AWE Management Limited (AWE ML). AWE ML is a consortium comprising three partners: Jacobs Engineering Group, the Lockheed Martin Corporation and Serco Group plc.

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The Biochemical Society works to promote the molecular biosciences; facilitating the sharing of expertise, supporting the advancement of biochemistry and molecular biology and raising awareness of their importance in addressing societal grand challenges. We achieve our mission by :

- bringing together molecular bioscientists;
- supporting the next generation of biochemists;
- promoting and sharing knowledge and
- promoting the importance of our discipline.

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Twitter: @BESPolicy

The British Ecological Society is an independent, authoritative learned society, and the voice of the UK's ecological community. Working with our members we gather and communicate the best available ecological evidence to inform decision making. We offer a source of unbiased, objective ecological knowledge, and promote an evidence-informed approach to finding the right solutions to environmental questions.

British In Vitro Diagnostics Association (BIVDA)

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www.bivda.org.uk

BIVDA is the UK industry association representing companies who manufacture and/or distribute the diagnostics tests and equipment to diagnose, monitor and manage disease largely through the NHS pathology services. Increasingly diagnostics are used outside the laboratory in community settings and also to identify those patients who would benefit from specific drug treatment particularly for cancer.

Contact: Policy Officer
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Website: www.bps.ac.uk

The British Pharmacological Society is a charity with a mission to promote and advance the whole spectrum of pharmacology. It is the primary UK learned society concerned with drugs and the way they work, and leads the way in the research and application of pharmacology around the world.

Founded in 1931, the Society champions pharmacology in all its forms, across academia, industry, regulatory agencies and the health service. With over 3,500 members from over 60 countries worldwide, the Society is a friendly and collaborative community. Enquiries about the discovery, development and application of drugs are welcome.

Tracey Guise, Chief Executive Officer
British Society for Antimicrobial Chemotherapy (BSAC)
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BSAC is a learned society whose members are among the world's leading infectious disease physicians, pharmacists, microbiologists, and nurses.

With more than 45 years of leadership in antibiotic research and education, BSAC is dedicated to saving lives by fighting infection. It does this by supporting a global network of experts via workshops, conferences, evidence-based guidelines, e-learning courses, and its own high-impact international journal.

BSAC also provides national surveillance and susceptibility testing programmes, an outpatient parenteral antimicrobial therapy (OPAT) initiative, research and development grants, and the secretariat for the All-Party Parliamentary Group on Antibiotics.

BSAC has members in 40 nations and active learners in more than 135 countries.

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The British Society for Immunology's mission is to promote excellence in immunological research, scholarship and clinical practice in order to improve human and animal health. We are the leading UK membership organisation working with scientists and clinicians from academia and industry to forward immunology research and application around the world. Our friendly, accessible community of over 3,500 immunologists gives us a powerful voice to advocate for immunological science and health for the benefit of society.

SCIENCE DIRECTORY

BRITISH SOCIETY OF SOIL SCIENCE

Contact: Sarah Garry
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Email: exec@soils.org.uk
Website: www.soils.org.uk

The British Society of Soil Science (BSSS) was founded in 1947 and is an established international membership organisation and charity committed to the study of soil in its widest aspects. The society brings together those working within academia, practitioners implementing soil science in industry and all those working with, or with an interest in soils.

We promote research and education, both academically and in practice, and build collaborative partnerships to help safeguard our soil for the future. This includes hosting the World Congress of Soil Science 2022 in Glasgow, where those with an interest in soil science can meet to discuss the critical global issues relating to soil.

Brunel University London

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Brunel University London is an international research active university with 3 leading research institutes:

Institute of Energy Futures: Led by Professor Savvas Tassou, the main themes of the Institute are *Advanced Engines and Biofuels, Energy Efficient and Sustainable Technologies, Smart Power Networks*, and *Resource Efficient Future Cities*.

Institute of Materials and Manufacturing: The main themes of research are *Design for Sustainable Manufacturing, Liquid Metal Engineering, Materials Characterisation and Processing, Micro-Nano Manufacturing*, and *Structural Integrity*. The Institute is led by Professor Luiz Wrobel.

Institute of Environment, Health and Societies: Professor Susan Jobling leads this pioneering research institute whose themes are *Health and Environment, Healthy Ageing, Health Economics Synthetic Biology, Biomedical Engineering and Healthcare Technologies*, and *Social Sciences and Health*.

