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# The value of diagnostics: Using IVD's can make a difference in reducing antibiotic resistance

Seventy percent of clinical decisions are based on an *in vitro* diagnostic (IVD) test. These have an increasing role to play to deliver cost effective healthcare and improve outcomes for patients.

The use of IVDs can significantly support the reduction of antibiotic resistance by:

- Supporting antibiotic stewardship
- Differentiating between bacterial and viral infection
- Rapidly identifying cause of infection to allow targeted antibiotic usage
- Monitoring infection levels during treatment



## About BIVDA

BIVDA is the national industry association for the manufacturers and distributors of IVD products in the UK. We currently represent more than 90% of the industry and over a hundred organisations ranging from British start-up companies to UK subsidiaries of multinational corporations. BIVDA members employ over 8,000 people in this country including in manufacturing and R&D, with a total industry turnover of approximately £900 million of direct sales.

Please don't hesitate to contact the Chief Executive, Doris-Ann Williams if you would like any further information about any of the aspects of this issue or about *in vitro* diagnostics in general. She is always more than willing to visit you in Westminster.

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Lord Oxburgh KBE FRS  
President, Parliamentary and  
Scientific Committee

It is a rare privilege to be allowed to write the Chairman's Editorial, but as I write, we have no Chairman - until our AGM on 16th June. After this we will know the name of the P&SC chair.

When Parliament is dissolved as happened at the end of March, many good things came to an end including all All Party Parliamentary Groups (of which there are more than 600!).

Happily, once the House of Commons reappears, the phoenix of all the APPGs will arise.

I am therefore delighted to be holding the fort pro tem.

This also gives me an opportunity to comment on one of the differences between the two Houses.

The paucity of scientists in the Commons has often been commented upon. This is exaggerated. There may only have been one PhD scientist in the last Parliament, but there were many more with first degrees in science.

The Lords of course are different because a dozen or so were appointed specifically because of their previous scientific careers.

Interestingly both Houses tackled an important topic recently – that of mitochondrial

transfer – and both went with the science. That is not to downplay the ethical issues which attach to human reproduction, but all the relevant issues were well aired. Once again the UK has shown the way in the application of science to increasing human health and happiness.

As I write, ministerial appointments are being announced by the new Government. We are watching closely for the appointment of a Minister for Science. We shall seek to have him speak to us at an early date. We shall see.



The Journal of the Parliamentary and Scientific Committee.

*The Committee is an Associate 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

## NATIONAL SPACE CENTRE

Chas Bishop

## THE WORLD NEEDS SCIENCE AND SCIENCE NEEDS WOMEN

Professor Dame Carol Robinson

## THE LONDON MATHEMATICAL SOCIETY: CELEBRATING 150 YEARS OF MATHEMATICS

## THE UNIVERSITY OF NOTTINGHAM ENTERPRISE ZONE

Professor Chris Rudd

## WHY SCIENCE IS IN THE DIPLOMATIC TOOL KIT

Professor Robin Grimes and Dr Emma Hennessey

## KEW LAUNCHES NEW SCIENCE STRATEGY

Professor Katherine Willis

## DEVELOPING A CIRCULAR ECONOMY

Jacob Hayler

## THE FUTURE OF LIFE SCIENCES IN THE UK

Addresses to the P&SC by Doris-Ann Williams and Dr Malcolm Skingle

## 2 DEVELOPING LOW-FIELD NMR SPECTROSCOPY FOR TACKLING FOOD FRAUD

Dr Kate Kemsley and Dr David Williamson

## 4 SUPPORTING TECHNOLOGICAL INNOVATION IN BRITISH INDUSTRY

Nigel Williams

## 6 THE ACOUSTIC DESIGN OF SCHOOLS

Professor Bridget Shield

## 8 SET FOR BRITAIN 2015

## VOICE OF THE FUTURE 2015

## 10 A SCIENCE LEGACY FOR THE NEXT PARLIAMENT

Addresses to the P&SC by Baroness Finlay and Andrew Miller MP

## 14 LIGHT

Addresses to the P&SC by Dr Rob Massey, Susie Wheeldon, Liz Benson and John Allen

## 16 THE INTERNATIONAL YEAR OF LIGHT SHEDS LIGHT ON THE 'DARK AGES'

Dr Anne-Maria Brennan

## 20 ELI IN THE CZECH REPUBLIC

Otakar Fojt

## 45 DEMENTIA HAS NO BORDERS

## 46 PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY

## 48 HOUSE OF COMMONS SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY

## 49 HOUSE OF LORDS SCIENCE AND TECHNOLOGY SELECT COMMITTEE

## 50 HOUSE OF COMMONS LIBRARY SCIENCE AND ENVIRONMENT SECTION

## 47 SCIENCE DIRECTORY

## 56 SCIENCE DIARY

# NATIONAL SPACE CENTRE

**Chas Bishop**  
Chief Executive, National Space Centre

*“A science centre can do so much more than entertain, but it must be entertaining.”*

Richard Attenborough said that; not actually about science centres, but about films. It seems to fit though, doesn't it? A science centre is likely to be run as a charity and have strict charitable objectives, but unless it attracts a mass audience it isn't going to last very long.

The National Space Centre is one of a raft of science centres launched with Millennium Commission funding with the express purpose of inspiring the next generation of scientists and engineers. Leicester doesn't appear an obvious location for such a project until one hears of the brilliance of the University of Leicester's Space Research Centre and its work on missions to Mars, to Mercury, to Jupiter and to look back at Earth.

How are these Millennium centres doing fifteen years on?

*... 'Visitor numbers' is the most obvious metric ...*

Whatever your measure, the answer is “pretty well”. ‘Visitor numbers’ is the most obvious metric and the most likely determining factor as to whether or not costs are covered. It is also a good indicator of one's worth to society: of the 265,000 visitors to the National Space Centre in 2014, 77,000 were children in school groups led by teachers looking to supplement their classroom teaching with exciting context. It is the same at the Centre for Life in Newcastle, @Bristol, Think Tank in

Birmingham and Glasgow Science Centre to single out four of the 60 operations that make up the Association of Science & Discovery Centre network: all striving to meet curriculum needs whilst providing an enjoyable day out.

Most will tell you that visitor numbers are growing, and that the past three years have seen ever-increasing pressure on capacity. Most will say that their ancillary business activities that make best use of their assets



are flourishing and adding vital surpluses to the bottom line. All will say that getting hands on capital funding is tough. The really successful ones have cash reserves and some ability to

invest their own money, but not enough to build new classrooms, corporate facilities and new exhibition space to welcome ever more people through their doors. The National Space Centre is a case in point, turning away much-prized school and corporate business and regularly running out of car parking space. It has a £3m expansion plan and is able to stump up £1m itself, but doesn't have a dedicated grant funding body to approach for support as do others in the arts,

be a great opportunity to build on success and offer more places to more people. There is employment in it too: 165 people work on site, with a further 25 teachers seconded from their schools for 25 days a year to help deliver National Space Academy programmes across the UK.

