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Parliamentary and
Scientific Committee

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in partnership with Confederation of British Industry, Royal Society and Universities UK

DISCUSSION MEETING

Science, Innovation and Brexit

Tuesday 10 October 2017 at 5.30pm

Boothroyd Room, Portcullis House

(Please check the room allocation by telephoning 020 7222 7085 on the day)

ADDRESSES BY:

Stephen Metcalfe MP, Chairman, Parliamentary and Scientific Committee

Sir Venki Ramakrishnan PRS, President, Royal Society

Tom Thackray, Director for Innovation, Confederation of British Industry

Dr Sarah Main, Executive Director, Campaign for Science and Engineering

Professor Julia Buckingham, Universities UK

The meeting will be followed by a drinks and canape reception
in Bellamy's Restaurant in 1, Parliament Street

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Stephen Metcalfe MP,
Chairman, Parliamentary and
Scientific Committee

Welcome to the first edition of *Science in Parliament* in the new Parliament. It has certainly been a time of change over the summer for both Parliament and for the Parliamentary and Scientific Committee (P&SC). Professor Alan Malcolm, who has been Executive Secretary to P&SC and Editor of *Science in Parliament* for five years decided to step down and in June we welcomed Dr Isabel Spence into the role.

Science continues to be a high priority on the political agenda featuring in all party manifestos in the lead up to the election. This commitment was reaffirmed at Parliamentary Links Day on 27 June 2017, the largest science event bringing together parliamentarians and the scientific community, which saw Members from all parties come together to discuss science on the global stage.

As we proceed with Brexit negotiations it is vital that scientific issues are considered alongside economic and social considerations. UK research and innovation allows us to compete on the global stage as an outward-looking nation that works with others around the world to tackle global challenges such as climate change and antimicrobial resistance and develop technologies and products that improve people's

lives around the globe. The strength of UK research and innovation can be maintained and grown with the right mix of skilled people, investment, networks and collaboration, and regulation and trade.

I and the P&SC are striving to ensure parliamentary colleagues understand what needs to be done to maintain and grow UK research and innovation and have published '*Science Priorities for Brexit*' which was distributed to all parliamentarians. We are also holding an event on 10 October 2017 to highlight these priorities in partnership with other key scientific organisations. I hope to see you there.



The Journal of the Parliamentary and Scientific Committee.
The Parliamentary and Scientific Committee is an All-Party Parliamentary Group of members of both Houses of Parliament and British members of the European Parliament, representatives of scientific and technical institutions, industrial organisations and universities.



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.

CONTENTS

PARLIAMENTARY LINKS DAY

Stephen Benn

SCIENCE PRIORITIES FOR BREXIT

Isabel Spence

THIRTY YEARS OF DAPHNE JACKSON FELLOWSHIPS

Katie Perry

THE UK NUCLEAR DETERRENT: A TECHNICAL PERSPECTIVE

Neil Gaspar

VOICE OF THE FUTURE

Stephen Benn

2 RE-GREENING OF BARREN LAND AS NEW BIODIVERSITY RESERVES

Christopher N. Page and Hylke J. Glass

5 WHY CAN'T WE HAVE GOOD BROADBAND NOW?

Suzanne Clear

6 COATINGS – THE BASIS OF THE UK'S MANUFACTURING ECONOMY

Trevor Crichton

8 MENTAL HEALTH RESEARCH – THE FUTURE BECKONS

Jeremy Hall

10

12 PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY

20

HOUSE OF COMMONS SELECT COMMITTEES SEPTEMBER 2017

21

HOUSE OF LORDS SELECT COMMITTEES SEPTEMBER 2017

22

16 SCIENCE DIRECTORY

24

SCIENCE DIARY

33

PARLIAMENTARY LINKS DAY 2017



Speaker Rt Hon John Bercow MP opens Parliamentary Links Day

(photo: RSB)

It was standing room only in the Attlee Suite in Portcullis House on 27 June for Parliamentary Links Day 2017 – which is the largest single science event held in both Houses in the annual Parliamentary calendar. The event, organised by the Royal Society of Biology on behalf of the Science Community, brings together hundreds of scientists, policymakers and politicians to discuss issues facing the science sector.

The Speaker of the House of Commons, Rt Hon John Bercow MP, once again opened the event – for a record fourth successive Parliament – and praised the scientific community for its continuing efforts to strengthen links between science and Members of Parliament in both Houses.

The tightly packed audience of Parliamentarians and members of the science community heard keynote speeches from Jo Johnson MP, the Minister for Universities, Science, Research and Innovation and Sir John Kingman, Chair Designate of UKRI. Two panel discussions thereafter focused on European and global opportunities.

Johnson emphasised how important it is that the UK remains world leading, alongside the need to achieve better geographic spread of excellence and investment, and the need to translate more research into commercial success.



Jo Johnson MP announces the UK Government will continue to fund JET post-Brexit

(photo: RSB)

“We maintain the enviable record for science and innovation; we are genuinely world class.

“We need to work harder to address economic imbalances and historic under investment in research and development. We want the UK to remain the go to place for scientists, innovators and tech investors from across the world.”

Announcing that the UK Government will continue to underwrite the Joint European Torus (JET) project post Brexit Johnson said: “JET is a prized facility at the centre of the UK’s global leadership in nuclear fusion research, which is why the Government is taking every possible step to secure its future and maintain highly skilled jobs in the UK.”



Standing room only as the packed out crowd filled up the Attlee Suite in Portcullis House

(photo: RSB)

In his speech, Kingman discussed the future development of UKRI, and the opportunities and challenges the organisation will face in the coming months and years. Both Johnson and Kingman also stressed the need for continued achievement to leverage continued Treasury support for public investment.

Two panel sessions followed, with leaders in the science sector, politicians and policymakers taking questions from the floor. Both discussions were chaired by BBC science correspondent Pallab Ghosh.



BBC science correspondent, Pallab Ghosh, leads the first panel discussion on science and Europe (photo: RSB)

Present on the first panel to discuss science and Europe were Professor Roberto di Lauro, Science Attaché for the Embassy of Italy, Dr Lorenzo Melchor, Science Attaché for the Embassy of Spain, Dr Sarah Main, Director of the Campaign for Science and Engineering and Chi Onwurah MP, Shadow Minister for Business, Energy and Industrial Strategy.



Chi Onwurah MP discusses concerns from EU scientists about their future in UK science

The discussion quickly focussed on the challenges for the sector in the run up to leaving the EU, with Onwurah acknowledging that some EU scientists are now apprehensive

about joining the UK community, as well as the need to reassure those already working here that they will be able to stay.

This was echoed by di Lauro, who told the audience that a survey of Italian academics across UK universities found that 82% of respondents were considering leaving post-Brexit. Melchor noted the findings of a recent SRUK study and explained that his embassy had set up a specific taskforce to help Spanish academics understand their options for remaining in the UK, as people were still uncertain over their rights to remain in the UK.

Dr Main commended the sector on coming together and helping define top priorities for the upcoming Brexit negotiations, but she stressed the importance that those in attendance also continue to engage with policymakers.

The second panel discussing science in a global context featured Professor Dame

Jocelyn Bell Burnell, President of the Royal Society of Edinburgh, Malcolm Brinded, Chair of Engineering UK and Professor Sir John Holman, President of the Royal Society of Chemistry.



Professor Dame Jocelyn Bell Burnell and Malcolm Brinded and John Holman discuss issues facing the international science community during the second panel

(photo: RSB)

Discussion across the second panel focused on the need to expand the global science sector. Burnell explained that schools need to offer more comprehensive careers advice for those going into STEM, and ensure not only pupils get excited over becoming



Stephen Metcalfe MP concluded this year's Parliamentary Links Day

(photo: RSB)

scientists, saying "We need to reiterate the value of being a scientist not just to children but to their parents too."

Meanwhile Holman explained the need for specialist science teachers to inspire students from a primary school age, to strengthen the "skills pipeline" and ensure there will be enough scientists for the future.

Brinded added that there is a skills shortage faced by global engineering as well as the need to address diversity. He explained that the UK is particularly dependant on overseas students coming to study at the UK, with 68% of current postgraduate engineers from overseas: "We have to factor these issues into any immigration policy, as well as improving the supply of UK nationals."

A Q&A across both panels covered issues of regulation, funding, political awareness of

science issues, leadership against xenophobia, and inspiring the next generation.

The event concluded with closing remarks from Stephen Metcalfe MP, the immediate past Chair of the Science and Technology Select Committee for the House of Commons. "We know the UK is world leading for science.

"We know that we have 1% of the world's population but contribute to 16% of the world's research citations.

"We now need to build an optimistic, outward looking, inspirational vision of science in the UK; we need to create a vision that attracts and not repels the best scientists in the UK and globally."

Professor Alex Halliday FRS delivered a keynote address at the House of Lords Luncheon, which is available to read on the Royal Society website.

EVENT COVERAGE

There was lots of tweeting on the day with #LinksDay17 trending in London and it helped to get the message out that UK Science is still in the business of being open, inclusive and looking forward.

You can read the RSB news story, view the event Storify, listen to it again on SoundCloud and see photos on Facebook and Flickr: www.rsb.org.uk/linksday. Please credit the Royal Society of Biology (RSB) when using these photographs, and contact media@rsb.org.uk for additional images.

QUOTE FROM SPEAKER RT HON JOHN BERCOW MP:

"I believe that Parliamentary Links Day will continue to play a helpful part in providing Members of Parliament with a greater and more rounded understanding of science and engineering and the scientific issues with which we must deal – and that can only be a very good thing in today's ever more technological and scientifically conscious world.

I know from my unique vantage point in the House, that Members on all sides continue to raise issues that have a scientific aspect to them and they value the assistance which the scientific community can offer them.

It is all the more important that every Member of Parliament should be able to benefit from non-partisan assistance of the kind offered by professional scientific bodies.

SCIENCE PRIORITIES FOR BREXIT

On 21 March 2017, Stephen Metcalfe, Chair of the Parliamentary and Scientific Committee, launched a statement outlining the priorities for the science community to help inform Brexit negotiations.

This statement was informed by advice and evidence from the research and innovation community, representatives of whom joined Stephen on a panel to discuss what action the UK must take now to send a bold, positive message that the UK is one of the best places in the world to research and innovate, and capture the benefits stemming from this to improve the lives of people all over the UK.

The statement outlined four priority areas summarised below:

PEOPLE

It is in the UK's national interest to attract diverse individuals from around the world with strategically valuable skills as well as give every one of its citizens the opportunity to develop the skills that the UK needs. Individuals with strategically valuable skills to the UK include successful leaders in research fields, early-stage researchers, technologists, technicians and those with entrepreneurial and management skills.

INVESTMENT IN RESEARCH AND INNOVATION

Signal the UK's intention to compete internationally by investing in scientific research and innovation and creating an attractive environment for other investors.

COLLABORATION AND NETWORKS

To realise the UK's ambition to remain one of the best places in the world to do research, to innovate and grow business, UK-based researchers must be able



to engage with the brightest minds, the best organisations and facilities, wherever they are in the world.

REGULATION AND TRADE

UK regulation should continue to support cutting-edge science and trade, while keeping people and the environment safe and earning public confidence.

Further details can be found in the statement and evidence report summarising the evidence and advice received on the Parliamentary and Scientific Committee website www.scienceinparliament.org.uk

The Parliamentary and Scientific Committee will be hosting an event on Science and Brexit with the Royal Society, Universities UK and the Confederation of British Industry on Tuesday 10 October 2017.