Brunel University London offers a wide range of expertise and knowledge, and prides itself on having academic excellence at the core of its offer, and was ranked in the recent REF as 33rd in the UK for Research Power (average quality rating by number of submissions) and described by The Times Higher Education as one of the real winners of the REF 2014.

Cavendish Laboratory

UNIVERSITY OF CAMBRIDGE

Contact: Departmental Administrator,
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http://www.phy.cam.ac.uk

The Cavendish Laboratory houses the Department of Physics of the University of Cambridge.

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Biological Universe: Physics of medicine, biological systems and soft matter

The Laboratory has world-wide collaborations with other universities and industry

Chartered Institute of Ergonomics & Human Factors

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Our vision is integrated design to improve life, wellbeing and performance through science, engineering, technology and psychology. The Institute is one of the largest in the world representing the discipline and profession of Human Factors and Ergonomics. We have sector groups in most industries from defence to aviation and pharmaceuticals that provide expert advice to industry and government. We accredit university courses and consultancy practices and work closely with allied learned societies.

The Cosmetic Toiletry & Perfumery Association | ctpa

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www.thefactsabout.co.uk

CTPA is the UK trade association representing manufacturers of cosmetic products and suppliers to the cosmetic products industry. 'Cosmetic products' are legally defined and subject to stringent EU safety laws. CTPA is the authoritative public voice of a vibrant and responsible UK industry trusted to act for the consumer; ensuring the science behind cosmetics is fully understood.

CLIFTON SCIENTIFIC Trust

Contact: Dr Eric Albone MBE, Director,
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The Council for the Mathematical Sciences

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The Council for the Mathematical Sciences is an authoritative and objective body that works to develop, influence and respond to UK policy issues affecting mathematical sciences in higher education and research, and therefore the UK economy and society by:

- providing expert advice;
- engaging with government, funding agencies and other decision makers;
- raising public awareness; and
- facilitating communication between the mathematical sciences community and other stakeholders

THE FRANCIS CRICK INSTITUTE

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The Francis Crick Institute is a biomedical research institute carrying out world-class discovery research to understand how living things work and to drive benefits for human health. Our discoveries will enhance our understanding of the fundamental processes of life, and have the potential to transform the prevention, diagnosis and treatment of human disease.

The Crick was formed in 2015, commencing full operations in 2017 in a brand new state-of-the-art building in central London which brings together more than 2,000 scientists, staff and students working collaboratively across disciplines.

Daphne Jackson Trust

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Founded in 1992 in memory of the UK's first female Professor of Physics, the Trust is the UK's leading charity dedicated to realising the potential of scientists and engineers returning to research after career breaks for family, caring and health reasons. Recently, we have expanded our remit to incorporate the social sciences and arts & humanities. Our Fellowship programme, working in partnership with universities, UKRI, charities, learned societies and industry, enables individuals to undertake part-time research in universities and research institutes. Fellowships comprise a research project alongside an individually tailored retraining programme, with additional mentoring and support, enabling recipients to re-establish their research credentials, update skills and redevelop confidence, in a suitably supportive environment.

SCIENCE DIRECTORY

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The Energy Institute (EI) is the chartered professional membership body bringing together expertise for urgent global challenges. Our ambition is that energy, and its critical role in our world, is better understood, managed and valued. We're a unique network with insight spanning the world of energy, from conventional oil and gas to the most innovative renewable and energy efficient technologies. We gather and share essential knowledge about energy, the skills that are helping us all use it more wisely, and the good practice needed to keep it safe and secure. We articulate the voice of energy experts, taking the know-how of around 20,000 members and 200 companies from 120 countries to the heart of the public debate. And we're an independent, not-for-profit, safe space for evidence-based collaboration, an honest broker between industry, academia and policy makers.

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EngineeringUK is an independent organisation that promotes the vital role of engineers, engineering and technology in our society. EngineeringUK partners business and industry, Government and the wider science and technology community: producing evidence on the state of engineering; sharing knowledge within engineering, and inspiring young people to choose a career in engineering, matching employers' demand for skills.

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Fera provides expert analytical and professional services to governments, agrichemical companies, food retailers, manufacturers and farmers to facilitate safety, productivity and quality across the agrifood supply chain in a sustainable and environmentally compatible way.