So why the growth in volume: is it the economy? Is it space? Probably both. Certainly the three year growth trend mirrors the UK's climb out of recession. The subject of space may be the trump card. Suddenly, it is front page news. First we had Rosetta and the audacious landing of its Philae probe on Comet 67P, “throwing a hammer in the air in London and hitting a nail in Beijing” as Andrew Miller MP recently quoted one scientist putting it. Next came the Americans and

*... a great opportunity to build on success ...*

their test launch of Orion: the successor to the Space Shuttle with a deliberate nod – in its splash down, trailing red and white striped parachutes – to the iconic Apollo programme. Then we had Beagle 2: the glorious affirmation of correct maths and brilliant engineering combining to land a tiny probe on a distant, hostile planet. We didn't know this on Christmas Day 2003: a terrible misfortune for Prof Colin Pillinger and his team who had put years of their lives into a project that was

ultimately let down by a malfunctioning solar panel. It was a bitter-sweet moment for Prof Mark Sims to present images of Beagle 2 from the surface of Mars to a packed press conference eleven years later. Every single box in the most complicated of missions could be ticked. It just didn't transmit.

interesting question. 100,000 by 2030 for the space sector alone is the UK Space Agency figure, fuelled by an expectation of a plethora of start-ups capable of taking data from space and turning it into applications useful to all industry sectors and in all walks of life. Telecommunications, banking, public transport, driving, running,



The image of the UK Space Sector suffered in the original aftermath of Beagle 2: a gross injustice for such a vital contributor to UK plc that leads the world on so many fronts. Its work in planetary exploration, Earth observation, satellite navigation and telecommunications is worth £13bn a year and employs

cycling, playing golf, looking after the Earth, responding to natural disasters, finding oil, keeping an eye on the kids, keeping an eye on people you want to keep an eye on: all these are already established. Farming, insurance, town planning: loaded and loaded. It should be an easy sell and yet, to many, 'space applications' remain unknown,

### *... Bringing down the cost of satellite launch ...*

30,000 people in hi-tech jobs. It has ambitious growth plans and, later this year, supports the first UK national to travel with the European Space Agency to the International Space Station for a six month stint. In Major Tim Peake it has chosen the perfect role model: a helicopter test pilot with the ability to speak and the urge to tweet: a winning combination for somebody already in hot demand to inspire the next generation of scientists and engineers.

Quite how many scientists and engineers we need is an

unexplained and seemingly irrelevant. There is a big communications job to be done, led by the Satellite Applications Catapult in Harwell, Oxfordshire. Bringing down the cost of satellite launch will help, and this is where the UK is leading the way with pioneering projects to miniaturise satellites and create reusable space planes. A UK spaceport could soon be built at one of four short-listed sites: not to lift us up for a sub-orbital flight (although that will come) but to launch a myriad small satellites.

This all needs skilled engineers. In 1983 we had 55,000\* A level physics students in the UK. Today it is around 35,000 a year; growing from 27,000 in 2006 but still a long way short of where we need to be. Space can help. It may be optimistic to argue that a happy day out at the National Space Centre leads directly to an engineering career, but a recognition that "space exploration" is a great moving factor in teaching the science

### *... land a tiny probe on a distant, hostile planet ...*

curriculum. This led to the launch of the National Space Academy in 2011 following a three year pilot programme in the East Midlands. Now, there is a two year student commitment, and this is providing increasing evidence of "impact". Of the eleven guinea pigs who started the post-16 course in Space Engineering (run jointly with Loughborough College and comprising A levels in physics and maths and a BTEC level 3

appear to be heading in the same general direction and similar full-time courses have been started in Banbury, Birmingham, Salford and Twickenham. 500 students will be taught this way by 2016 and other colleges are asking to join the affiliation. A further 5,000 students and 1,000 teachers a year take part in half and full day master classes. A post-18 Higher Apprenticeship in Space Engineering is just under way.

With high fixed costs and an innate desire to keep costs affordable for families, science centres have developed highly creative ways of generating additional income. Some rent out space for office use or events, some have ice rinks at Christmas and some create exhibits for purchase or hire. The National Space Centre has NSC Creative: an animated film production company that makes planetarium and simulator shows for clients worldwide. With shows currently playing in over 400 planetaria in 30 countries, it employs 30 full-time, highly creative individuals who are also masters of story-



in engineering), six had no family history of higher education. Nine of the eleven got the grades needed to go to their first choice university and one took an apprenticeship with Airbus. The eleventh hopes for an apprenticeship with Rolls-Royce. Cohorts two and three

telling: vital if you are to entertain a diverse audience with a great range of age and understanding.

*\*numbers from the Institute of Physics*



# THE WORLD NEEDS SCIENCE AND SCIENCE NEEDS WOMEN

Celebrating the 2015 European Laureate of the “L’Oréal-UNESCO For Women In Science” awards, Professor Dame Carol Robinson.



Professor Dame Carol Robinson  
Professor of Chemistry,  
University of Oxford

Over the past decade, the percentage of women among scientific researchers has increased by 12% but gender parity is far from being reached: women account for only 30% of the world’s researchers. The current situation indicates that well into the third millennium, a discrepancy exists between what we believe is the right gender balance and what we are prepared to do about changing it.

I like to think that the barriers are reducing all the time but unfortunately evidence does not support this. There are still relatively few women who remain in science, despite a good take up at the undergraduate level. More programmes exist to address this but there is a lot more we can do to reach gender equality in science.

Science is still perceived as a man’s world and it really should not be. A career in science is both rewarding and exciting. Women should not be put off by perceptions. One of the main issues is the lack of role models with whom women can identify. When I was young there were very few – Dorothy Hodgkin or Marie Curie. Nowadays, we are seeing more women and programmes like the L’Oréal-UNESCO For Women In Science Awards are helping to put women scientists on the world

stage and to celebrate their successes. I was delighted when I learnt that I was to receive the award as the European Laureate for 2015. It is a great honour and I hope it has a very positive effect on young women considering a career in science. I hope that it gives young women something to aspire to.

I also would like to think that my unusual career path might inspire others into the world of science. I knew that when I left school I wanted to stay in

Pfizer. When I finished my degree I was delighted to be accepted to do a PhD at Cambridge University. This was beyond my wildest dreams.

Finishing my PhD I then took another unconventional path by having an 8-year career break to begin raising my children. I loved this time and didn’t return to science until my late thirties, initially at quite a low level. I was grateful for the chance to prove myself. By my mid-forties I was appointed as a Research

*... senior women can make a difference ...*

science so I became a technician at Pfizer, aged 16, working on a mass spectrometer. I was very fortunate that one of my colleagues told me I should have gone to university and that it wasn’t too late. I didn’t believe him, but he encouraged me to study part-time for a degree while continuing my ‘day job’ at

Professor at the University of Oxford. I think in the mid 1990s, when I obtained my first grant, I felt I had started my career in science.

Nowadays the grant funding situation is much tougher. Student numbers have increased dramatically in the last 10 years which brings its own



All photos L’Oréal-UNESCO For Women In Science 2015



From left to right: Prof. Dame Carol Robinson – University of Oxford, UNITED KINGDOM; Prof. Thaisa Storch Bergmann – Federal University of Rio Grande Do Sul, Porto Alegre BRASIL; Irina Bokova – Director General UNESCO; Jean-Paul Agon – Chairman & Chief Executive Office, L'ORÉAL; Prof. Molly S. Shoichet – University of Toronto, CANADA; Prof. Rajaâ Cherkaoui El Moursli – Mohammed V- Agdal University, Rabat, MOROCCO; Prof. Yi Xie – University of Science & Technology of China, Hefei, CHINA.  
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pressures in terms of space and resources. Similarly the number of academics has increased and in a tougher funding climate I have seen this cause some young scientists to leave research. If I were the Minister for Universities and Science, I would try to ensure that universities were properly funded. There are moves to put research into institutes and to leave universities to focus on teaching – I think this would be a big mistake. Many of the great innovations in science were discovered in universities.