Please contact office@scienceinparliament.org.uk for further information.

THIRTY YEARS OF DAPHNE JACKSON FELLOWSHIPS

By Dr Katie Perry, Chief Executive



The celebration was held at the Royal Society of Chemistry in London

2016 was an important year for The Daphne Jackson Trust

In 2016 we celebrated the 30th anniversary of the first Fellowship being awarded in 1986 by Daphne Jackson, the UK's first female Professor of physics and a lifelong campaigner for encouraging women in science, technology, engineering and mathematics (STEM) to return to their careers after a break.

Following Daphne's sad death in 1991 at the age of 54, the Trust was established in her memory and continues her inspired work to this day. To date, we have helped 329 STEM researchers retrain and return to their careers.

Providing support and flexible retraining opportunities to men and women

Science is at the heart of the world in which we live. Progress and diversity in STEM research affects everyone and is essential as society tackles the big challenges of the 21st century in areas such as climate change, medicine, artificial intelligence, big data and agricultural technologies, to name but a few. We are the only charity in the UK dedicated to realising the potential of STEM researchers to retrain and return to research careers following a prolonged career break. Our unique Fellowships provide an individually tailored retraining programme alongside a challenging research project, with additional mentoring guidance and advice. The fellowships enable recipients to re-establish scientific credentials, update skills and boost confidence.

Many people still struggle needlessly to return to STEM research after a career break

For many researchers, life happens: they have a family, relocate, need to care for a loved one or are ill. This should not mean that they find themselves disadvantaged and unable to re-enter their careers at a level commensurate with their skills and experience. Many are forced to quit the research and scientific work environments until they find the Trust and realise that there is a way to return to their career.

Women are also still massively underrepresented in STEM roles - maintaining an equal, diverse and talented workforce matters now and for the future. We believe more needs to be done to improve working practices and support mechanisms - too many talented women and men face unnecessary barriers in their efforts to return to their STEM career.

Our future plans

As the Daphne Jackson Trust enters its third decade, the importance of our Fellowship programmes is becoming ever more evident and it is essential that the number of fellowships offered increases. This will only be possible with increasing levels of support from our sponsors and host organisations - drawn from universities, the research councils, learned societies, charities and industry.

Raising awareness of the Trust and the fellowships is key and we are keen to work in partnership with our fellow members of the P&SC as much as possible.

Celebrating with our Fellows and Supporters

To celebrate our 30th year, we held a special celebration event at the Royal Society of Chemistry in London on 9th November 2016.

Professor Teresa Anderson, our Chair of Trustees, introduced the event and Dr Katie Perry, the Trust's Chief Executive, shared her personal memories of Daphne.



Professor Teresa Anderson, Chair of Trustees for Daphne Jackson Trust introduces the event



Vijayalakshmi Ramdas shares how the fellowship has helped her career

Former Daphne Jackson Fellows Dr Sianne Schwikkard and Vijayalakshmi Ramdas provided an insight into their Fellowships and resulting successes.

Vijayalakshmi, one of the first Fellows mentored by Daphne personally in 1989, is now Head of Rail in the Infrastructure Division at the Transport Research Laboratory.

Remembering Daphne, Vijayalakshmi said: "I will always be grateful for the fellowship and the personal encouragement from professor Daphne Jackson. I was one of the first four people awarded a fellowship in chemistry under the scheme."

Dr Sianne Schwikkard, Lecturer in Organic and Natural Products Chemistry at Kingston University, highlighted how her Daphne Jackson Trust Fellowship was instrumental in her successful

return to her chemistry career after a break for children. "None of it would have been possible without the Daphne Jackson Trust, and the charity's life-changing work"

The event was attended by over 100 supporters of the Trust, including current and former Fellows, representatives from host and sponsor institutions, and some very special guests from Daphne Jackson's family, her brother Ronald Jackson and her niece Susan Balgarnie.

'A people person' A personal reflection from Daphne's family

Reflecting about Daphne and the Trust, Ronald says: "My sister, amongst her many attributes, was very much a people person. She was always ready to offer a friendly ear to help and advise her colleagues whilst at school, studying at Imperial and later in her various

roles at Surrey. She was a particularly caring aunt to my children and always concerned about their future. Also, in spite of heavy responsibilities as Professor, Head of Department, Dean and serving on many national committees, she personally carried the burden of caring for our mother in her declining years.

"Not surprisingly, therefore, she came to recognise the need to help able people to catch up with the progress made in their particular field of expertise during a career break for family or health reasons. It became clear that financial aid was often the critical factor in determining whether to be able to continue on the chosen career path.

"So she worked hard on her idea for a returners support scheme. Canvassing support and financial backing took up no small part of her limited free

time in the early days. Once the Trust was established, its development has been due to the hard work and dedication of those who have been inspired by Daphne's original concept. She would have been delighted at the progress and growth which has resulted in the thriving Trust it is today."

For further information about the Daphne Jackson Trust, please contact the Trust's office on 01483 689166 or email djmft@surrey.ac.uk or visit daphnejackson.org

Individuals wishing to contact Dr Katie Perry directly to discuss becoming a supporter of the Trust or collaborator, please contact Katie.Perry@surrey.ac.uk

Follow 'The Daphne Jackson Trust' on Facebook and find us on Twitter @DaphneJacksonTr

THE UK NUCLEAR DETERRENT: A TECHNICAL PERSPECTIVE

Neil Gaspar, AWE

HISTORY OF THE UK NUCLEAR DETERRENT

The UK Government's nuclear weapons policy is to maintain Continuous at Sea Deterrence (CASD). Preparations began for Britain to develop its own independent nuclear deterrent after its contribution to the American led programme during World War II. The UK nuclear weapon programme was officially started in 1947 by Dr William Penney (later became Lord Penney) at Fort Halstead, Kent. It was determined that a large site was needed for the programme, so an airfield that had been used by the US Air Force during WWII was identified and the programme moved there from 1950. Today, it is the Aldermaston site, often referred to as 'the home' of the UK nuclear weapons programme.



Lord Penney

In 1952, the UK successfully demonstrated its first detonation of a nuclear device in the Monte Bello Islands. Six years later a series of thermonuclear tests or 'hydrogen bombs' were carried out in the Central Pacific. By



Vanguard class submarine

today's standards, this is an astonishingly quick growth in understanding of the complex science, technology, engineering and mathematics required and overall capability.

Through to the 1990s, the nuclear weapons programme carried out research & development of the capability at Aldermaston and underground testing at the Nevada test site in the US. The underground testing supported and validated the science capability. During this period, the UK's nuclear deterrent included Blue Danube, Polaris, Chevaline, WE177 and currently Trident. Trident has been in-service since 1994. It is delivered by submarine-launched ballistic missiles (SLBM), procured from the US and carried on four UK Vanguard class nuclear submarines.

In 1996, the Comprehensive Nuclear Test Ban Treaty (CTBT) was signed and subsequently ratified by the UK in 1998, bringing to an end five decades

of nuclear tests. Testing of either a representative device or an actual warhead has two outcomes. First, the science and technical development is assured to a high level mitigating the areas that are not yet fully understood; and second, the credibility of the deterrent is established. With the cessation of testing, the science and technology methods for nuclear weapons had to change to maintain those two outcomes.

The science, technology, engineering and mathematics (STEM) that underpins the UK nuclear deterrent

AWE provides support for the entire life cycle of Trident. Over many decades, from concept and design, through maintenance, in-service support and decommissioning, AWE is the custodian of the enduring capability. AWE is also responsible for the operation of the sites and for the transportation of the warheads.

The core of AWE's work is the routine certification of the safety and performance of the stockpile. The experience gained from the historic tests is still enormously relevant in this CTBT era. However, it is over 25 years since the last test and direct experience from that period is gradually being lost due to staff retirement. This can make applying older knowledge, data and techniques to current challenges difficult.

In addition, over the life of the warhead there are many changes that demand an increase in understanding to maintain the same level of certification. Such as, the ageing of existing materials and the introduction of new materials and processes due to changes in regulation and manufacturing.

Certification in the CTBT era is achieved through large calculations. High Performance Computers (HPC) carry out enormous simulations of the physics, materials and components. With requirements for detailed understanding increasing, there is a need for a resultant increase in HPC capability. AWE has a continuous programme to increase its HPC capability. Currently AWE has two of the most advanced and powerful supercomputer systems in the world; with each machine capable of two thousand million million calculations per second or 2 petaFLOPS. Computer technology continues to develop rapidly with increases in microprocessor speed and architecture sophistication. Whilst

this sounds beneficial, increased sophistication of microprocessors presents the challenge of maintaining the provenance of the code that runs on them. The increase in speed also comes with a notable increase in running cost through power consumption.

To make use of the HPC, specialist computer code has to be written that simulates the complex science at different points in the warhead's life. This code has to be established on the provenance of code from previous decades that has been validated against underground test data. Specialist weapon code cannot be bought commercially so AWE has to develop much of its own in-house. There are also supporting codes developed in the nuclear energy industry, academia, and conventional science and engineering. These codes do not run in isolation. Specialist materials models are developed and materials data has to be obtained for use in those models – all at extreme conditions. Validation of these codes is obtained through plasma physics and hydrodynamic experiments thus providing empirical evidence to validate and verify the calculations.

Plasma physics experiments, which require matter to be made very hot and dense, is accomplished on large-scale laser facilities such as Orion at AWE. Orion generates matter many times denser than solid, similar to that found at the centre of a giant planet such as Jupiter and at temperatures in excess of 10 million degrees. The laser, inside a facility the size of a football pitch, is delivered to a high-vacuum target chamber four metres across and focussed into a target only a few millimetres in size. The laser has to be operated in

ultra-clean conditions; better than those found in a hospital's operating theatre. The complex combination of 10 'long-pulse' beams and two 'short-pulse' beams make this a facility unique in the world.

Although the CTBT era prevents nuclear tests, representative devices using surrogate materials can be tested. Hydrodynamic tests use large-scale radiography to interrogate the implosion of the representative devices. This part of the programme benefits from a bilateral agreement with France to develop a joint hydrodynamics capability called Teutates. Other hydrodynamic testing involves gas guns firing projectiles into targets to measure the response of specific materials to explosive shock. Complex electronic and optical sensors make fast and minute measurements of the target which are analysed to provide the material data.

The warhead contains components made from a wide range of materials, not least of all the fissile isotope of plutonium and highly characterised conventional explosive, each requiring a different manufacturing capability for a relatively small quantity of units. Each element of material manufacture requires dedicated facilities and technically skilled staff.

To completely certify the warhead, AWE has to account for all of the environments that the warhead will experience – such as remaining in storage for many years, road transport, deployment undersea and potentially riding the ballistic missile into orbit and back. The science of sustained acceleration, vibration, temperature changes, stress and many others have to be understood over timescales of seconds to years. Engineering



Inside the target chamber of Orion

testing and modelling, materials analysis and a continuous programme of surveillance feed into the computer design codes for certification.

KEEPING OUR NATION SAFE

AWE is also home to the UK Nuclear Threat Reduction programme which combines STEM with operational response. This programme, worthy of an article in its own right, develops AWE's nuclear weapons expertise to support the MoD and other Government departments. This support covers a wide range activities in a number of subject fields including international treaties; detection of material outside of regulatory control, nuclear forensics; counter-terrorism and emergency response. The knowledge obtained from our nuclear weapons programme enables AWE to contribute in ways that a non-nuclear state cannot.