Fera uses its world leading scientific expertise to provide robust evidence, rigorous analysis and professional advice to governments, international bodies and companies worldwide. Our food integrity, plant health, agri-tech and agri-informatics services ensure that our customers have access to leading edge science, technology and expertise.

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GAMBICA is the voice of the laboratory technology, instrumentation, control and automation industries, providing influence, knowledge and community. We offer members a common platform for voicing their opinions and representing their common interests to a range of stakeholders. GAMBICA seeks to spread best-practice and be thought leaders in our sectors.

The Geological Society
serving science, profession & society

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The Geological Society is the national learned and professional body for Earth sciences, with 12,000 Fellows (members) worldwide. The Fellowship encompasses those working in industry, academia and government, with a wide range of perspectives and views on policy-relevant science, and the Society is a leading communicator of this science to government bodies and other non-technical audiences.

IBMS Institute of Biomedical Science

Contact: Lynda Rigby, Executive Head of Marketing and Membership
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Advancing knowledge and setting standards in biomedical science

With over 20,000 members in 61 countries, the Institute of Biomedical Science (IBMS) is the leading professional body for scientists, support staff and students in the field of biomedical science.

Since 1912 we have been dedicated to the promotion, development and delivery of excellence in biomedical science within all aspects of healthcare, and to providing the highest standards of service to patients and the public.

By supporting our members in their practice, we set quality standards for the profession through training, education, assessments, examinations and continuous professional development.

Institute of Food Science + Technology ifst

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We are the UK's leading professional body for those involved in all aspects of food science and technology. We are an internationally respected independent membership body, supporting food professionals through knowledge sharing and professional recognition.

Our core aim is the advancement of food science and technology based on impartial science and knowledge sharing.

Our membership comprises individuals from a wide range of backgrounds, from students to experts, working across a wide range of disciplines within the sector.

IKE®
Institute of Innovation & Knowledge Exchange

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IKE is the UK's professional body for innovators. It accredits and certificates innovation practices. We influence the inter-relationship between education, business, and government through research and collaborative networks. Our Innovation Manifesto highlights our commitment to support the development of innovative people and organisations. IKE runs think-tanks, conducts research, develops new business models and tools and supports organisations to benchmark their innovation capabilities.

Institute of Marine Engineering, Science and Technology (IMarEST)

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Established in London in 1889, the IMarEST is a leading international membership body and learned society for marine professionals, with over 15,000 members worldwide. The IMarEST has an extensive marine network of 50 international branches, affiliations with major marine societies around the world, representation on the key marine technical committees and non-governmental status at the International Maritime Organization (IMO) as well as other intergovernmental organisations.

SCIENCE DIRECTORY

Institute of Measurement and Control

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Registration Charity number: 269815

The Institute of Measurement and Control is a professional engineering institution and learned society dedicated to the science and application of measurement and control technology for the public benefit. The InstMC has a comprehensive range of membership grades for individuals engaged in both technical and non-technical occupations. Also, it is licensed by the Engineering Council to assess and register individuals as Chartered Engineers (CEng), Incorporated Engineers (IEng) and Engineering Technicians (EngTech).

The InstMC works to develop the knowledge and skills of individual engineers, fostering communication and advancing the science and practices within the industry.

IOP Institute of Physics

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The Institute of Physics (IOP) is the professional body and learned society for physics in the UK and Ireland. The IOP's mission is to raise public awareness and understanding of physics, inspire people to develop their knowledge, understanding and enjoyment of physics and support the development of a diverse and inclusive physics community. As a charity, the IOP seeks to ensure that physics delivers on its exceptional potential to benefit society.

IPEM

Institute of Physics and Engineering in Medicine

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IPEM is a registered, incorporated charity committed to our Mission of Improving Health through Physics and Engineering in Medicine. Our vision is one in which professionalism drives improvements in diagnosis, treatment and care, transforming the lives of patients. Our members, the professional community of medical physicists, biomedical engineers and clinical technologists working in hospitals, academia and industry around the world are the people who deliver our mission and vision. We work to support them through professional development, community and leadership initiatives, including training and CPD, events, campaigns, publications and scientific meetings. IPEM is licensed by the Science Council to award CSci, RSci and RSciTech, and by the Engineering Council to award CEng, IEng and EngTech.