*... very positive effect on young women considering a career in science ...*

In my career I benefited enormously from good mentoring and I feel this is an important part of getting women to stay, and progress, in science. I would never have applied for my Royal Society Chair without a lot of persuasion. Encouraging

women to apply for senior academic positions and sitting on electoral boards is one way in which senior women can make a difference.

The work-life balance also plays a major role. The long hours culture is in conflict with family life, and life in general and in my opinion this is the

biggest perceived obstacle for women entering science and academia but I am a strong advocate of how flexible a career in science can be. Commitment is the important thing. Balancing family and career was my biggest challenge. Initially, I resolved this by giving up my scientific career for eight years; later I managed to find the right balance between the two things that mattered most to me.

Finally I would like to stress the positives of careers in research: to work on something that becomes your hobby, flexible hours, international friendships, mentoring students and post-doctoral researchers – the list is long. Don't think of it as being stuck in the lab all day. The opportunities to present your research, to interact at conferences and to carry out collaborations across the world are tremendously exciting. It is also very rewarding working with bright young students, watching them develop and take up their own careers. It really is a great career choice.

**The L'Oréal-UNESCO For Women In Science International Programme** was founded seventeen years ago by L'Oréal and UNESCO on the premise that 'the world needs science and science needs women'. The awards programme is designed to promote and highlight the critical importance of ensuring greater participation of women in science, by awarding promising female scientists with fellowships to help them further their research. There are three distinct schemes:

- 1.0 The International Laureate Programme: The founding awards provide five leading female scientists, one from each continent, every year with a prestigious laureate of €100,000 in recognition of their ground-breaking achievements and contributions to scientific progress. These women are at the cutting edge of their research fields. The international structure of the programme ensures that the laureates are distributed among women who are working under a wide variety of conditions. 87 laureates have been given since this programme's creation.
- 2.0 The International Fellowships – Rising Talents. These fellowships help young women scientists from around the world take up research positions in other countries, allowing them to pursue their research in some of the world's most prestigious laboratories. There are 15 fellowships given out each year to support 'the faces of science for tomorrow'.
- 3.0 The National Fellowships, such as the UK & Ireland programme, are run in over 46 countries around the world. Each National Fellowship helps women scientists at a critical point in their career to continue to pursue their research with flexible financial aid.

**Since its creation in 1998 the L'Oréal-UNESCO For Women in Science programme has supported 2,250 women in 110 countries**



# THE LONDON MATHEMATICAL SOCIETY: CELEBRATING 150 YEARS OF MATHEMATICS

This year marks the 150th Anniversary of the London Mathematical Society (LMS), the UK's learned society for mathematics. The Society is commemorating this with an exciting programme of events celebrating the contributions of UK mathematics through the years. The Society and its membership includes many creative mathematical scientists, past and present.



One of the objectives of the celebrations is to reach out to both non-mathematicians and mathematicians alike, and to foster a deeper appreciation of the value of mathematics to our culture and society. The varied programme of activities and events provides a wonderful opportunity to celebrate past achievements, and also to look forward and challenge ourselves and society to make the best of this ever-changing and beautiful discipline.

Under the overarching theme of *Mathematics: Unlocking Worlds*, we will communicate

the following messages to as wide an audience as possible:

- Mathematics transforms people's lives
- Mathematics is everywhere and for everyone

*... essential value of mathematics to the UK economy ...*

- Mathematics Research: Curiosity, Creativity, Discovery

The year began with the Anniversary Launch on 16th January 2015 at The Goldsmiths' Hall, London. Both the date and venue were of particular significance to the

Society; 16th January 2015 was exactly 150 years to the day since the Society held its inaugural meeting and Goldsmiths' Hall was also the location for the Society's Centenary Dinner. The aim of

the Launch was to introduce the Society's year of celebrations, recognise and promote the history of the Society, and demonstrate the essential value of mathematics to the UK economy.

Over 300 guests, including school and university students, were entertained by talks from leading mathematicians. In addition to the Society's historical focus on pure mathematics, a range of applied topics was covered, including machine learning for human motion capture (particularly in Microsoft's Kinect for Xbox), the linking of signals to masts that enable the use of mobile phones, and the special effects behind TV programmes such as *Doctor Who* and *Sherlock* and films such as *Harry Potter* and *Life of Pi*.



An Early Day Motion, dated 16 January, supported by Andrew Miller MP, Stephen Metcalfe MP, Dr Julian Huppert MP and Sir Peter Bottomley MP, congratulated the LMS on reaching its 150th Anniversary, for which the Society is grateful.

In February, there was an exhibition of early documents and photographs from the LMS archives at the University College



Professor Sir Andrew Wiles

London (UCL) Main Library. The exhibition will remain open until December and highlights include a student's sketch of the LMS founding President Augustus de Morgan, a sketch of an early LMS logo by Sophia de Morgan, and a letter from George de Morgan and Arthur Cowper Ranyard inviting Thomas Archer Hirst to the inaugural meeting of the Society.

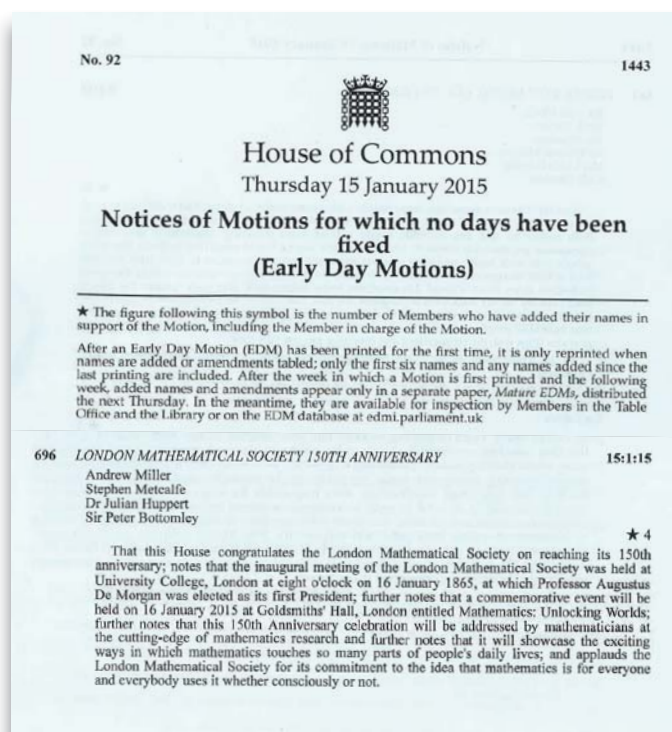
This year's Mary Cartwright Lecture was also held in February. The lecture, which each year is given by a prominent female mathematician, was given by Maria Esteban (Université Paris-Dauphine) on *Bose-Einstein Condensation: History, Model and Recent Mathematical*

### ... interviews with prominent UK-based mathematicians ...

**Results.** The talk was described as "world-class" by LMS President Terry Lyons and it provided a distinguished platform for other Women in Mathematics events later in the year.

Later in March the LMS launched the Sir Christopher

Zeeman online archive with a small ceremony at Hertford College, University of Oxford. The Archive was launched soon after Sir Christopher's 90th birthday and came to fruition as a result of the hard work and dedication of Sir Christopher's family. The online archive represents a lifetime of Sir Christopher's work, including letters he wrote, papers and books he published, and interviews he gave. Sir Christopher Zeeman is widely considered an icon of modern mathematics and the LMS is



delighted to be hosting the archive on its website, particularly as he is a Past President of the Society.