PARTNERING

Both national and international outreach is vital to the STEM work at AWE. Under the 1958

Mutual Defence Agreement, AWE collaborates with the equivalent US laboratories gaining vast benefit from shared expertise, facilities and test data. With UK universities, two-way relationships provide a foundation of expertise and sharing of facilities across the wide range of required subjects. AWE offers sponsorship for academics and students as well as employer engagement and professional activities to support UK STEM capability.

STEM skills are at heart of the UK's nuclear weapons programme, driving improvements in capability and safety. They have had to adapt to an era without nuclear testing and provide continuous assurance of the credibility and safety of the deterrent. The community also continues to provide expertise and support to national security in an ever changing environment and in both cases be ready to meet future challenges to national defence.

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VOICE OF THE FUTURE

WEDNESDAY 15 MARCH 2017

Students and young scientists put MPs and Ministers in the hot seat at this year's *Voice of the Future* on 15 March in the House of Commons. It was a Select Committee with a difference: a role reversal. Its 'members' were scientists and engineers and most of its 'witnesses' were MPs. In the words of the distinguished former MP Andrew Miller "there is no other event like it on the planet".



The tables are turned as students and young scientists scrutinise politicians and their advisors

Science Minister Jo Johnson MP and a range of other political and scientific figures were quizzed by young scientists and engineers on topics as diverse as artificial intelligence, gene editing, research funding, STEM careers, post-truth politics and space exploration during *Voice of the Future 2017* organised by the Royal Society of Biology on behalf of the science and engineering community (www.rsb.org.uk/VOF).

The event turned the tables on MPs, Ministers and senior officials and gave students and young scientists – representing two dozen science organisations and some schools – the chance to scrutinise politicians and their

advisors in a real House of Commons committee room where they experienced exactly what it is like to sit as a Select Committee.

Broadcast live on ParliamentTV, the event created enough interest online that at one point '#VOF2017' was trending on Twitter above Chancellor Philip Hammond's Commons post-Budget U-turn on NI contributions for the self-employed.

In the run-up to the event literally hundreds of suggested questions had been submitted and these had to be whittled down to a manageable number or the session would have

lasted all day! Unsurprisingly many of these questions overlapped and covered familiar topical themes.

Jo Johnson, appointed Minister for Universities and Science in 2015, responded to questions on academic freedom, Brexit, and investment in science, and reemphasised the Government's commitment to investing in research, which he said would equate to the biggest increase in R&D spending in 40 years.

"Research is a big priority for this Government," he told he told the committee of school students, undergraduates and early career scientists. We have made it clear we are going to

put real resources behind this endeavour."



Jo Johnson MP reemphasises the Government's commitment to investing in research

Other panellists included Shadow Science Minister Chi Onwurah MP, the Government's Chief Scientific Advisor Sir Mark Walport, and Members of the

Science and Technology Select Committee itself led by its then Chair Stephen Metcalfe MP.

Chi Onwurah MP had to field answers to direct questions about the Trump Presidency's apparent attitude to science. Sir Mark Walport, who had been recently appointed Chief Executive-designate of the UK's new overarching research body UKRI, took questions on science publishing, science careers and science regulation post-Brexit. He said much of the EU regulation on research had been influenced by the UK's own legislation, and so the UK would be well-placed to regulate itself once it leaves the EU.

Stephen Metcalfe MP appeared with three of his Select Committee colleagues – Carol Monaghan MP, Dr Tania Mathias MP and Matt Warman MP – and got a feel for what it is like when having to reply to questions rather than being the ones asking them.

The two schools involved – Queens Park Community School

and Wallington High Schools for Girls – said their A-Level science students had found the experience hugely valuable as did the young scientists and engineers drawn from the UK's leading scientific organisations including the Royal Society, the Royal Academy of Engineering, the Royal Society of Biology, the Institute of Physics, the Council for the Mathematical Sciences, the Royal Society of Chemistry and many more.

Greg Satchell, an early career forensic scientist who works for the Thames Valley police force, said it was a 'privilege' to represent members of the Royal Society of Biology in Parliament.

"Very few people in my position ever get this opportunity, so being able to represent the Royal Society of Biology on behalf of scientists in my field is definitely a milestone in my career".

A full video of the *Voice of the Future* hearing is available on the parliamentlive.tv website.



Sir Mark Walport faces questions regarding science publishing, science careers and science-regulation post-Brexit



Chi Onwurah MP addresses direct questions about the Trump Presidency's apparent attitude to science



Select Committee Members Stephen Metcalfe MP, Carol Monaghan MP, Dr Tania Mathias MP and Matt Warman MP experience what it is like on the other side of the table

RE-GREENING OF BARREN LAND AS NEW BIODIVERSITY RESERVES



Christopher N. Page
Honorary Senior Research Fellow in
Environment



Hylke J. Glass
Professor of Mining and Minerals
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Disused areas which formerly hosted quarrying and mining activities often feature 'holes-in-the-ground' in various states of post-industrial abandonment. Revegetation programmes are being developed aimed at preparing such areas for green re-use through informed tree-planting programmes to create future biodiversity reserves. The overall aim is to establish unique long-term re-use of these sites, offering multiple benefits associated with greening and biodiversity gain.

THE PROBLEM

Across the UK, there are disused sites of former quarrying and mining activity with crater-like, irregular pit structures (holes) which may be lined with material which was previously removed to uncover resources such as minerals and metals, china clay, ball clay, coal, slate, building stone, and aggregate. While the size of the pits can vary, all have associated dumps consisting of rocks varying in size from boulders to stones, gravels and sands. There may also be evidence of residues from former extraction and purification processes: fine particles sedimented from aqueous flows may have filled nearby ponds or spread widely across local landscapes. Such residues may continue to cause release of toxic substances or contribute towards acid mine drainage and influence local watercourses away from the sites of the mines themselves.

Such surfaces are typically exposed, highly mineralised, sometimes toxin-loaded, nutrient deficient and often only semi-

stable. These surfaces are generally unsuited to any future agricultural 'food-chain' use or for construction purposes. Often several of these legacy features combine to leave rocky scars on the landscape which are potentially long-lived and have little positive future purpose. Such sites are also generally inhospitable to natural plant development, requiring several centuries of weathering and amelioration processes to achieve adequate mineral downwash first settlement of plants.

To replace the past tradition of general abandonment, there is an important need to find uses for former mine sites. Growing experience with experimental plant establishment on a range of mine site surfaces reveals a considerable potential for targeted and structured greening of such sites. This effectively 'paves the way' for future site utilisation, provided an appropriate scientific approach is taken to matching appropriate species to sites, as based on detailed ecological knowledge of species selection.

REVEGETATION PROGRAMME

Proposals are being developed for the establishment of a scientifically-coordinated and species-structured, mine site revegetation programme. The focus of the programme is in Cornwall, which has an extensive mining history and current aspirations to achieve successful re-use of at least some of the former mine sites, which are regarded by many as blight on the landscape. Many of

the older mine site areas are now included within the '*Cornwall and West Devon Mining Landscape World Heritage Site*'. In recognition of this, we are not proposing re-disturbing such older sites, aware of both their heritage value and that any artificial re-disturbance would also be counterproductive in re-exposing old toxic sediment layers that time has, to varying degrees, already naturally ameliorated.

In newer sites, however, strategies involve careful site matching of tree species proven to have high tolerance levels, aimed at ultimate landscape greening of some, or potentially many, site areas, to create scientifically-structured biodiversity reserves. To these ends, tree species which are potentially tolerant of specific mine-site habitats are being trialled in an integrated development where academic input based on knowledge of wild plant ecology, is combined with mine ownership and management, which harbours detailed knowledge of the mine sites.

Current research

Our research combines a focus on bioengineered landscape-greening on rocky, low-nutrient, and often initially highly vegetation-hostile terrains, with their follow-up utilisation as well-structured long-term international biodiversity reserves. Such knowledge builds towards understanding of future matching of species with habitat-tolerance potentials, while promoting greening throughout the process.

An integral part of our strategy is to attempt to achieve plantings, wherever possible, on innately low-nutrient habitats without the need for extensive prior artificial site-nutrient enhancement 'amendment' or modification. Former mine sites can offer, through a natural deficiency of fertiliser over-enrichment, a relatively pristine low-nutrient habitat, a key factor to enhancing biodiversity. Low-nutrient status habitats are often suited to establishing rarer plant arrays which require freedom from nutrient excesses, often encountered in surrounding landscapes such as farmlands. A carefully designed, science-based 'tree-to-site-matching' approach aims to identify tree species which have the potential to adapt to typically relatively hostile rock surface terrains. Current research suggests that this property is especially prevalent amongst mostly evergreen gymnospermous tree species, which can also provide pioneering woody, long-term vegetation cover.

We have chosen to trial these species deliberately in locations where previous attempts were made by commercial horticultural companies to plant relatively 'standard' native tree species mixes, and where that strategy failed. This intentionally gives our selective tree-establishment techniques some of the maxima of conditions of site-establishment-hostility to overcome, as an assessment of their minimal likely suitability for wider site application. We are thus not 'doing things the easy way', but instead are taking the most difficult route. Our largest trial to date has been running for seven years and provides a good indication of establishment success. The location is a site where commercial native tree planting achieved a 100% failure rate. Our selected tree planting strategies have so far achieved over 70%

establishment success in a single 'first round' of planting.

Benefits of revegetation

Our pioneering 'terra-greening' enables planting directly into the relatively hostile habitats initially presented by outworked mine site surfaces, with little needing to be added in terms of pre-treatments, achieving long-term land cover and site stabilisation. Wider ranges of species and locational plantings will be gradually developed from this experience. Such future materials, especially as seed resources, can also be returned to the wild, to their original sites of origin, for wild re-forestation of deforested areas. For the successful delivery of revegetation we need:

1. APPROVAL: local approval of long-term re-greening of former mine sites.
2. DESIGNATION: protection of sites used for re-greening programmes.
3. SITE COMMITMENT: well-coordinated joint research involving academia and mine site owners.

Academic/industrial partnership

Academic partners are typically in a good position to provide knowledge about tree species diversity, their wild ecology, site soil and rock chemistry testing, tree-species site-matching and selection of intrinsic ecology to habitat types within mine site availability, and procurement, authentication, and propagation of necessary materials. The mine site owners are in the best position to implement the more applied aspects of site planting, modest site engineering and tree protection, and habitat maintenance as may be locally necessary, onward site security and assurance of permanency of dedication of purpose. Remaining aspects, which includes recording, onward habitat development, variations in trials and plantings resulting

from experience gained, require joint input and revision on the basis of accumulated experience.

Societal and environmental Impact

The revegetation programme will achieve a societal need to redress the presence of such scars on the landscape, in ways which are also likely to achieve public approval. The programme also aims to inspire younger generations who are becoming more strongly environment and biodiversity-aware, and who will be the ultimate inheritors of such achievements. The programme helps to address increasingly urgent environmental issues such as carbon capture, reduction of external impact, and formation of new habitat diversity.

THE FUTURE

This revegetation programme combines gaining important knowledge into bioengineering strategies of terra-greening on to rocky, low-nutrient, and often initially highly vegetation-hostile terrains, with knowledge about site engineering, species matching and resource planning. Once through early establishment phases, where tree-root systems have formed,

it is likely that onward growth progression of trees planted today is strongly assured. Their onward presence should be regarded as an asset for future generations rather than a liability. Such biodiversity reserves then have the potential to rapidly become self-sustaining, and, with adequate site designation, their future is protected.