IChemE ADVANCING CHEMICAL ENGINEERING WORLDWIDE

The Institution of Chemical Engineers

The Institution of Chemical Engineers (IChemE) advances chemical engineering's contribution worldwide for the benefit of society. We support the development of chemical engineering professionals and provide connections to a powerful network of around 35,000 members in 100 countries.

We support our members in applying their expertise and experience to make an influential contribution to solving major global challenges, and are the only organisation to award Chartered Chemical Engineer status and Professional Process Safety Engineer registration.

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Kuala Lumpur | London | Melbourne | Rugby | Singapore | Wellington

IET The Institution of Engineering and Technology

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The IET is a world leading professional organisation, sharing and advancing knowledge to promote science, engineering and technology across the world. Dating back to 1871, the IET has over 163,000 members in 127 countries with offices in Europe, North America, and Asia-Pacific.

LGC

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LGC is a global leader in the life sciences tools sector, including human healthcare and applied markets (food, agbio and the environment). LGC provides a comprehensive range of measurement tools, proficiency testing schemes, supply chain assurance standards and specialty genomics tools (oligos, PCR tools, NGS reagents), underpinned by leading analytical and measurement science capabilities. Under the Government Chemist function, LGC fulfils specific statutory duties as the referee analyst and provides advice for Government and the wider analytical community on the implications of analytical measurement for matters of policy, standards and regulation. LGC is also the UK's National Measurement Laboratory for chemical and bio-measurement.

With headquarters in Teddington, South West London, LGC has laboratories and sites across Europe, the US, China, Brazil, India, and South Africa.

L'ORÉAL UK AND IRELAND

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L'Oréal employs more than 3,800 researchers world-wide and dedicates over €877 million each year to research and innovation in the field of healthy skin and hair. The company supports women in science research through the L'Oréal UNESCO For Women In Science Programme and engages young people with science through the L'Oréal Young Scientist Centre at the Royal Institution. L'Oréal also collaborates with a vast number of institutions in the UK and globally.

The LINNEAN SOCIETY of London

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As the world's oldest active biological society, the Linnean Society is an essential forum and meeting point for those interested in the natural world. The Society holds regular public lectures and events, publishes three peer-reviewed journals, and promotes the study of the natural world with several educational initiatives. The Society is home to a world famous library and collection of natural history specimens. The Society's Fellows have a considerable range of biological expertise that can be harnessed to inform and advise on scientific and public policy issues.

A Forum for Natural History

Marine Biological Association

THE MARINE BIOLOGICAL ASSOCIATION Est. 1884 Incorporated by Royal Charter 2013

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Since 1884 the Marine Biological Association has been delivering its mission *'to promote scientific research into all aspects of life in the sea, including the environment on which it depends, and to disseminate to the public the knowledge gained.'* The MBA represents its members in providing a clear independent voice to government on behalf of the marine biological community. It also has an extensive research programme and a long history as an expert provider of advice for the benefit of policy makers and wider society.

SCIENCE DIRECTORY

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The Institution provides politicians and civil servants with information, expertise and advice on a diverse range of subjects, focusing on manufacturing, energy, environment, transport and education policy. We regularly publish policy statements and host political briefings and policy events to establish a working relationship between the engineering profession and parliament.

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The Met Office doesn't just forecast the weather on television. Our forecasts and warnings protect UK communities and infrastructure from severe weather and environmental hazards every day – they save lives and money. Our Climate Programme delivers evidence to underpin Government policy through the Met Office Hadley Centre. Our Mobile Meteorological Unit supports the Armed Forces around the world. We build capacity overseas in support of international development. All of this built on world-class environmental science.

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The Microbiology Society is a membership charity for scientists interested in microbes, their effects and their practical uses. It is one of the largest microbiology societies in Europe with a worldwide membership based in universities, industry, hospitals, research institutes and schools.

Our principal goal is to develop, expand and strengthen the networks available to our members so that they can generate new knowledge about microbes and ensure that it is shared with other communities. The impacts from this will drive us towards a world in which the science of microbiology provides maximum benefit to society.

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The National Physical Laboratory (NPL) is the United Kingdom's national measurement institute, an internationally respected and independent centre of excellence in research, development and knowledge transfer in measurement and materials science. For more than a century, NPL has developed and maintained the nation's primary measurement standards - the heart of an infrastructure designed to ensure accuracy, consistency and innovation in physical measurement.