April and May proved busy months for the Society with large events such as the joint meeting between the British Mathematical Colloquium (BMC) and the British Applied Mathematics Colloquium (BAMC), which this year was held at the University of

Cambridge and included a day of events celebrating the Anniversary, with lectures from Professor Sir Andrew Wiles (University of Oxford), who proved Fermat's Last Theorem and Professor Robert Calderbank

### ... platform for other Women in Mathematics events ...

(Duke University, US), followed by a special four-day Women in Mathematics event held at the University of Oxford.

As the year progresses there will be a number of other

and architect George Legendre. The year will culminate in an exciting, interactive five-day Mathematics Festival in collaboration with the London Science Museum which will be held at the Museum from

Wednesday 25th – Sunday 29th November in which nine research groups will be involved.

The usual Society events such as the LMS Popular Lectures, which already attract large audiences from mathematicians and students to the general public, have been extended to include more speakers at various locations around the UK. There will also be a joint meeting with the Institute of Physics (IOP) and the Royal Astronomical Society (RAS) in November to mark the centenary of General Relativity.

The 150th year of the Society is an opportunity to reflect on the ground-breaking achievements of the LMS through the years and to look forward to building a sustainable future for the discipline which will allow mathematics to continue to contribute to society and to provide the critical foundations to 'unlocking worlds'.



Professor Robert Calderbank

For more information about the Society's 150th Anniversary visit [www.lms.ac.uk/2015](http://www.lms.ac.uk/2015) You can also follow the LMS on Twitter @LondMathSoc

# THE UNIVERSITY OF NOTTINGHAM ENTERPRISE ZONE

## Helping to create the next generation of science and technology entrepreneurs



Chris Rudd  
Pro-Vice-Chancellor  
(External Engagement),  
The University of Nottingham

In September 2013, Sir Andrew Witty, Chief Executive of GlaxoSmithKline and Chancellor of The University of Nottingham, published his independent review, entitled 'Encouraging a British Invention Revolution' which investigated how universities could drive economic growth, benefiting both their local areas and the wider UK.

The Witty Review called for stronger incentives for universities to realise their potential to enhance national and local economic growth. It highlighted the need for universities to work with local partners to seek out small and medium enterprises (SMEs) with the potential to innovate, and to support such businesses with technology, expertise, talent and know-how.

In response to the Witty Review and previous reports on the subject of business-university collaboration, in 2014 the government announced that

four new University Enterprise Zones were to be created in Nottingham, Liverpool, Bradford and Bristol.

University Enterprise Zones (UEZs) are specific geographical areas where universities and businesses can work together to increase local growth and innovation. Each UEZ will be supported by a partnership between a university and Local Enterprise Partnerships (LEPs).

As part of our plans for the University of Nottingham Enterprise Zone, we are developing a new Technology Entrepreneurship Centre (TEC). The £2.6m we have received from government for the UEZ is being matched pound-for-pound to develop a £5.2m state-of-the-art business incubation facility.



A new Technology Entrepreneurship Centre for technology entrepreneurs will be at the heart of Nottingham's University Enterprise Zone

The new 2,000m<sup>2</sup> building will provide office-based accommodation for small businesses, and will be designed to facilitate interaction between occupants, with the

flexibility to host individuals in both seminar and idea-generation modes. Within the Centre, technology-based entrepreneurs will be able to engage with our expertise in key sectoral technologies and enterprise education, and link with its significant international connections through its campuses in China and Malaysia.

### STIMULATING TECHNOLOGY-DRIVEN BUSINESSES

The University of Nottingham's Technology Entrepreneurship Centre will provide space and incubation support for 50 technology-driven start-up businesses, (including student enterprises) from the local

development and Intellectual Property Commercialisation.

One of the key advantages for businesses which will be based in the Technology Entrepreneurship Centre is the linkage with the local escalator of finance, which includes Nottingham City Council's Regional Growth Fund grants for



Enterprising Nottingham students developed a pathogen diagnosis kit for the agri-food industry

technology development, the University's Angel Network and the City Council's Foresight Fund for high-growth businesses, providing the opportunity to tap into a unique package of financial support.

### SUPPORTING STUDENT SCIENTISTS TO BE ENTREPRENEURS

University students are a rich source of innovative business ideas and creativity. However, these skills are often untapped, under-supported and under-utilised while they are at university. The University of Nottingham recognises the need to develop the entrepreneurial potential of science students so that when they leave university



they are given the tools to launch successful new ventures, creating jobs and wealth. One way in which the University is helping to develop the next generation of entrepreneurs is through joint MSc courses, where students are able to combine studying science subjects with entrepreneurship, where they can learn about the practical aspects of business development and build their entrepreneurial skills.

Student entrepreneurship at The University of Nottingham is supported through the Haydn Green Institute for Innovation and Entrepreneurship, which hosts an Ingenuity Lab where students are able to come and get support to develop their ideas and set up their own businesses. The Haydn Green Institute also provides competitions with financial prizes to help students get their ventures off the ground. One such competition is the Biotechnology Young Entrepreneurs Scheme (YES) – an annual business plan competition, designed to raise awareness of commercialisation among young researchers. Topics covered in the Biotechnology YES competition include business plan writing, understanding intellectual property and patents, raising finance, marketing strategies and regulatory affairs.

## DETECTING FOODBORNE DISEASES

One of the innovative student ideas that came through the Biotechnology YES scheme was from a group of University of Nottingham MSc Crop Biotechnology and Entrepreneurship graduates. The students have developed a mobile diagnostic service for pathogen detection – an idea developed for their master's dissertation. Their method can be used to detect foodborne diseases such as *Campylobacter*, *Listeria* and *Salmonella*, which

cause hundreds of deaths in the UK per annum. The mobile kit enables testing to take place in the field, producing results within just two hours, compared with up to several weeks in lab-based tests.

The three students have now formed a company, called DiagMole, and believe that it is the combination of an academic subject combined with the study of entrepreneurship which has given them the skills and confidence to go into business. They are all positive that their business will become their employment for the foreseeable future and has the potential for high growth.



Rt Hon Greg Clark meeting the University of Nottingham students who designed the Freefall Camera

## THE FREEFALL CAMERA

The Freefall Camera is an example of a University of Nottingham student-led research and development project which has led to the development of a product with real commercial potential.

The starting point for this venture was a team of Mechanical Engineering masters students, who are also skydiving enthusiasts. They wanted to see if it was possible to solve the problems around autonomously filming skydivers in freefall without jeopardising safety. They set themselves the challenge of creating a fully working robot prototype designed with four vertical aerofoils which adjust to affect its terminal velocity. To ensure the camera kept locked on its target, a state-of-the-art vision sensor and glove were used to develop the camera's tracking systems. A steerable parachute and robust casing was

also developed to improve further the functionality and reusability of the product.

The device will enable skydivers to be filmed at any time they choose instead of being bound by camera flyer availability. Tested in the windtunnel at Airfix in Manchester, the prototype is now progressing towards becoming a fully developed marketable product.

## COMMERCIALISING NEW TECHNOLOGIES

Each year, a number of exciting new technologies are developed by universities across the country and Nottingham is no exception. Most famous for developing Magnetic Resonance Imaging, The University of Nottingham is still commercialising many exciting and innovative technologies.