This programme offers potential for re-greening of mine sites, utilising sites currently of limited use, into future green areas in the landscape, which have wider habitat value, safeguard future genetic resources, act as carbon-sinks and habitat pioneers, and provide renewed purpose for sites currently regarded as scars on the landscape. We are pioneering these studies in the UK, and there is much to be learned about its implementation. Although this integrated programme is developed in Cornwall, the scientifically-founded principles and their application may be, in future, eminently exportable. When properly studied, recorded, and documented, what we are pioneering and achieving today will most likely be regarded as adding to, rather than detracting from, future Heritage Value.



This abandoned quarry typifies the age of mining history in Cornwall

WHY CAN'T WE HAVE GOOD BROADBAND NOW?

Suzanne Clear, Senior Advisor Planning and Rural Affairs, National Farmers' Union

In modern farming, reliable broadband and mobile connectivity is vital to enable farmers and growers to remain competitive and to continue to produce the nation's food.

The National Farmers' Union (NFU) represents 55,000 farmer and grower businesses in England and Wales, who want future-proofed connections to superfast broadband and complete mobile phone coverage.

'Good broadband' according to NFU survey evidence is a service that farmers and growers need to compete and to increase productivity. It is the way to get the information they need from the wide range of technology that will make a difference on their farms. Access to good broadband service will also allow them to enjoy family life.

The NFU has set out a range of solutions as to how this can be achieved in our Spotlight on Farm Broadband and Mobile Networks Document, published in 2016. In 2017, we applied this within the context of the Government's AgriTech and Industrial Strategies.

Broadband delivery is still assessed by Government in terms of potential delivery targets, whilst farmers' ability to do business and prepare for the opportunities and challenges of Brexit, depends on the broadband connection they receive now. To understand actual broadband coverage the NFU surveyed more than 500 members in 2015 and 2016 by

phone with a further 300 responding online to each survey. The respondents provided significant information on their actual connectivity and how this impacts on their businesses.

SPEED

The results confirmed that, by and large, the £1.7billion Government funded superfast broadband programme had not reached farms; they were in the last 5% outside the programme that would not receive funding support. Only 6% of farmers who responded to the NFU survey in 2016 reported that they could achieve 24 megabits per second (Mbps), the speed the Government established for its superfast programme¹. Many more had very poor broadband speeds; only 56% had download speeds of 2Mbps or less and 83% had an upload speed of 2Mbps or less. This is just measuring broadband by speed, there are further issues which will determine 'good broadband' including latency, strength of signal and reliability of coverage in all weathers and locations.

In September 2016, the EU set out ambitious new targets to achieve universal ultrafast broadband coverage (measured at 100 megabits per second by 2025)². In contrast, there is doubt as to whether the UK government can achieve the Digital Economy Act's target of a broadband Universal Service Obligation of 10 Mbps for homes and businesses by 2020. In December 2016, Ofcom



reported that it may cost £49,000 to connect the most remote properties, which may not be offered access to the universal service unless they pay more or accept lower service standards.³ The NFU is concerned that these properties will be predominantly farms, rural businesses and remote rural homes.

We are increasingly reminded that digital service providers cannot connect broadband for all farmers economically; this is despite the opportunities to play a huge part in increasing farm connectivity and improving rural life. The majority of NFU members are still reliant on copper or aluminium wires. Some relied on dial-up services for broadband until they were withdrawn, 6% use satellite.

The message farmers have given us is simple: farmers and rural areas need access to a fully functioning rural broadband market.

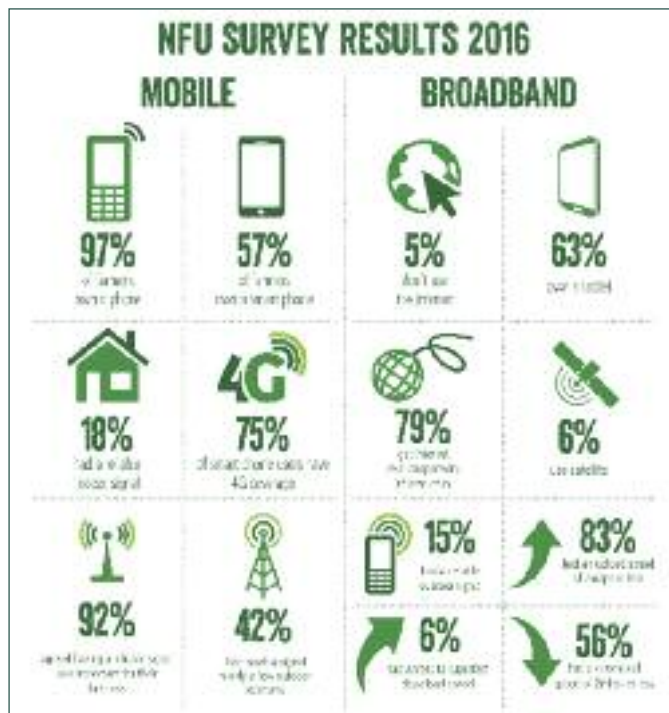
INNOVATORS

Farmers are the innovators who excel at growing an

increasingly wide range of produce under glass; they can manage irrigation through radio technology and host grain store and anaerobic digester plants that are remotely monitored. Farmers have mechanised dairies, virtual fences and animals that wear sensors through which their health is monitored. GPS-controlled tractors are utilising technology to reduce reliance on pesticides and to monitor crop water requirements.

Yet NFU members still report having to write down information, as they don't have a signal to get their information back to the office computer!

Mobile phone connectivity is equally as important to the farmer, and indeed our farm survey in 2016 demonstrated that there had been significant improvements in delivery of 4G in some areas, which farmers quickly embraced. Where opportunities exist, farmers are prepared to be both innovative and hands on to get infrastructure on farm. They have



embraced alternative digital technologies, dug the trenches to lay connections and hosted infrastructure on farm for their own and wider community benefit. When major suppliers approach them they just want a fair land deal.

So, perhaps the more urgent question is 'Why can't we have good broadband now, when we need to compete and to be our most productive?' Here are just a few of the reasons NFU members told us why they needed good broadband, when we surveyed them in 2015 and 2016:

to raise yields; create increased revenue, cut costs; improve record keeping, enable efficient management and reduce wasted time; reduce environmental impact, improve the UK's drive for self-sufficiency; access online applications, ensure farmers can access guidance and comply with regulations and gain detailed access to local and international market information and customers.

There are many more and inability to access regulation to ensure compliance is a particular

concern. Farmers' frustrations were made worse when the Rural Payments Agency went 'online only' in 2015, only to have to revert to paper forms. This move reportedly wasted millions of taxpayer's pounds, not taking into account the impact on farm business.

On the 21st February 2016, the NFU launched *'Feeding the future, four years on: A review of innovation needs for British farming'*⁴. This report identified that there are so many efficiencies that can be gained with better technology. Indeed, farmers identified harnessing the power of recent developments in data and digital technologies, as a key objective for future farming innovation.

We need to make the massive leap from having sub 2Mbps broadband speeds and 15% of farm coverage for mobile to a complete 5G network in a very short amount of time to remain competitive.

The good news is we are not alone in seeing the benefit of digitally connected farms. The House of Lords Science and Technology Committee's report

'Connected and Autonomous Vehicles'⁵ concluded that:

The Government must broaden its focus so that it's work on Connected and Autonomous Vehicles (CAV) cuts across all sectors and does not focus so heavily on road vehicles. Early benefits are likely to come in sectors such as marine and agriculture therefore the Government must not allow media attention around driverless cars to cause it to lose sight of the many potential benefits that CAV can provide in areas outside the roads sector.

So why can't we have good broadband when the Government pushes ahead to online only services, before there is sufficient digital access in place? This is especially relevant when there has not been sufficient policy or fiscal incentives to address rural market failure. Governments can both create problems and also address them, which is why the NFU set out ten ways to help the UK Government help create the best connected country in the World.

THE PROVISION OF GOOD BROADBAND IS LONG OVERDUE.

UK farm businesses and, indeed, rural businesses more generally need access to digital

infrastructure to be able to be progressive, profitable and crucially to be able to compete in future world markets.

Completing geographical coverage for broadband and mobile services has to be a priority. Whilst this is especially relevant for farmers now, it will apply more widely for connected communities in the future, for commuting along roads and railways and using footpaths. Consumers of digital services will require access at all times in a 5G world.

If solutions can be found for farmers now, they will benefit us all in the future.

References

- 1 NFU Spotlight on Farm Broadband and Mobile Networks: One Year on.
- 2 European Commission: Digital Single Market: Digital Economy & Society <https://ec.europa.eu/digital-single-market/en/broadband-europe>
- 3 Ofcom: Designing the broadband universal service obligation - Final report to Government <https://www.ofcom.org.uk/consultations-and-statements/category-1/broadband-iso>
- 4 Feeding the future, four years on: A review of innovation needs for British farming <https://www.nfuonline.com/cross-sector/science-and-technology/research-and-innovation-news/feeding-the-future-four-years-on-a-review-of-innovation-needs-for-british-farming/>
- 5 Science and Technology Committee Connected and Autonomous Vehicles: The future? <https://www.publications.parliament.uk/pa/ld201617/ldselect/ldsctech/115/11502.htm>



COATINGS – THE BASIS OF THE UK'S MANUFACTURING ECONOMY

Trevor Crichton, Science Committee Chair for the Institute of Materials Finishing

In 2015/16 the surface coatings industry contributed an estimated £13.5bn to the UK economy. By improving surface characteristics and performances, it positively impacted products valued at about £173bn, directly adding value to 50% of the UK's £358bn total manufacturing sales.

Ever since tools were first used by hominoids, improvements to their performance have been the bedrock of mankind's technological, economic and social evolution and attributable to the tools' critical outermost surface coatings. Surface coatings are substances applied to another material to change the surface properties¹ resulting in promoting the longer use of engineering and structural components as well as providing reduced environmental impacts. The technologies and processes supporting the surface coating industry are known generically as surface engineering.

SURFACE COATINGS AND THE MANUFACTURING SECTOR

Between 2011 and 2015 the total sales from the UK's manufacturing sector grew by 5%, from £341bn to £358bn². In 2014 the UK's surface coatings business had a turnover of about £11.2bn and represented about 7.8% of the total value of products requiring surface coatings³, but the Institute of Materials Finishing (IMF) now believes that by 2015/16, this had grown by

about 20% to an estimated £13.5bn, giving a total market impact value of £173bn, or 50% of the UK's total manufacturing sales.

The surface coatings market embraces virtually all manufacturing sectors, but is dominated by three sectors - oil and gas, construction and automotive (Figure 1).

The oil and gas industries use a wide variety of coatings that

can both withstand their harsh operating environments and provide maximum reliability to their functional parts; the coatings may also provide specialist intumescent and heat resistant properties.

The construction industry's surface coatings are more based on wet paints, plastics and powder coatings, whilst both the automotive and aerospace industries use virtually the whole range of coating

technologies for component protection and corrosion inhibition. It is estimated that about 60% of the aerospace industry's maintenance costs are due to corrosion⁴.