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We challenge the way people think about the natural world – its past, present and future

We use our unique collection and unrivalled expertise to tackle the biggest challenges facing the world today.

We are leaders in the scientific understanding of the origin of our planet, life on it and can predict the impact of future change.

We study the diversity of life and the delicate balance of ecosystems to ensure the survival of our planet.

We help enable food security, eradicate disease and manage resource scarcity.

We inspire people to engage with science to solve major societal challenges.

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The University of Northampton is an institution committed to science education through initial teacher training, a STEM Ambassador network which works within the community and teaching and research to doctoral level. We are an Ashoka U 'Changemaker Campus' status university recognising our commitment to social innovation and entrepreneurship.

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With 43,000 students and campuses in Nottingham, China and Malaysia, The University of Nottingham is 'the nearest Britain has to a truly global university'. With more than 97 per cent of research at the University recognised internationally according to the Research Excellence Framework 2014, the University is ranked in the top 1% of the world's universities by the QS World University Rankings.

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The Nutrition Society is a not for profit, membership organisation which is dedicated to delivering its mission of advancing the scientific study of nutrition and its application to the maintenance of human and animal health. Highly regarded by the scientific community, the Society is one of the largest learned societies for nutrition in the world and anyone with a genuine interest in the science of human or animal nutrition can become a member.

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As the largest network of physiologists in Europe, with academic journals of global reach, we continue our 140-year tradition of being at the forefront of the life sciences.

We bring together scientists from over 60 countries, and our Members have included numerous Nobel Prize winners from Ivan Pavlov to John O'Keefe.

SCIENCE DIRECTORY

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Prospect is an independent, thriving and forward-looking trade union with over 120,000 members across the private and public sectors and a diverse range of occupations. We represent scientists, technologists and other professions in the civil service, research councils and private sector.

Prospect's collective voice champions the interests of the engineering and scientific community to key opinion-formers and policy makers. With negotiating rights with over 300 employers, we seek to secure a better life at work by putting members' pay, conditions and careers first.

QUADRAM INSTITUTE

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The £75m Quadram Institute opened in 2019 and is focused on fundamental and translational research into the interfaces between the gut microbiome, food, and human health. The Quadram Institute combines leading-edge bioscience capabilities with NHS endoscopy, clinical trials and biobank facilities. The Quadram Institute is a partnership between the Norfolk and Norwich University Hospital, University of East Anglia, Quadram Institute Bioscience and BBSRC.

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As the UK's national academy for engineering, we bring together the most successful and talented engineers for a shared purpose: to advance and promote excellence in engineering. We have four strategic challenges: drive faster and more balanced economic growth; foster better education and skills; lead the profession; and promote engineering at the heart of society.

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RBG Kew is a centre of global scientific expertise in plant and fungal diversity, conservation, and sustainable use, housed in two world-class gardens. Our scientific vision is to document and understand global plant and fungal diversity and its uses, bringing authoritative expertise to bear on the critical challenges facing humanity today.

Kew's strategic priorities for science are:

1. To document and conduct research into global plant and fungal diversity and its uses for humanity.
2. To curate and provide data-rich evidence from Kew's unrivalled collections as a global asset for scientific research.
3. To disseminate our scientific knowledge of plants and fungi, maximising its impact in science, education, conservation policy and management.

These priorities enable us to curate, use, enhance, explore and share Kew's global resource, providing robust data and a strong evidence base for our UK and global stakeholders. Kew is a non-departmental government body with exempt charitable status, partially funded by Defra.

The Royal Institution Science Lives Here

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The Royal Institution (Ri) has been at the forefront of public engagement with science for over 200 years and our purpose is to encourage people to think further about the wonders of science. We run public events and the famous CHRISTMAS LECTURES®, a national programme of Masterclasses for young people in mathematics, engineering and computer science, educational activities at the L'Oréal Young Scientist Centre and policy discussions with science students. And through the Ri Channel we share the stories behind cutting-edge science with people around the world.

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The Royal Society is the academy of science in the UK and the Commonwealth comprising 1400 outstanding individuals representing the sciences, engineering and medicine. The Society has played a part in some of the most fundamental, significant and life-changing discoveries in scientific history and Royal Society scientists continue to make outstanding contributions to science across the wide breadth of research areas. Through its Fellowship and permanent staff, it seeks to ensure that its contribution to shaping the future of science in the UK and beyond has a deep and enduring impact, supporting excellence in science and encouraging the development and use of science for the benefit of humanity.