In recent years we have had a number of successful exits of spin-out businesses. One of these, Molecular Profiles, which provides innovative services to the pharmaceutical industry, such as formulation, manufacturing and expert consultation for Intellectual Property issues, was sold to an



Professor Ted Cocking has developed a technology which has the potential to enable crops to fix nitrogen atmospherically

American pharmaceutical business for £16m in 2013. In addition, the University's pre-clinical oncology research company, PRECOS, which focuses on providing unique patient relevant and predictive cancer models to international biotech and pharmaceutical companies, was also sold in a multi-million dollar deal.

Other Nottingham spin-out businesses in the medical sector are gaining worldwide interest. Scancell has developed a therapeutic DNA vaccine which stimulates the body's immune system to make T-cells which then seek out and kill tumour cells that would otherwise be hidden. The company has secured £17m funding to date.

NuVision is a spin-out that has developed a biological wound dressing which aids the regeneration and healing of the surface of the eye. The dressing, known as Omnigen, can be used as a graft, or an innovative emergency dressing to help regenerate damaged or diseased corneal tissue. The technology has been backed by £2 million research funding including support from the UK MOD.

In the agricultural sector, Azotic Technologies is commercialising a new technology developed by the University called N-Fix. N-Fix has the potential to enable crops to fix half their nitrogen needs from the atmosphere. This could transform global agriculture, by making it cheaper for farmers to cultivate crops while also reducing the massive damage caused to rivers and lakes by nitrogen run-off from fertiliser.

## AN ENTERPRISING FUTURE

The creation of the Technology Entrepreneurship Centre at the University of Nottingham Enterprise Zone will further help students, academics and local businesses to nurture and develop ideas, creating a new generation of science and technology entrepreneurs, bringing new jobs and wealth to the Midlands and beyond and helping to strengthen the UK's position as a world-leader in innovation.

# WHY SCIENCE IS IN THE DIPLOMATIC TOOL KIT



Professor Robin Grimes<sup>1</sup>  
and Dr Emma Hennessey<sup>2</sup>

In 2010, the Royal Society published a report on “New Frontiers in Science Diplomacy”, which set the scene for UK science diplomacy in the 21st Century. This built on over 280 years of international science engagement since the Royal Society appointed its first foreign secretary, Philip Zollman, in 1723. The UK Government’s first Foreign Secretary, the colourful Charles James Fox, was only appointed in 1782! This paper reminds us of the various contributions of science diplomacy, reviews the current state of play and looks to the future.

## WHAT IS SCIENCE DIPLOMACY?

In addition to the traditional foreign policy issues of security, trade and international relations, there is a host of new challenges, including food and energy security, health (Ebola, anti-microbial resistance, AIDS), national disaster management and the environment (climate change). These demand international collaboration and require new ways of working, including science diplomacy.

Science diplomacy has been defined as “the use and application of science cooperation to build bridges and enhance relationships among

societies, with a particular interest where there might not be other mechanisms for engagement at an official level<sup>3</sup>”. It is an evolving concept but it applies to the role of science, technology and innovation in: informing foreign policy objectives by supplying scientific advice (science in diplomacy); facilitating international science cooperation (diplomacy for science); and using science cooperation to improve international relations (science for diplomacy).

*Science in diplomacy* is akin to evidence-based policy making: the principle that the best policy decisions are those that are informed by expert advice and evidence. This could include economic advice and statistics about trade opportunities, social research on behaviour or perhaps information on technological advances. Science can play a particularly important role during emergencies when a State’s response can rely heavily on predictions of how events are likely to unfold. During the Fukushima nuclear power plant accident in Japan, science advice underpinned the decision by the UK embassy in Tokyo not to evacuate personnel, leading to a long term benefit to UK-Japan relations.

*Diplomacy for science* builds networks for research cooperation. Researchers have always sought out the best people with whom to collaborate. National academies are increasingly international in their scope and reach. Programmes such as the Newton Fund<sup>4</sup> and the European Commission Framework programmes<sup>5</sup> facilitate collaboration. High-level national engagement/diplomacy is essential to ensure that the

scope of the Framework programme aligns with UK’s expertise to ensure UK scientists can access such funds.

*Science for diplomacy* is especially important when normal diplomatic relations are difficult or even impossible. The scientific community often works beyond national boundaries so is well placed to support forms of diplomacy that do not depend on traditional alliances and can be an important source of “soft power”. This was recognised in a 2014 House of Lords report<sup>6</sup> which recommended that the UK Government should identify ways in which science can inform diplomacy. Scientists also provide longevity, developing and maintaining international relationships, complementing the shorter-term personal relationships of diplomats and politicians. The international relationships of scientists at RBG Kew are excellent examples of this.

UK excellence in research is acknowledged overseas<sup>7</sup> and as such the UK is in an especially good position to use science for diplomacy. It enhances our national reputation, opens doors to influence trade and investment, and can help with power projection when used appropriately. Further benefits arise, such as when other nations use our science structures or standards, making the UK a natural trade partner, or when overseas students, who studied in the UK, maintain their connections, building confidence and relationships that will last decades.

## WHAT IS THE UK DOING?

There are many examples of UK institutions contributing to science for diplomacy. Our

learned societies have played a particularly important role. The Royal Society as a sequel to its Commonwealth Science Conference (in November 2014), is working with the Commonwealth Secretary General to put science at the heart of the Commonwealth agenda. The Royal Academy of Engineering is currently supporting an academic industry exchange scheme, with the University of Zimbabwe as one of the hubs.

Academics can work in places where diplomatic relations are fragile. The Royal Society brokers arrangements by which volcanologists from Imperial College and Cambridge have been working with North Korean scientists to monitor Mount Paektu, responsible for one of the largest eruptions in history.

The British Council has commented that science and research diplomacy is one of the most powerful tools for building trust and understanding with the Islamic Republic of Iran<sup>8</sup> (IRI). IRI has maintained some leading science education and research facilities; IRI scientists contribute to projects such as CERN, and lead the region in terms of contributions to peer-reviewed journals. The UK’s science and research is highly regarded in Iran, and there is a strong desire to move forward with exchange and research partnerships.

After a hiatus of several years, a strategic agreement on cooperation has been signed by the British Council, The Royal Society and the Russian Foundation for Basic Research, opening the way for collaboration. President Putin’s Russian Academic Excellence Project provides opportunities to engage with the university sector



and facilitate links and collaboration between Russia and the UK. This will ensure that Russian universities are represented on the world stage, achieving excellence in teaching and research. Maintaining scientific dialogue continues to be important for Russia.

In 2001, the UK government set up the Science and Innovation Network (SIN), to link science directly to its foreign policy priorities. SIN contributes to *diplomacy for science* by providing: a gateway to science and innovation (S&I) opportunities, for UK and host country research institutions, universities and businesses; policy insight through a two-way flow of ideas in the UK and partner countries; new international partnerships, acting as a catalyst for new projects. It also contributes SIN experts in our overseas Posts, working closely with partner organisations, and in particular UKTI, to promote engagement. SIN is focusing on specific themes to increase impact and ensuring a balance between “quick wins” – and longer term strategic and diplomatic gains.

Since August 2009, the Foreign and Commonwealth Office (FCO) has had a Chief Scientific Adviser (CSA), who provides advice to the Foreign Secretary, Ministers and officials on science, technology and innovation. The CSA ensures that the FCO’s work on key issues undergoes proper scientific challenge, strengthening the use of scientific advice to underpin policy. The FCO has set up a Diplomatic Academy for FCO staff, and the curriculum includes science and innovation, ensuring that FCO staff are better informed about science diplomacy. It also builds more links between the FCO and other key UK science stakeholders.