METAL COATINGS INDUSTRY

In 2014 there were just over 1,300 enterprises in the UK whose main activities were treating and coating metals (SIC 2561). They employed an estimated 21,600 people⁵ with an average employment level of about 17 people, so the industry is dominated by small and medium sized enterprises (SMEs). These enterprises had a gross turnover of about £1.6bn and net sales of about

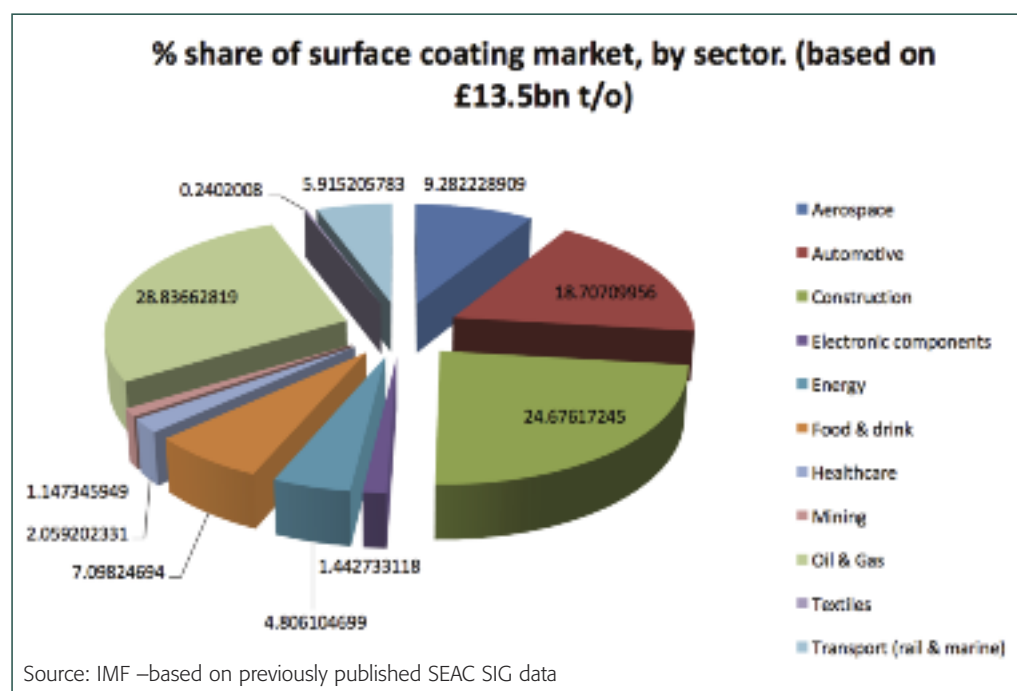


Figure 1: The % share of the surface coating market, by end user.

£1.3bn⁶, but these figures exclude many organisations with in-house facilities that are part of their product manufacturing system.

Metal treatment processes, such as plastic and powder coating, followed by molten metal immersion and wet paint coatings, are used to enhance product performances, resulting in major environmental benefits such as reduced carbon dioxide emissions for both the manufacture and use of the final products. Through correct product specification and design, surface engineering can also facilitate upcycling as well as reuse and recycling of critical materials and natural resources.

There is a need for both fundamental and continual education within the industry, as very few specialist courses are run by UK academic bodies. The IMF offers both professional grades and recognitions, as well as running educational courses from technician level through to Grad.IMF; each year about 140 students enrol on them. These courses are available as either distance or tutored learning and can be tailored to an employer's needs. The Institute also runs specialist bespoke short courses that target a company's specific needs.

CORROSION

It is estimated that corrosion costs the USA 6.2% of GDP⁷, with the majority of costs being in utilities (34.7%) and transport (21.5%)⁸. No comparable data are available for the UK and Europe, but we believe the figures to be similar to the USA. Since 2000, corrosion's avoidable costs have decreased by 10-15%, but 20-25% of these costs remain avoidable⁹, potentially saving the UK £27-35bn annually.

In 2010 the US Department of Defense estimated that

corrosion costs represented about 3.5% of its annual budget; only 9% was within the military infrastructure and facilities and 91% was incurred by the weapons systems and equipment corrosion¹⁰. UK technologies have helped reduce these costs as well as increase the arsenal's reliability by developing self-lubricating coatings that avoid the need for liquid lubrication in handguns. The Department also made inquiries about using similar coatings for parts of the Lockheed F117 Nighthawk "stealth fighter".

SUSTAINABILITY

Appropriate surface coatings are essential for economic and environmental sustainability, as demonstrated with the recent development of new paint technologies for the Forth Bridge in Scotland (Figure 2). For the first time in its 100+ year history, the bridge does not need continual painting and it is estimated that the new paint should last over 20 and possibly up to 40 years.

Without the continual repainting of the bridge, Network Rail believes the bridge could have survived for only 20-30 years¹¹.

IMPACTS OF LEGISLATION

The surface engineering industry faces many challenges, such as health and environmental legislation. The industry has evolved universally through using often hazardous materials and processes that are now facing increased controls, although they can obtain limited exemptions, such as with cadmium, hexavalent chromium, lead and nickel. However, these controls can sometimes, incorrectly, assume that economic and performance-meeting substitutes can be found without creating unwanted secondary effects. For example, the prohibition of lead in solder has contributed to issues with "tin whiskers" for which the surface engineering industry is seeking methods of preventing, or mitigating, their growth (Figure 3), as they can

cause electrical and electronic component failures ranging from heart pacemakers to military missiles and space satellites^{12,13,14}.

The mechanisms of metal whisker growth are not understood, although Loughborough University is actively studying them^{15,16}. Their potential impacts are increased as the electronics sector develops ever smaller components, as although tin whiskers are usually only a few microns in diameter, they can be up to a millimetre or so long; the "world record" is over 25mm¹⁷. They can also potentially and adversely impact the UK's electronic and electrical components manufacturing industry, which includes integrated circuits, semiconductors, passive electronic components and solar panels. This industry has gross sales of about £2bn¹⁸ and supports an industry worth about £80bn¹⁹.

It has been suggested that tin whiskers may also be

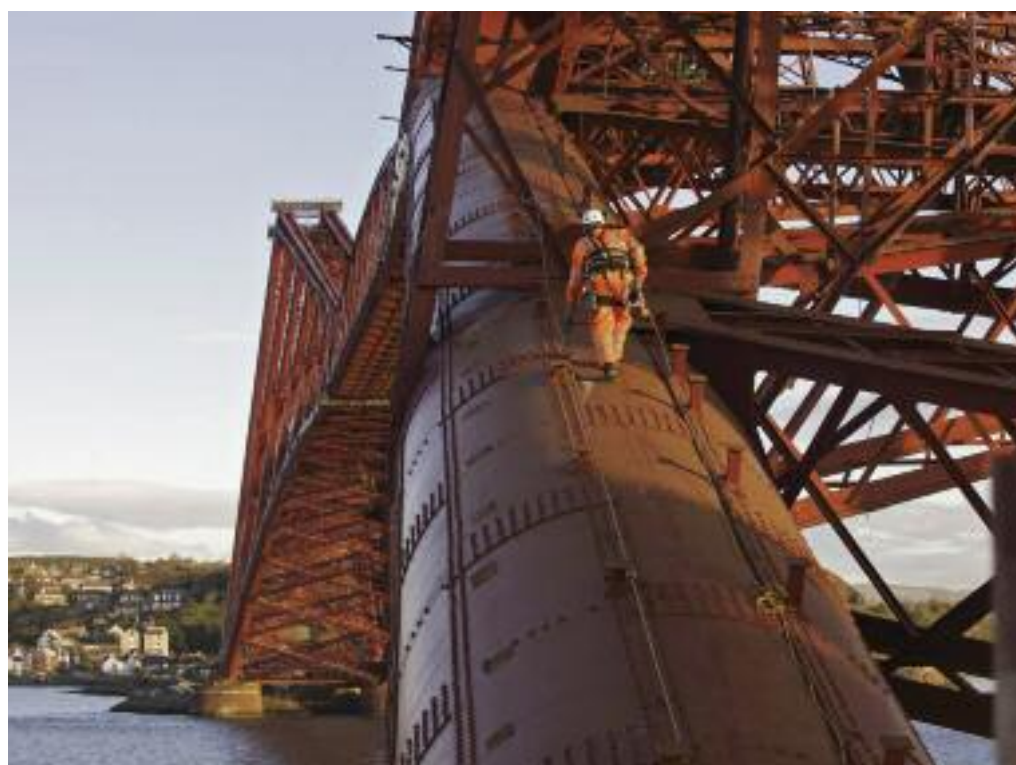


Figure 2: The Forth Rail Bridge Source: www.Networkrailmediacentre.co.uk

responsible for electronic failures in automobiles and could contribute to reduced reliability in consumer electronics²⁰, where 31% fail within 3 years²¹. To mitigate their potential damage, NASA now requires their essential-component solders to contain a minimum of 3% lead²².

FUTURE OPPORTUNITIES

Future quantum leap opportunities in surface

engineering include the development of ionic liquids. These use non-aqueous chemistries and offer exciting opportunities through making possible currently unachievable new coatings and treatments for meeting the increasing performance demands from the aerospace, electronics, energy and automotive sectors; they will also strengthen and mitigate the industry's health, safety and environmental credentials. One

of the world's leaders in this technology is the University of Leicester which is working in conjunction with major industrial partners and funding from EU Framework programmes, InnovateUK and the Royal Society to commercialise this technology.

References

- 1 <http://encyclopedia2.thefreedictionary.com/Surface+coating>
- 2 Office of National Statistics; Prodcom; Intermediate estimates 2015.
- 3 SEAC SIG; "Time for a Strategic Change: UK Surface Engineering and Advanced Coatings Industry"; pub SEAC SIG June 2014
- 4 Prevention and control in corrosion; Colavita, M., Italian Air Force
- 5 Eurostat; Annual detailed enterprise statistics for industry (NACE Rev. 2, B-E) updated 14th December 2016
- 6 Office of National Statistics; Prodcom Intermediate estimates 2015; pub 15th December 2016
- 7 <http://www.g2mtlabs.com/cost-of-corrosion/>
- 8 <http://www.nace.org/uploadedFiles/Publications/ccsupp.pdf>
- 9 Chapter 1; Corrosion: Understanding the Basics; ASM International (www.asminternational.org)
- 10 "The annual cost of corrosion for the DOD"; Herzberg, Eric; 2009
- 11 Private Communication; Network Rail to author 26th July 2017
- 12 <http://www.fda.gov/ICECI/Inspections/InspectionGuides/InspectionTechnicalGuides/ucm072921.htm>;
- 13 <https://www.calce.umd.edu/tin-whiskers/TINWHISKERFAILURES.pdf>
- 14 <https://nepp.nasa.gov/Whisker/background/index.htm>
- 15 NASA "Green Engineering" pub December 2012;
- 16 Osterman, Michael; "Assessment of Tin Whisker Mitigation for Conformally Coated SnPb Assemblies"; Tin Whisker Group Teleconference January 11, 2012.
- 17 Wilcox, Geoff; Private communication February 2017.
- 18 ONS; UK Manufacturing Sales by product Survey (Prodcom) Intermediate estimates 2015.
- 19 ICT; personal communication January 2017
- 20 Osterman, M.; CALCE-EPSC; "Mitigation Strategies for Tin Whiskers"
- 21 <http://www.squaretrade.com/pages/laptop-reliability-1109/>.
- 22 NASA "Standard For JSC Lead free Control Plans (LFCP)"; JSC-66491; pub July 2013

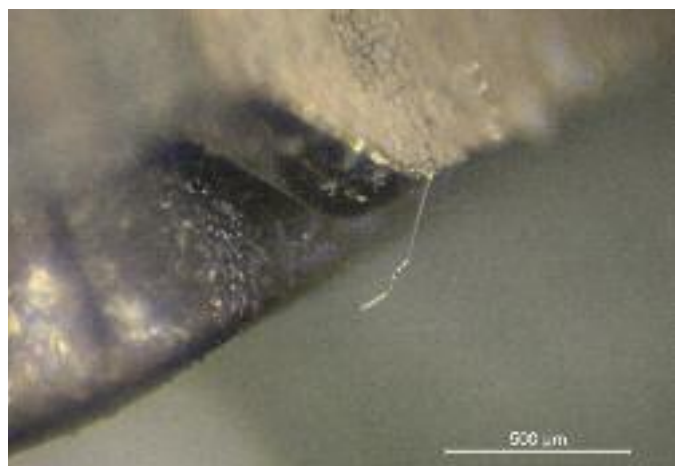


Figure 3: A tin whisker on a SCART connector from a 2009 digital TV recorder. Source: Loughborough University (G Wilcox/ M. Ashworth)

MENTAL HEALTH RESEARCH – THE FUTURE BECKONS



Professor Jeremy Hall
Director of the Neuroscience and
Mental Health Research Institute,
Cardiff University.