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The Royal Society of Biology is a single unified voice, representing a diverse membership of individuals, learned societies and other organisations. We are committed to ensuring that we provide Government and other policy makers – including funders of biological education and research – with a distinct point of access to authoritative, independent, and evidence-based opinion, representative of the widest range of bioscience disciplines. Our vision is of a world that understands the true value of biology and how it can contribute to improving life for all.

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The Royal Society of Chemistry is the world's leading chemistry community, advancing excellence in the chemical sciences. With over 50,000 members and a knowledge business that spans the globe, we are the UK's professional body for chemical scientists; a not-for-profit organisation with 170 years of history and an international vision of the future. We promote, support and celebrate chemistry. We work to shape the future of the chemical sciences – for the benefit of science and humanity.

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*Sf*AM utilises the expertise of its international membership to advance, for the benefit of the public, the application of microbiology to the environment, human and animal health, agriculture, and industry. Our values include equality, diversity and inclusivity; collaboration to amplify impact; scientific integrity; evidence-based decision-making and political neutrality. With Wiley-Blackwell, *Sf*AM publishes five internationally acclaimed journals.

SCIENCE DIRECTORY

Society for Underwater Technology

Society for Underwater Technology
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The SUT is a multidisciplinary learned society that brings together individuals and organisations with a common interest in underwater technology, ocean science, and offshore/subsea engineering. The society was founded in 1966 and has members from over 40 countries, including engineers, scientists, other professionals and students working in these areas.

Society of Chemical Industry

SCI: where science meets business

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Established by Royal Charter in 1881, SCI is a unique multi-disciplinary community. Set up by a prominent group of forward thinking scientists, inventors and entrepreneurs, SCI continues to be a multi-science and industry network based around chemistry and related sciences. Our charitable objective is to promote links between science and industry for the benefit of society. Our passion is invention and creation.

We deliver our charitable objective by:

- Supporting the commercial application of science into industry
- Tackling global challenges across Agrifood, Energy, Environment, Health and Materials

Society of Cosmetic Scientists

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Advancing the science of cosmetics is the primary objective of the SCS. Cosmetic science covers a wide range of disciplines from organic and physical chemistry to biology and photo-biology, dermatology, microbiology, physical sciences and psychology.

Members are scientists and the SCS helps them progress their careers and the science of cosmetics ethically and responsibly. Services include publications, educational courses and scientific meetings.

SMI

Society of Maritime Industries - UK

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The Society of Maritime Industries (SMI) is the voice and champion of the UK maritime engineering, marine science & technology and business service sectors.

THE SOCIETY FOR RADIOLOGICAL PROTECTION

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The Society for Radiological Protection is the principal independent professional body for radiation protection in the UK. Its members operate in the fields of medicine, the nuclear power cycle and other industries, research, and teaching. We offer a profession-wide view to regulators and are involved in training and educational outreach. We ensure that professional standards are maintained at the highest levels.

UK INNOVATION & SCIENCE SEED FUND

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The **UK Innovation & Science Seed Fund** is a leading patient capital investor with more than £330 million private investment leveraged to date. The Fund works to build technology companies from the earliest stage by working closely with its partners led by STFC, BBSRC, NERC and Dstl, with the National Research and Innovation Campuses they support, and with entrepreneurial science-led teams. UK Innovation & Science Seed Fund is also closely aligned with the Catapults and InnovateUK, helping to commercialise key technological advances in industrial biotech, agricultural technology, healthcare, medicine, clean energy, materials, artificial intelligence, software and space.

Understanding ANIMAL RESEARCH

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Understanding Animal Research is a not-for-profit organisation that explains why animals are used in medical, veterinary, environmental and other scientific research. We aim to achieve a broad understanding of the humane use of animals in medical, veterinary, scientific and environmental research in the UK. We work closely with policymakers to ensure regulation is effective and are a trusted source of information for the national and international media. We are funded by our members who include universities, professional societies, trade unions, industry and charities.