## WHAT DO OTHER COUNTRIES DO?

France has long recognised the importance of scientific cooperation and research as key

to its influence on the world stage<sup>9</sup>. The French government is intending to increase its contribution to world science, especially through Horizon 2020, the forthcoming EU Framework Programme for Research and Innovation, and as part of the European Research Area reform agenda.

In the United States, a move towards enhanced science diplomacy has been reflected by the appointment of Science Envoys tasked with resuming a dialogue with the elites in the Muslim world (Middle East, Africa, and South-East Asia), and also through a \$1.6 million university cooperation programme with Africa. In December 2014, President Obama announced plans to establish new diplomatic ties with Cuba, including changes that will make it easier for scientists in the two countries to collaborate.

Other countries recognise the value of Science Envoys. Professor Sir Peter Gluckman, New Zealand’s Chief Scientific Adviser, assists New Zealand’s diplomatic efforts, including acting as New Zealand’s Science Envoy. At the end of August 2014 Sir Peter convened the first meeting of science advisers to discuss science diplomacy.

While much science diplomacy proceeds through bilateral projects and agreements, multilateral organisations also play a key role. The European Organization for Nuclear Research (CERN) was created in 1954 by 12 member nations and is now run by 20 European member states with many non-European countries also involved. Scientists from some 608 institutes and universities around the world use CERN’s facilities. The successful landing on comet 67P/Churyumov–Gerasimenko of the *Philae* robotic European Space Agency lander (November 2014) showed the value of international collaboration<sup>10</sup>.

A powerful example of multilateral progress is provided by the Intergovernmental Panel on Climate Change (IPCC). The IPCC is the leading international body for the assessment of climate change. It was established in 1988 to provide a scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts. In 2007, the IPCC and Al Gore were awarded the Nobel Peace Prize “for their efforts to build up and disseminate greater knowledge about man-made climate change” – a clear example of the power of science diplomacy.

An older example comes from the sharing of weather data since the 19th Century. By 1995, the Members of the World Meteorological Organisation (WMO) formally agreed they shall “provide on a free and unrestricted basis essential data and products ... required to describe and forecast accurately weather and climate”. The current 191 Members share data every hour. This provides the foundation of the Met Office’s ability to deliver effective forecasting services in the UK and overseas, with 96% of the data needed to run our weather model coming from other countries and organisations. These essential data and derived products usually keep flowing, even in times of conflict or political unrest. There is still free exchange between Russia and Ukraine.

## WHAT MIGHT THE FUTURE HOLD?

Since the Royal Society published its report, science diplomacy – in all its forms – has become increasingly important.

UK scientists are increasingly leveraging international funds and are working with international partners to ensure their work has impact: scientific papers derived from internationally collaborative

projects are cited more often; and in the UK there is more access to funding for international co-operation. Governments are keen to promote collaboration to advance prosperity, and open access to markets.

The value of science for diplomacy is more widely recognised as a valuable tool for improving international relations, particularly when other forms of diplomacy won’t work. More foreign ministries are appointing science advisers, science envoys or scientific advisory committees to steer activities.

It is a challenge to assess the impact of science diplomacy. While the overall impact is long-term, it is built upon more rapid successes from diverse activities. It is increasingly important to justify activity and criteria need to be established against which to make assessments, so that funding decisions can better reflect the contributions made by international activity.

Science diplomacy will be part of the mechanism through which the UK Government’s current investment in research can deliver greater prosperity. For the FCO this will mean an increased science-engagement role, delivered in particular by the SIN, providing scientists and engineers with better understanding of overseas structures and opportunities, thereby helping to maximise benefit for the UK.

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# KEW LAUNCHES NEW SCIENCE STRATEGY



Professor Katherine Willis  
Director of Science

2015 marks the beginning of an exciting new phase for the Royal Botanic Gardens, Kew. The launch of the Science Strategy in February has set the organisation on a clearly defined pathway in pursuit of a re-invigorated scientific vision: **to document and understand global plant and fungal diversity and its uses, bringing authoritative expertise to bear on the critical challenges facing humanity today.**

This embodies a simple but often overlooked truth: all our lives depend on plants and fungi. Kew has a responsibility to take a leading role emphasising the importance and relevance of botany, mycology and taxonomy in the minds of the public and decision makers. This will ensure that we are able to do this. Our science will be accessible, inspirational and will demonstrate the value of plant and fungal science to all of our lives.

## A GLOBAL RESOURCE IN PLANT AND FUNGAL KNOWLEDGE

Kew's position as a global resource in plant and fungal knowledge hinges on our world-class and unique collections and on the wealth of knowledge and



A seed collection of alder, *Alnus glutinosa*, ready to be put into the dry room at the Millennium Seed Bank. The seeds were collected as part of the UK National Tree Seed Project, which aims to establish a national tree seed collection to facilitate long term research into native trees and their conservation and management in the UK landscape. [Photo: Simon Kallow]

expertise of our scientists. Taxonomy, evolutionary biology, anatomy, biochemistry and conservation biology are just some of the disciplines represented. The vast collections, which include around 7 million herbarium specimens, 1.25 million fungus specimens in the fungarium,

45,000 samples in the world's largest wild plant DNA bank, and over 2 billion seeds in the Millennium Seed Bank, are at the heart of Kew's science and provide an unrivalled resource for scientific investigation.

The key to achieving the aims in the strategy is therefore recognising the potential of the collections to contribute to relevant research that provides a strong evidence-base for decision making. Kew's collections contain information covering huge spatial and temporal scales and over the next five years we will work at the forefront of new developments in technology to mine our data and use them in a predictive capacity. This articulates the role that collections-based research must play in addressing the complex questions and enormous challenges facing humanity: climate change, food and fuel security, disease, poverty and ecological scarcity. To ensure that we have maximum impact in key areas of science, education, conservation policy and natural resource management, we need to ensure effective dissemination of our knowledge and communication of our global science and conservation work. A further challenge is to enhance our education and training and to build capacity in the core skills of biodiversity science. We will achieve this through the development of a series of strategic outputs.

## STRATEGIC OUTPUTS

Nine strategic outputs will ensure that the organisation disseminates its research more

widely than ever to conservation NGOs, researchers outside the world of plant science, governments, policy makers and business to influence responsible stewardship of important plant and fungal resources the world over.

### Plants of the World Online

**Portal:** All of the information that Kew holds about the world's known plant species will be accessible online by 2020, creating a multi-dimensional, digital catalogue of plant life, including information on identification, distribution, traits, threat status, molecular phylogenies and uses. It will utilise Kew's extensive resources alongside images from the collections. The portal will fulfil Kew's responsibility to share vital information and knowledge on the plant diversity with stakeholders across the world. We will also build an online resource for our vast fungal collections.



The 'gobstopper' fruits of *Salacia arenicola*, a recently discovered, threatened species of shrub from the Republic of the Congo. It was discovered by Kew scientists working with local botanists in 2013, and published in 2014. [Photo: Martin Cheek]

### State of the World's Plants:

The results from this annual horizon scan of the status of the Plant Kingdom will be revealed in December 2015. It is Kew's ambition that this study will become an essential document



for governments, policy makers and conservationists who will use the results to identify research and policy priorities for plants. It will tackle a range of topics beyond the threat levels to plants, for example: Which plant communities and species show resilience to environmental change? What is the status of plant genetic resources? Which crop's wild relatives are most promising for use in breeding programmes? Where are the emerging plant diseases?