MENTAL ILL HEALTH – A NATIONAL EMERGENCY

Mental ill health is a national crisis. Every year one in four people in the UK suffer from a mental health problem, with huge impact on the individual, their family and society. Mental health problems are one of the largest causes of sickness leave from work, accounting for more than 15 million lost working days per year. The total cost of mental health problems to the economy is estimated to be £70-£100 billion per year. Suicide is the leading cause of death amongst young people aged 20-34 in the UK.

Treatments have not significantly advanced for decades and services are massively stretched meaning that many people do not get the support they need. We urgently need to do better.

WHY RESEARCH IS CRITICAL

The fundamental problem that limits our ability to treat mental illness is a lack of adequate understanding of the biological and psychological mechanisms underlying these conditions. Until we understand the causes of a disease or disorder it is extremely hard to improve treatment. This was the case in the rest of

medicine – treatment for diseases like pneumonia and cancer only progressed once we understood their causes. Our understanding of the fundamental causes of mental health problems such as depression, autism and schizophrenia has lagged behind our understanding of conditions like cancer. There is however now real hope as research is beginning to uncover some of the key risk factors for mental illness.

PROGRESS IN UNDERSTANDING RISK

It has long been recognised that both genetic and environmental risk factors

("nature and nurture") can influence mental health. Understanding these risk factors provides a key route to understanding the causes of mental health problems. Many mental health problems run in families and we know from a range of different studies that genetics is important in these conditions. Until recently it has proved very difficult to identify the exact genes involved. However, in the last decade there has been exponential progress in finding the genes for conditions like autism, schizophrenia and bipolar disorder, with the UK playing a significant role in this research. This has been possible through advances in technology (for example DNA sequencing) and major international collaboration. Genetic studies have shown that genes involved in synapses (the connections between nerve cells) as well as genes affecting the brain's immune system and genetic control are important in these conditions. This means we are now beginning to understand the causes of mental disorders, and to identify new targets for treatments.

We also know that environmental factors – including early life events and influences such as stress can also influence risk for mental ill health. Again considerable progress has been made in understanding the relationship between factors such as birth problems, childhood maltreatment and stress and mental health problems. These areas also offer opportunities for novel interventions to prevent mental disorders, be it through psychological treatments, societal changes or new medications.

THE TOOLS TO DEVELOP NEW TREATMENTS

To take forward the promise of this new understanding of risk for mental ill health into better treatments, we need to understand how genetic and environmental factors affect the brain. Studying the brain is however difficult due to both its complexity and inaccessibility. Fortunately, recent advances in neuroscience now make such research possible. In particular, the ability to take peripheral cells (such as a skin sample) from patients and turn them into



brain cells in a dish (so called induced pluripotent stem cell technology) means we can directly study the functions of brain cells from patients. Such cells also provide a new way of testing novel treatments. Advances in brain scanning also mean that we have unprecedented means to investigate the structural, functional and chemical changes in the brain associated with mental health problems. The coincidence of these advances in neuroscience with the greater understanding of risk means that this is a time of enormous opportunity for the development of new treatments for mental disorders.

WHAT WE NEED TO DO NEXT

The UK has great strengths in mental health and neuroscience research, but this is currently distributed across different centres. Mental health research receives only 6% of our national spending on health research, despite the huge burden of these disorders. What we need now is a national strategy to bring together our excellent researchers in these fields and to generate a national programme for mental health research bringing together the diverse expertise required to make progress. Such a strategy could parallel that recently developed for dementia research, and ideally would benefit from close synergies in the study of these important brain disorders. A national strategy for mental health research, allied with appropriate investment, would also provide a strong message to help tackle the stigma that still exists in association with mental disorders, and would provide a platform against which to support and improve our mental health services. Finally, given the huge unmet need in mental health and the great opportunity for advances in treating a range of brain disorders, a clear national programme of research in this area in the UK will provide an important basis for ongoing industrial investment in our health sector.





PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (POST)

NEWS FROM POST

The last few months at POST have seen a number of changes. On the staff front, Chris Tyler has left to be Head of Public Policy at the University College London's Science, Technology, Engineering and Public Policy (STeAPP) department, while Chandrika Nath takes over as acting Head of POST. Aaron Goater has been seconded to the Committee on Climate Change and we welcome Jack Miller as our new energy adviser. Sarah Foxen joins us as a social science adviser focusing particularly on academic engagement.

A new Parliament means a new Board for us. The POST Board oversees our work programme, and comprises members of both Houses (four Peers and ten MPs) as well as four external scientists and four ex-officio members. We are delighted that Lord Winston, Lord Oxburgh and Lord Haskel will remain on our Board. The Earl of Selbourne has stepped down as chair of the Lords Science and Technology Committee and so we welcome Lord Patel, the Committee's new chair, to our Board. Work is underway to confirm Commons appointments and we hope to have membership finalised in time for our first meeting in October.

We also welcome Bernard Silverman (former Chief Scientific Adviser to the Home Office), who replaces Sir David Davies as an external board member.

We sincerely thank both the Earl of Selbourne and Sir David Davies for their support and contributions to POST.

On the research front, we have also been busy. Since March we've published nine POSTnotes and three POSTbriefs, the details of which are below. There are a number of new briefings due for publication when the House returns in September: Clinical Trials Regulation in the UK, Risk Assessment for Nanoparticles, Research and Gambling, Regulating Advanced Therapies, Benefits of Earth Observation, Alternative Gases for UK Heating, Risk Assessment of Nanoparticles and Communicating Risk.

RECENT POSTNOTES

Quantum Technologies

April 2017

POSTnote 552

Quantum Technologies use the behaviour of matter and light that is normally only observed at very small scales. This POSTnote introduces recent advances, applications, and UK initiatives to support their development and commercialisation. It also reviews policy concerns such as privacy, access to new technologies and secure communications.

Global Health Inequalities

May 2017

POSTnote 553

This POSTnote reviews trends in global health inequalities in the context of the transition from the Millennium Development Goals to Sustainable Development Goals.

Cyber Security of UK Infrastructure

May 2017

POSTnote 554

The Government has identified 'cyber' as one of six Tier 1 threats to UK national security. This POSTnote focuses on the cyber security of the UK's critical national infrastructure, describing measures to improve cyber security and challenges in implementing them. It also reviews the new National Cyber Security Strategy, along with international policy and legislation.

Rising Sea Levels

June 2017

POSTnote 555

Sea level rise increases the frequency and severity of coastal flooding and rates of coastal erosion. Sea level rise will continue far beyond the 21st century, even if global temperature increase is limited to 2°C above pre-industrial levels. This POSTnote sets out the causes and likely future levels of sea level rise and its implications. It updates POSTnote 363 on Sea Level Rise, published in September 2010.

Security of UK Food Supply

July 2017

POSTnote 556

This note outlines current UK trade in food and animal feed, examines the challenges raised to the security of UK food supply by withdrawal from the EU and analyses the policy options available for improving UK food security.

Environmentally Sustainable Agriculture

July 2017

POSTnote 557

Agricultural practices can reduce water quality, degrade soils and cause biodiversity loss. This in turn can disrupt natural processes that support food production. Environmentally sustainable agriculture seeks to reduce environmental damage and restore such processes. This POSTnote summarises associated land management options, agricultural policies and the constraints imposed by a new trading environment.

Supply of Medical Isotopes

July 2017

POSTnote 558

This POSTnote highlights the critical role of radioactive isotopes used in medicine, and outlines the challenges for the UK in ensuring their future supply.

Online Information and Fake News

July 2017

POSTnote 559

Internet search engines and social media platforms are an increasingly popular way of accessing news and information. In 2017, the proportion of UK adults consuming news online exceeded those who watched news on TV (74% versus 69%). This note considers how people access news online, how algorithms (sequences of instructions) and social networks influence the content that users see, and options for mitigating any negative impact.

Migrants and Housing

August 2017

POSTnote 560

Migration is often cited in public debate as a significant factor in the demand for UK housing. This POSTnote provides an overview of available research on migrants and housing. It examines definitions and data sources on migration and its implications. It also outlines the possible impact of migrants on housing, including variation by tenure type, migrant characteristics and region. Finally, it considers the impact of housing on migrants and local communities.



HOUSE OF COMMONS SELECT COMMITTEES SEPTEMBER 2017

Following the General Election in June 2017, the House of Commons Select Committees have been re-forming in the new Parliament. At time of publication, most of the Committees have elected a Chair but had not elected other members of the Committee. Details of Committees with relevance to Parliamentary and Scientific Committee Members are shown below. Further details of membership of House of Commons Select Committees and their inquiries can be found at <http://www.parliament.uk/business/committees/>

BUSINESS, ENERGY AND INDUSTRIAL STRATEGY COMMITTEE

The Business, Energy and Industrial Strategy Committee is appointed by the House of Commons to examine the administration, expenditure and policy of the Department for Business, Energy and Industrial Strategy (BEIS) and its associated public bodies.

The BEIS Committee is chaired by Rachel Reeves MP.

Contact: Business, Energy and Industrial Strategy Committee, House of Commons, London SW1A 0AA Telephone: 020 7219 5777

Email: beiscom@parliament.uk

EDUCATION COMMITTEE

The Education Committee monitors the policy, administration and spending of the Department for Education and its associated arms length bodies, including Ofsted. The Committee is an investigative Committee rather than a legislative Committee: it sets its own programme and chooses subjects for inquiries.

The Committee's Chair is Rt Hon. Robert Halfon MP.

Contact: Education Committee, House of Commons, London SW1A 0AA Telephone: 020 7219 1376 Email: educum@parliament.uk

ENVIRONMENT, FOOD AND RURAL AFFAIRS COMMITTEE

The Environment, Food and Rural Affairs Committee (EFRA) is appointed by the House of Commons to examine the expenditure, administration and policy of the Department for Environment, Food and Rural Affairs (Defra) and its associated public bodies. The

Committee chooses its own subjects of inquiry on environmental, agricultural subjects.

Following the 2017 General Election, Neil Parish MP was re-elected as Chair of the EFRA Committee.

Contact: Environment, Food and Rural Affairs Select Committee House of Commons, London, SW1A 0AA Telephone: 020 7219 7341

Email: efracom@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.

The Chair of the Environmental Audit Select Committee is Mary Creagh MP.