University of Essex

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Established in 1964, the University of Essex is ranked as one of the Top 20 universities in the Research Excellence Framework and is awarded Gold in the Teaching Excellence Framework. It is home to world-leading expertise in analytics and data science, with research peaks spanning the social sciences, sciences, and humanities. Pioneers of quantitative methods and artificial intelligence techniques, Essex is also in the UK top 10 for Knowledge Transfer Partnerships, and works with businesses to embed innovation into operations, through KTPs, knowledge exchange and contract research.

Universities Federation for Animal Welfare

UFAW Established 1926

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Registered in England Charity No: 207996

UFAW, the international animal welfare science society, is an independent scientific and educational charity. It works to improve animal lives by:

- supporting animal welfare research
- educating and raising awareness of welfare issues in the UK and overseas
- producing the quarterly scientific journal Animal Welfare and other high-quality publications on animal care and welfare
- providing advice to government departments and other concerned bodies.

SCIENCE DIRECTORY

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The Welding Institute is the leading institution providing engineering solutions and knowledge transfer in all aspects of manufacturing, fabrication and whole-life integrity management.

Industrial membership provides access to innovative problem-solving from one of the world's foremost independent research and technology organisations.

Non-Corporate services include membership and registration, education, training and certification for internationally recognised professional development and personnel competence assurance.

TWI provides Members and stakeholders with authoritative and impartial expert advice, knowhow and safety assurance through engineering, materials and joining technologies.

SCIENCE DIARY

PARLIAMENTARY AND SCIENTIFIC COMMITTEE – ALL-PARTY PARLIAMENTARY GROUP

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www.scienceinparliament.org.uk
follow us on Twitter @ParlSciCom

FORTHCOMING DISCUSSION AND OTHER MEETINGS

Monday 12th September
Discussion Meeting
5.30pm to 7.00pm

Monday 10th October
Discussion Meeting
5.30pm to 7.00pm

Monday 28th November
Discussion Meeting
In partnership with The Physiological Society
5.30pm to 7.00pm, Palace of Westminster

Wednesday 14th December
Christmas Parliamentary Reception
Attlee Suite, Portcullis House
6.00pm to 8.00pm

ROYAL SOCIETY OF BIOLOGY

For further details please contact
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ROYAL SOCIETY OF CHEMISTRY

Monday 17th October
Science and Stormont
Parliament Buidings, Belfast
For further details please contact
events@rsc.org

ROYAL SOCIETY

Details of all events can be found on the events calendar at events@royalsociety.org
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THE ROYAL INSTITUTION

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Printed by Premier Print Group Ltd

Published by Parliamentary and Scientific Committee – All-Party Parliamentary Group, 2nd Floor, 201 Great Portland Street, London W1W 5AB. Correspondence address: 1 Lych Gate Walk, Hayes, UB3 2NN. Published four times a year.
The 2021 subscripton rate is £80. Single numbers £20. ISSN 0263-6271

The Parliamentary & Scientific Committee's STEM for BRITAIN 2023 takes place on Monday 6th March, in the Attlee Suite, Portcullis House, House of Commons, during British Science Week

Applications are invited with effect from **Monday 12th September 2022**, from early-career research scientists, engineers, technologists and mathematicians who wish to exhibit posters in one of the following areas:

- **Biological and Biomedical Sciences**
- **Chemistry**
- **Engineering**
- **Mathematics**
- **Physics**

The closing date for applications is Monday 28th November 2022.

A wide range of important scientific, engineering and mathematics institutions and organisations are lending their support to this event, including the Royal Society of Biology, the Institute of Physics, The Physiological Society, the Royal Society of Chemistry, the Royal Academy of Engineering, the Council for the Mathematical Sciences, the Institute of Biomedical Science, the Clay Mathematics Institute, the Nutrition Society, British In Vitro Diagnostics Association (BIVDA), the Heilbronn Institute, United Kingdom Research and Innovation, the Biochemical Society, and the Society of Chemical Industry.

This reflects the importance we all attach to the encouragement of researchers at this stage in their careers.

Prizes will be awarded for the posters presented in each discipline which best communicate high level science, engineering or mathematics to a lay audience.

The Westminster Medal will be judged and presented at a separate event in Parliament. It is awarded in memory of the late Dr Eric Wharton, who did so much to establish SET for Britain as a regular event in the Parliamentary calendar.

From the 12th September full details of the competition and exhibition including the application form will be on the STEM for Britain website www.stemforbritain.org.uk.