*Boletus edulis*, an edible porcini mushroom, growing near beech trees (*Fagus sylvatica*) at Wakehurst Place. Kew scientists recently highlighted how little is known about the diversity of fungi when DNA sequencing revealed three new species of porcini in a single packet of commercial porcini purchased from a London grocer. [Photo: Bryn Dentinger]

### Tropical Important Plant

**Areas (TIPAs):** Kew's expertise in the naming and identification of plants is strong in the species-rich, highly threatened, tropical regions. In a project that represents a first for plants in the tropics, we will focus this expertise on identifying the most diverse and highly threatened pockets of tropical plant diversity and designate them as TIPAs. It will focus on seven areas: Bolivia, Guinea, Uganda, Cameroon, Mozambique, Tanah Papua and the Caribbean UK Overseas Territories.

### The Plant and Fungal Trees

**of Life:** Since the 1990s, Kew has pioneered the classification of flowering plants based on genetic (DNA) information. Whilst evolutionary relationships of flowering plants are now well understood, the next step is to flesh out this framework by

producing DNA data for a representation of all genera of plants and fungi and, ultimately, all known species. Evolutionary trees provide a powerful tool for prediction, for example, opening the way to identifying new plants for foods or medicines and enabling scientists to determine which plants will be resilient to environmental change.

### Banking the World's Seeds:

In 2010, Kew's Millennium Seed Bank Partnership celebrated collecting, banking and conserving 10% of the world's wild plants. A programme to conserve a further 15% of the world's plants by 2020 is well under way. By 2020, some 75,000 species will be stored in the Millennium Seed Bank and in partner seed banks, representing 25% of known and bankable seed plant species. These collections capture the genetic diversity of wild plants, and hold the key to conserving threatened species and investigating useful traits such as pest and disease resistance in the wild relatives of our crop species.

### Useful Plants and Fungi

**Portal:** Kew has a long history of research into useful plants and fungi. Current projects include helping the Ethiopian Government to develop a climate resilient coffee industry, investigating the chemistry of plants to search for naturally occurring pesticides and using plants to benefit some of the world's poorest communities. A newly created Natural Capital and Plant Health department consolidates this expertise and gives this important area of research a new impetus. One of the channels through which the team will communicate its work will be in the development of an on-line web interface – the Useful Plants and Fungi Portal.

**Digitising the Collections:** To increase access to our collections, we will use modern technologies, including high-throughput scanning of herbarium sheets and microscope slides, to digitise Kew's collections. We aim to achieve 80% digitisation by 2020, creating the foundation for a virtual herbarium and other online resources, and feeding into the Plants of the World Online Portal (POWOP). In addition we will also target parts of the collections for more in-depth data capture to address particular science questions. Such data can be used to support conservation assessments or to model future species distributions under different climate scenarios. We will also continue to develop the UK Overseas Territories virtual herbarium, which has already proven itself to be an indispensable planning tool for plant conservation. Capturing and making available data from our substantial UK and UKOTs fungal collections will be a priority, to provide fundamental support for conservation. We will also undertake crowd-sourcing as a mechanism for capturing data from imaged specimens and to connect our science with a broader audience.

### Training the Next Generation of Scientists:

As one of the foremost research institutes in the world, Kew has a responsibility to pass on its knowledge, skills and expertise to the next generation, both in the UK and globally, and to encourage and inspire questioning minds to delve further into pure and applied biodiversity science. This will be achieved through updating our portfolio of short courses, continuing to host PhD students, and delivering our new MSc course in *Plant and Fungal Taxonomy, Diversity and*

*Conservation* in conjunction with Queen Mary University of London. The new MSc will begin in 2015, and will address the skills gap in taxonomy and systematics identified by the Natural Environment Research Council and Living with Environmental Change in their 2012 report *Most Wanted II. Postgraduate and Professional Skills Needs in the Environment Sector*. It will equip students with the knowledge and skills to undertake research in the fields of taxonomy, molecular systematics, ecology and evolution, or to engage in more applied conservation work. We will train a new generation of taxonomists in cross-disciplinary skills with applications in academia, government, industry, consultancy and non-governmental organisations.



Wild Arabica coffee, *Coffea arabica*, flowering in the highlands of south-western Ethiopia. Kew is leading a project that aims to improve the capacity of Ethiopia's coffee sector to deal with climate change. Our work demonstrates how our specialist knowledge of crop species biology and computer modelling can be combined to generate science-based policy resources and intervention strategies.

**Science in the Gardens:** The gardens at Kew and Wakehurst Place provide the perfect setting for disseminating the importance of plants and fungi and the work of Kew's scientists. We aim to make Kew a world leader amongst botanic gardens in engaging visitors in new ways. By exploiting modern technologies, such as mobile apps and location-specific sensor technology, we will deliver information tailored to

different audiences and also allow self-guided themed walks. Emerging technologies are providing the opportunity to transform the way science is communicated to the public, both on-site and through digital channels, and full use will be made of these to encourage our audience to seek out information on plants and fungi and the science behind the scenes. Our vision is for the development of a 'Virtual Kew' allowing people to 'e-walk' round the Gardens at different times of year, with plants linked to an online portal giving instant access to names and interesting information. In addition a plant science festival for children will be a new addition to the 2016 visitor programme. The festival will play a role in reinvigorating the way in which plants feature



Kew's scientific work spans 110 countries (shaded green) and involves over 400 collaborating institutions worldwide (red dots).

on the science education curriculum.

We will make Kew's scientific resources a global asset, bringing benefits to science, conservation policy and education. Understanding and

conserving plant and fungal diversity has never been more relevant for society at large. I am excited by the opportunities for Kew's scientists to continue world-class research and make an important and unique

contribution to addressing major challenges of our time.

To download the strategy and find out more, visit: [www.kew.org/science-strategy](http://www.kew.org/science-strategy)

Contact: [kewscience@kew.org](mailto:kewscience@kew.org)

# DEVELOPING A CIRCULAR ECONOMY – the critical role of the waste and resources industry



Jacob Hayler  
Executive Director,  
Environmental Services Association

**The unprecedented pace and scale of Chinese development in the past decade has transformed the world order and placed unforeseen pressures on global resources. The expansion of the Chinese middle class has been perhaps the most spectacular story in the history of economic development and drove a worldwide commodity boom which reversed a long term trend of falling prices.**

This focused the minds of the world's leaders on a new era of competition for resources. Despite recent falls in commodity prices (and oil in particular), increases in demand for goods and services are expected to occur as more of the developing world reaches income levels previously only enjoyed by Western consumers. The scale of this likely increase

in demand has driven calls for a new approach to economic systems which could provide the ultimate win-win scenario.

A circular economy, where we recover the materials and energy from our discarded materials and use them as inputs into production, provides a potential solution to future development. Economic drivers can be aligned

with reducing environmental pressures, thereby solving the critical problem of our age: how to raise living standards for all without despoiling the environment.

The recent highs in commodity prices drove change at all levels of the "waste hierarchy" (reduce waste, re-use, recycle, recover energy, with landfill used only as



a last resort). High input prices incentivised manufacturers to reduce material use at the front end and waste at the back end of their processes. The long term need to secure resources at reasonable prices encouraged the increasing use of recycled materials as a substitute for primary commodities. The recognition that we should make the best use of all of our waste is driving a shift away from disposal to energy recovery for that material which cannot be recycled.