Contact: Environmental Audit Committee, House of Commons, London SW1A 0AA Telephone: 020 7219 5776 Email: eacom@parliament.uk

EXITING THE EUROPEAN UNION COMMITTEE

The Exiting the European Union Committee is appointed by the House of Commons to examine the expenditure, administration and policy of the Department for Exiting the European Union and matters falling within the responsibilities of associated public bodies.

Following nominations and elections among MPs, Rt Hon Hilary

Benn MP was re-elected Chair of the committee for the 2017 Parliament.

HEALTH COMMITTEE

The Health Committee is appointed by the House of Commons to examine the policy, administration and expenditure of the Department of Health and its associated bodies. The Committee chooses its own subjects of inquiry.

Dr Sarah Wollaston MP has been re-elected as Chair of the Health Committee for the 2017 Parliament.

Contact: Health Committee, House of Commons, London SW1A 0AA Telephone: 020 7219 6182 Email: healthcom@parliament.uk

SCIENCE AND TECHNOLOGY COMMITTEE

The Science and Technology Committee exists to ensure that Government policy and decision-making are based on good scientific and engineering advice and evidence. The Science and Technology Committee is unusual amongst departmental select committees in that it scrutinises the Government Office for Science (GO-Science), which is a "semiautonomous organisation" based within the Department for Business, Energy and Industrial Strategy.

GO-Science "supports the Government Chief Scientific Adviser and works to ensure that Government policy and decision-making is underpinned by robust scientific evidence". The committee therefore has a similarly broad remit and can examine the activities of departments where they have implications for, or made use of, science, engineering, technology and research.

Rt Hon Norman Lamb MP was elected as Chair of the Science and Technology Committee on 12 July 2017.

Contact: Science and Technology Committee House of Commons, London SW1A 0AA Telephone: 020 7219 2793 Fax: 020 7219 0896 Email: scitechcom@parliament.uk

TRANSPORT COMMITTEE

The Transport Committee is charged by the House of Commons with scrutiny of the Department for Transport. Its formal remit is to examine the expenditure, administration and policy of the Department of Transport and its associated public bodies.

Lilian Greenwood MP was elected as Chair of the Transport Committee on 12 July 2017.

Contact: Transport Committee, House of Commons, London SW1A 0AA Telephone: 020 7219 3266 Email: transcom@parliament.uk Twitter: @CommonsTrans



HOUSE OF LORDS SELECT COMMITTEES SEPTEMBER 2017

This article provides details of House of Lords Select Committees with relevance to the interests of the Parliamentary and Scientific Committee.

ARTIFICIAL INTELLIGENCE COMMITTEE

The Select Committee on Artificial Intelligence was appointed on 29 June 2017 to consider the economic, ethical and social implications of advances in artificial intelligence, and to make recommendations. The Committee was established following the recommendation of the Liaison Committee. It will report by 31 March 2018.

The Committee is Chaired by Lord Clement-Jones.

The focus of the Committee's inquiry will include:

- The current state of artificial intelligence
- The pace of technological change and the development of artificial intelligence
- The impact of artificial intelligence on society
- The public perception of artificial intelligence
- The sectors most, and least likely, to benefit from artificial intelligence
- The data-based monopolies of some large corporations

- The ethical implications of artificial intelligence
- The role of the Government and
- The work of other countries or international organisations.

The deadline for submitting evidence is 6 September 2017.

Contact: Select Committee on Artificial Intelligence, House of Lords, London, SW1A 0PW Telephone: 020 7219 4384 Fax: 020 7219 4931 Email: HLAIAHoc@parliament.uk

EU ENERGY AND ENVIRONMENT SUB-COMMITTEE

The EU Energy and Environment Sub-committee is a sub-committee of the EU Committee. The Sub-Committee focuses on a range of policy areas related to agriculture, fisheries, environment and energy. Attention is given to agricultural issues, particularly legislation relating to the Common Agricultural Policy (CAP) and animal health and welfare issues. The Common Fisheries Policy (CFP) and wider environmental issues are also examined, as are policies relating to energy and climate change.

The Committee is Chaired by Lord Teverson.

INQUIRY: Brexit: energy security inquiry

The EU Energy and Environment Sub-Committee is conducting a short inquiry to examine the implications of Brexit for energy security in the UK. The inquiry aims to highlight the issues the Government will need to consider when developing a new energy relationship with the EU.

Contact: EU Energy and Environment Sub-Committee, House of Lords, London SW1A 0PW Telephone: 0207 219 3015, Fax: 0207 219 6715

SCIENCE AND TECHNOLOGY COMMITTEE

The Science and Technology Committee has a broad remit “to consider science and technology”. It 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.

The Chair of the Committee is Lord Patel.

INQUIRY: Life Sciences and the Industrial Strategy

The Government set out in its Industrial Strategy Green Paper its intention to create a new Life Sciences strategy to make the UK the best place in the world to invest in life sciences. To tackle challenges like cancer and dementia it is important that the UK has a strong life sciences sector. But the sector faces a number of challenges and opportunities, including Brexit and making innovative new treatments available on the NHS.

This inquiry will investigate issues such as whether the Government has the necessary structures in place to support the life sciences sector; how the NHS can use procurement to stimulate innovation in the life sciences; and the content of the new Life Sciences industrial strategy, when published.

The Committee is inviting written evidence on the issue, to be received by Friday 15 September 2017, and will start taking oral evidence on the inquiry in October.

Contact: Science and Technology Select Committee, Committee Office, House of Lords, London SW1A 0PW Telephone: 020 7219 5750 Fax: 020 7219 4931 Email: hls-science@parliament.uk

Research Councils UK

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Each year the Research Councils invest around £3 billion in research covering the full spectrum of academic disciplines from the medical and biological sciences to astronomy, physics, chemistry and engineering, social sciences, economics, environmental sciences and the arts and humanities.

Research Councils UK is the strategic partnerships of the seven Research Councils. It aims to:

- increase the collective visibility, leadership and influence of the Research Councils for the benefit of the UK;
- lead in shaping the overall portfolio of research funded by the Research Councils to maximise the excellence and impact of UK research, and help to ensure that the UK gets the best value for money from its investment;
- ensure joined-up operations between the Research Councils to achieve its goals and improve services to the communities it sponsors and works with.

Biotechnology and Biological Sciences Research Council (BBSRC)



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BBSRC invests in world-class bioscience research, innovation and training on behalf of the UK public. Our aim is to further scientific knowledge to promote economic growth, wealth and job creation and to improve quality of life in the UK and beyond. BBSRC research is helping society to meet major challenges, including food security, green energy and healthier lifespans and underpins important UK economic sectors, such as farming, food, industrial biotechnology and pharmaceuticals.

Economic and Social Research Council



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The ESRC is the UK's largest organisation for funding research on economic and social issues and is committed to supporting the very best research with wide-ranging impact. Social science contributes to greater knowledge and understanding of the many challenges our society faces today and by ensuring that ESRC-funded research makes the biggest possible impact, our research shapes public policies and makes business, voluntary bodies and other organisations more effective, as well as shaping wider society. We also develop and train the UK's future social scientists.



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EPSRC is the UK's main agency for funding research and training in engineering and physical sciences, investing around £800m a year in research and postgraduate training, to help the nation handle the next generation of technological change.

The areas covered range from information technology to structural engineering, and mathematics to materials science. This research forms the basis for future economic development in the UK and improvements for everyone's health, lifestyle and culture. EPSRC works alongside other Research Councils with responsibility for other areas of research.

Medical Research Council



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Over the past century, the MRC has been at the forefront of scientific discovery to improve human health. Founded in 1913 to tackle tuberculosis, the MRC now invests taxpayers' money in the highest quality medical research across every area of health. Thirty-one MRC-funded researchers have won Nobel prizes in a wide range of disciplines, and MRC scientists have been behind such diverse discoveries as vitamins, the structure of DNA and the link between smoking and cancer, as well as achievements such as pioneering the use of randomised controlled trials, the invention of MRI scanning, and the development of therapeutic antibodies. We also work closely with the UK's Health Departments, the NHS, medical research charities and industry to ensure our research achieves maximum impact as well as being of excellent scientific quality.

Natural Environment Research Council



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NERC is the UK's leading public funder of environmental science. We invest £330 million each year in cutting-edge research, postgraduate training and innovation in universities and research centres.

Our scientists study the physical, chemical and biological processes on which our planet and life itself depends – from pole to pole, from the deep Earth and oceans to the atmosphere and space.

We partner with business, government, the public and the wider research community to shape the environmental research and innovation agenda. Our science provides knowledge, skills and technology that deliver sustainable economic growth and public wellbeing.



Science & Technology Facilities Council

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The Science and Technology Facilities Council is one of Europe's largest multidisciplinary research organisations undertaking and supporting a broad range of research across the physical, life and computational sciences. We operate world class, large-scale research facilities in the UK and Europe and provide strategic advice to the UK Government on their development. We partner in two of the UK's Science and Innovation Campuses. We also manage international research projects in support of a broad cross-section of the UK research community, particularly in the fields of astronomy, nuclear physics and particle physics.

Association of the British Pharmaceutical Industry



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The Association of the British Pharmaceutical Industry (ABPI) represents innovative research-based biopharmaceutical companies, large, medium and small, leading an exciting new era of biosciences in the UK. Our industry, a major contributor to the economy of the UK, brings life-saving and life-enhancing medicines to patients. Our members are researching and developing over two-thirds of the current medicines pipeline, ensuring that the UK remains at the forefront of helping patients prevent and overcome diseases. Topics we focus on include:

- All aspects of the research and development of medicines including clinical research and licensing
- Stratified medicine
- Vaccines, biosimilars, small and large molecules, cell therapy and regenerative medicine



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AIRTO – Association of Innovation, Research & Technology Organisations – is the foremost membership body for the UK's innovation, research and technology sector, representing 80% of organisations in the sector.

AIRTO's members deliver vital innovation and knowledge transfer services which include applied and collaborative R&D, (frequently in conjunction with universities), consultancy, technology validation and testing, incubation of commercialisation opportunities and early stage financing. AIRTO members have a combined turnover of over £5.5bn from clients both at home and outside the UK, and employ over 47,000 scientists, technologists and engineers.

AMP's

The Association of Management and Professional Staff

Contact:
Tony Harding
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.



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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.



British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

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British Antarctic Survey (BAS), an institute of NERC, delivers and enables world-leading interdisciplinary research in the Polar Regions. Its skilled science and support staff based in Cambridge, Antarctica and the Arctic, work together to deliver research that uses the Polar Regions to advance our understanding of Earth as a sustainable planet. Through its extensive logistic capability and know-how BAS facilitates access for the British and international science community to the UK polar research operation. Numerous national and international collaborations, combined with an excellent infrastructure help sustain a world leading position for the UK in Antarctic affairs. For more information visit www.bas.ac.uk @basnews



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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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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.



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The British Nutrition Foundation (BNF), a registered charity, delivers impartial, authoritative and evidence-based information on food and nutrition. Its core purpose is to make nutrition science accessible to all, working with an extensive network of contacts across academia, education and the food chain, and through BNF work programmes focussing on education in schools and nutrition science communication.



**BRITISH
PHARMACOLOGICAL
SOCIETY**

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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.



**BRITISH
SOCIETY
OF SOIL
SCIENCE**

Contact: Ian Brown
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Bedfordshire
United Kingdom

The British Society of Soil Science (BSSS) or "BS cubed" as it is fondly known was founded in 1947 by a number of eminent British soil scientists. It was formed with the aims: to advance the study of soil; to be open to membership from all those with an interest in the study and uses of soil; and to issue an annual publication.



**The British Society for
Antimicrobial Chemotherapy**

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www.bsac.org.uk | www.antibiotic-action.com
www.e-opat.com | www.nas-pps.com
lwww.appg-on-antibiotics.com
www.bsacsurv.org

The BSAC is an inter-professional organisation with over forty years of experience and achievement in antibiotic education, research and leadership. The Society has an active international membership and:

- Is dedicated to saving lives through the effective use and development of antibiotics, now and in the future.
- Communicates effectively about antibiotics and antibiotic usage via workshops, professional guidelines and its own high impact international journal, the Journal of Antimicrobial Chemotherapy.
- Is home to the UK-led global initiative Antibiotic Action
- Serves as secretariat to the All Party Parliamentary Group on Antibiotics



**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.

**British Society for
immunology**

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The BSI is one of the oldest, largest and most active immunology societies in the world. We have over 5,000 members who work in all areas of immunology, including research and clinical practice.

The BSI runs major scientific meetings, education programmes and events for all ages. We disseminate top quality scientific research through our journals and meetings and we are committed to bringing the wonders and achievements of immunology to as many audiences as possible.

**Cavendish
Laboratory**



**UNIVERSITY OF
CAMBRIDGE**

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http://www.phy.cam.ac.uk

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

The research programme covers the breadth of contemporary physics

Extreme Universe: Astrophysics, cosmology and high energy physics

Quantum Universe: Cold atoms, condensed matter theory, scientific computing, quantum matter and semiconductor physics

Materials Universe: Optoelectronics, nanophotonics, detector physics, thin film magnetism, surface physics and the Winton programme for the physics of sustainability

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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Ergonomics, also called Human Factors, sometimes abbreviated 'E/HF' is a science-based discipline about 'designing for people'. E/HF takes into account the physical and mental capabilities, aptitudes and abilities of people acting individually (a pilot, a surgeon or nurse, train driver) or collectively, with or without equipment (a theatre team, air traffic control) in the design of workplaces, equipment and ways of working to deliver the least harmful, safest, most efficient, most elegant possible outcomes'. E/HF uses science to improve the places in which we work, live and relax and the ways in which we interact with people, equipment and systems.



ctpa

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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**

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**Science for Citizenship and Employability,
Science for Life, Science for Real**

We build grass-roots partnerships between school and the wider world of professional science and its applications

- for young people of all ages and abilities
 - experiencing science as a creative, questioning, human activity
 - bringing school science added meaning and motivation, from primary to post-16
 - locally, nationally, internationally (currently between Britain and Japan; also the Ukraine)
- Clifton Scientific Trust Ltd is registered charity 1086933



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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



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The Energy Institute (EI) is the chartered professional body for the energy sector, supporting over 22,000 individuals and 200 companies worldwide. The EI provides learning and networking opportunities, professional recognition and technical and scientific knowledge resources on energy in all its forms and applications.

The EI's purpose is to develop and disseminate knowledge, skills and good practice towards a safe, secure and sustainable energy system. It addresses the depth and breadth of the energy sector and informs policy by providing a platform for debate and scientifically-sound information.

A registered charity, the EI serves society with independence, professionalism and a wealth of expertise in all energy matters.



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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, agricultural 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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Website: www.firstgroup.com

FirstGroup are the leading transport operator in the UK and North America and each day, every one of our 110,000 employees works hard to deliver vitally important services for our passengers. During the last year around 2.2 billion passengers relied on us to get to work, to school or college, to visit family and friends, and much more.



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GAMBICA Association is the UK trade association for instrumentation, control, automation and laboratory technology. The association seeks to promote the successful development of the industry and assist its member companies through a broad range of services, including technical policy and standards, commercial issues, market data and export services.



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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.



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IFST is the independent qualifying body for food professionals in Europe. Membership is drawn from all over the world from backgrounds including industry, universities, government, research and development and food law enforcement.

IFST's activities focus on disseminating knowledge relating to food science and technology and promoting its application. Another important element of our work is to promote and uphold standards amongst food professionals.



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IKE is the UK's professional body for innovators. It accredits and certifies 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.

Institute of Measurement and Control



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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 is a leading scientific membership society working to advance physics for the benefit of all. We have a worldwide membership from enthusiastic amateurs to those at the top of their fields in academia, business, education and government. Our purpose is to gather, inspire, guide, represent and celebrate all who share a passion for physics. And, in our role as a charity, we're here to ensure that physics delivers on its exceptional potential to benefit society.

Alongside professional support for our members, we engage with policymakers and the public to increase awareness and understanding of the value that physics holds for all of us. Our subsidiary company, IOP Publishing, is a world leader in scientific communications, publishing journals, ebooks, magazines and websites globally.



Institute of Physics and Engineering in Medicine

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IPEM is a registered, incorporated charity for the advancement, in the public interest, of physics and engineering applied to medicine and biology. Its members are medical physicists, clinical and bio-engineers, and clinical technologists. It organises training and CPD for them, and provides opportunities for the dissemination of knowledge through 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.



The Institution of Chemical Engineers

With over 44,000 members in 120 countries, IChemE is the global membership organisation for chemical engineers. A not for profit organisation, we serve the public interest by building and sustaining an active professional community and promoting the development, understanding and application of chemical engineering worldwide.

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

Institution of Civil Engineers



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Established in 1818 and with over 86,000 members in 167 countries worldwide, ICE is a leading source of expertise in infrastructure and engineering policy and is widely seen as the independent voice of infrastructure. ICE provides advice to all political parties and works with industry to ensure that civil engineering and construction remain major contributors to the UK economy.

Institution of Engineering Designers



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The only professional membership body solely for those working in engineering and technological product design. Engineering Council and Chartered Environmentalist registration for suitably qualified members. Membership includes experts on a wide range of engineering and product design disciplines, all of whom practise, manage or educate in design. **New for 2015: Chartership for Product Designers (CTPD).**



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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.



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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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LGC is an international science-based company and market leader in the provision of analytical, forensic and diagnostic services and reference standards to customers in the public and private sectors.

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 chemistry for matters of policy, standards and regulation. LGC is also the UK's designated National Measurement Institute for chemical and biochemical analysis.

With headquarters in Teddington, South West London, LGC has 36 laboratories and centres across Europe and at sites in China, Brazil, India, South Africa and the US.



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As the world's oldest biological society, the Linnean Society of London is an essential forum and meeting point for those interested in natural history. The Society holds regular public events, publishes three peer-reviewed journals, promotes the study of the natural world with several educational initiatives and 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



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L'Oréal employs more than 3,800 researchers world-wide and dedicates over €850 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.

Marine Biological Association



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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.



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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 the largest learned microbiological society in Europe with a worldwide membership based in universities, industry, hospitals, research institutes and schools. The Society publishes key academic journals, organises international scientific conferences and provides an international forum for communication among microbiologists. The Society promotes the understanding of microbiology to a diverse range of stakeholders, including policy-makers, students, teachers, journalists and the wider public, through a comprehensive framework of communication activities and resources.



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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.



Advancing the science of nature

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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.



**The University of
Nottingham**

UNITED KINGDOM • CHINA • MALAYSIA

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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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Prospect is an independent, thriving and forward-looking trade union with 117,000 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.



**ROYAL
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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.

PHARMAQ

PHARMAQ Ltd

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PHARMAQ is the only global pharmaceutical company with a primary focus on aquaculture. Our mission is to provide environmentally sound, safe and efficacious health products to the global aquaculture industry through targeted research and the commitment of dedicated people. We have a product portfolio that includes over 20 fish vaccines along with specialist feed additives, anaesthetics, antibiotics, sea lice treatments and biocide disinfectants. Through our sister company, PHARMAQ Analytiq, we also offer a range of diagnostics services that can be used to help safeguard fish welfare and improve productivity.



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The Rainbow Seed Fund is a £24m, early-stage venture capital fund dedicated to kick-starting promising technology companies emerging from the UK science base. The Fund is backed by ten UK publicly-funded research organisations and the Department of Business, Innovation and Skills and holds investments in some of the UK's most innovative companies in areas as diverse as novel antibiotics, research into Alzheimer's disease, "green" chemicals and airport security. The Fund is managed by Midven, a specialist venture capital company. We are prepared to invest early and help build a proposition to attract additional investment and get to market.



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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
Physiological
Society**

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Physiology is the science of how molecules, cells and organs work in the body. Representing over 3500 life scientists, The Physiological Society supports scientific research through its grants schemes, conferences and its three open access journals.

The Society also supports the teaching of physiology in schools and universities, and works to promote an understanding of physiology amongst policy-makers and the general public.



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Risk Solutions helps our clients make better decisions in a complex and uncertain world.

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- training, coaching and guidance.



**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.

THE ROYAL SOCIETY

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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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SfAM is a UK organization, serving microbiologists internationally. It works to advance, for the benefit of the public, the science of microbiology in its application to the environment, human and animal health, agriculture, and industry. With Wiley-Blackwell, SfAM publishes five internationally acclaimed journals. Value for money and a modern, innovative and progressive outlook are its core principles. A friendly society, SfAM values integrity, honesty, and respect, and seeks to promote excellence and professionalism and to inspire young microbiologists.

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.



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The Society of Maritime Industries (SMI) is the voice of the UK's maritime engineering and business sector promoting and supporting companies which design, build, refit and modernise ships, and supply equipment and services for all types of commercial and naval ships, ports and terminals infrastructure, offshore oil and gas, maritime security and safety, marine science and technology, maritime autonomous systems and marine renewable energy.



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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



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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.



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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

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Tuesday 10 October 2017, 5:30pm

Discussion meeting followed by drinks reception

Science and Brexit

Held in partnership with the Confederation of British Industry, Royal Society and Universities UK

Tuesday 14 November 2017, 10:00am

Discussion Meeting

Data

Tuesday 21 November 2017, 12:30pm

Parliamentary and Scientific Committee

Annual Lunch

Monday 4 December 2017, 5:30pm

Discussion Meeting:

Science and Food Manufacturing

ROYAL SOCIETY OF BIOLOGY

11 October 2017 19:00-22:00 |

Biology Week: Parliamentary Reception
Churchill Room, Houses of Parliament
SW1A 0AA
https://www.rsb.org.uk/events?event_id=1905

6 December 2017 19:00-22:00 |

Christmas Parliamentary Reception (for science and engineering)
Churchill Room, Houses of Parliament
SW1A 0AA
https://www.rsb.org.uk/events?event_id=1906

25 April 2018 19:00-22:00 |

Royal Society of Biology Accreditation Award Ceremony
Terrace Pavilion, Houses of Parliament
SW1A 0AA
https://www.rsb.org.uk/events?event_id=1911

26 (TBC) June 2018 10:00-12:30 |

Parliamentary Links Day
The Attlee Suite, Portcullis House, Houses of Parliament, London SW1A 2LW

Please contact Karen Patel and Stephen Benn at events@rsb.org.uk for more details.

THE ROYAL SOCIETY

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

For scientific meetings queries:
scientific.meetings@royalsociety.org

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Published by Parliamentary and Scientific Committee, 3 Birdcage Walk, London SW1H 9JJ. Published four times a year. The 2017 subscription rate is £80. Single numbers £20. ISSN 0263-6271

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Rt Hon Norman Lamb MP and Stephen Metcalfe MP

Carol Monaghan MP and Chi Onwurah MP

invite you to attend a Parliamentary Reception to celebrate

Biology Week

Wednesday 11 October 2017, 19:00 - 22:00

The Churchill Room, House of Commons, London SW1A 0AA

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