The upside to the circular economy is huge. The Ellen MacArthur Foundation has estimated that implementing circular opportunities world wide could yield over \$1 trillion per annum in savings. In the UK, the Environmental Services Association has estimated that this could boost GDP by £3 billion while generating 50,000 new jobs. Such figures highlight some of the gains on offer. What does it mean in practice for waste and resource managers?

Circular processes can exist at different scales along the supply chain. Closing the material loop can happen within companies, within sectors and between sectors. Examples of the first exist where companies – usually operating where there is high value in their products, such as aerospace – change business models to retain ownership of their products and instead make service-based offerings to their customers.

There is an increasing trend for mobile telephones and other electronic devices to be recovered from consumers. In Europe this is helped by the implementation of the WEEE (waste electrical and electronic equipment) Directive but we can expect the underlying economics – high material costs and the presence of difficult to

obtain materials – to influence the closing of the resource loop.

The third scale – closing the loop between different sectors – is where the waste and resources industry comes in. It acts as facilitator, transforming a mix of different waste streams from households and businesses into a variety of products.

Taking advantage of all these opportunities will not be easy. Existing linear production processes are deeply ingrained into our economic system and enjoy significant incumbency advantages. Overcoming the costs which have already been sunk into existing infrastructure will require ambition, vision, and support from our political leaders. Only through the application of a clear and consistent long term policy framework will we be able to accelerate the transition to a circular economy and realise the large benefits on offer.

Beneath that broad policy support, there is another, more immediate, challenge which will have to be addressed if we are to be early adopters of the circular economy, thereby gaining a competitive advantage, and maximising the benefits: managing risk.

Circular economy projects which operate along supply chains (rather than within companies) possess multiple overlapping risks. There are input risks relating to the volume and composition of feedstocks (ie different waste types) that a project might be able to attract. There are process risks relating to the construction and operation of technologies which might be new to the market and which are therefore unable to provide examples of previous operations at scale or under local conditions. And there are output risks relating to the price of outputs (materials and

energy) and the availability of end destinations.

Historically, energy from waste projects has been able to gain long term contracts with local authorities, and hence to secure bank lending for large-scale facilities. The waste PFI programme has now closed and any new projects are faced with a mismatch problem between short term (two to three year) feedstock contracts with multiple smaller businesses, and trying to secure multi-million pound long term loans.

An additional problem for energy from waste projects in the UK is the continued outdated perception that “dirty incinerators” pose a health risk to local residents. But, according to the Environment Agency, it would take an average sized plant around 120 years to produce the same amount of dioxins as those produced by London’s New Year’s Eve fireworks display. These plants are operated safely and without opposition all over the world.

A mismatch problem has also arisen for recycling collection contracts where there has been a huge increase in the contribution of recyclate sales to overall contract values. These revenues are highly volatile which contrasts with local authorities’ (and other waste producers’) desire for stable collection charges. Recent falls in commodity prices have put some contractors, as well as recycling companies further along the supply chain, under pressure.

How can we get from where we are now to where we need to be? The European Commission’s 2014 Communication “towards a circular economy” and accompanying legislative proposals set out an ambitious programme of new targets and regulations. These were intended

to bring forward investment in new waste and resources services and infrastructure.

The proposals aimed at diverting material away from landfill and towards much higher recycling levels. They could have been criticised for not focusing sufficiently on incentivising increased European demand for recycled materials. The Commission withdrew the circular economy package at the end of last year but has promised to bring back more ambitious proposals which address this shortfall before the end of 2015. We hope this proves to be the case.

European waste management policy has been pretty successful at pushing up the supply of recycled materials. The lack of complementary policies aimed at developing markets for these resources has however meant that a significant proportion of recovered material currently goes overseas. There is now a significant opportunity for policy makers to integrate circular economy thinking into the design of industrial strategies that will deliver the resource efficient manufacturing sectors of the future. These could take secondary resources as their inputs and shift their dependence away from primary commodities with high and volatile prices. In this way stability would be improved for both the suppliers and users of recycled materials, strengthening the markets of the future.

The UK’s waste and resources sector has already moved a long way in a short period of time from being a logistics-based industry a decade ago to the heart of a new circular economy. Mitigating risks and improving incentives for new approaches could place the UK in a strong position to benefit from moves towards an increasingly circular world.

# The Role of Innovative Diagnostics in the NHS



Doris-Ann Williams MBE  
Chief Executive, The British  
In Vitro Diagnostics Association

**In Vitro Diagnostics (IVDs) play a key role in healthcare management – the information from these tests can be used to diagnose or rule out causes of disease, to screen at risk individuals and to monitor response to therapy and manage diseases such as diabetes. IVDs are also essential to screen the blood supply in order to remove risk of infection during transfusions and play an increasing role in the prevention and prediction of disease.**

In vitro diagnostics, literally meaning “in glass”, are tests performed on body fluids or tissue. Most tests are traditionally performed in hospital pathology laboratories and in public health laboratories. With miniaturisation of technology and simplification of procedures, an increasing amount of testing is now done in a point of care setting either within a hospital but also closer to the patient such as on a ward or in Accident & Emergency. This also includes in the community by GPs and other healthcare professionals, or by individuals themselves, including self-monitoring of blood glucose levels by people with diabetes. Simple products like pregnancy kits, bought over the counter, are IVDs.

There are many emerging health needs which IVDs can address including antimicrobial resistance, helping with unmet clinical needs and saving NHS resources within patient pathways. Three separate examples illustrate the role which IVDs can play to improve healthcare.

The first is the use of diagnostics to identify patient cohorts who might respond to specific drug therapies. These have been known as companion diagnostics but could also be termed Diagnostics Dependent Drugs – as without the test, the drug should not be used. There is a rapidly increasing number of these and to date they have mostly been in the area of oncology. Their use will be

supported later in 2015 when the Government funded Precision Medicine Catapult will open with the role of supporting the use of diagnostics to enable more tailored treatments, “precision medicine”.

Pharmacogenetics is the response of an individual to a specific drug according to their genetic profile. In precision medicine, tests can be pharmacogenetic or they can be used to identify other factors such as a protein produced by certain cancers as in tumours producing the protein HER2neu responding to Herceptin in breast cancer. These drugs are

companion diagnostics test (the cobas 4800 *BRAF* V600 mutation test produced by Roche Molecular Systems) has been developed and validated. The cobas 4800 *BRAF* V600 mutation test has been validated in national and international collaboration studies. It allows the treatment of vemurafenib providing that:

- the patient has been diagnosed with unresectable or metastatic melanoma
- *BRAF* V600 mutation analysis test is required for diagnostic purposes to guide therapeutic decision-making.

*“The upcoming years may well be known as the age of diagnostics”*

*Janet Woodcock, Director of CDER, FDA April 2012*

expensive and highly toxic so it is beneficial both to the NHS and to the patient not to use drugs which won't work.

In February 2012 vemurafenib (Zelboraf, Roche), an inhibitor of *BRAF* kinase, was approved by the European Medicine Agency for the treatment of patients with unresectable or metastatic melanoma with the *BRAF* V600 mutations. Vemurafenib produced improved rates of overall and progression-free survival in patients with previously untreated melanoma with the activating *BRAF* V600 mutation compared with standard first-line treatment with dacarbazine. Reliable detection of *BRAF* V600 mutation is therefore critical for therapeutic choice in these patients and a

Routine tests used in hospital laboratories are now numerous across disciplines such as biochemistry, haematology, microbiology, histopathology and immunology. The role they play can be as simple as providing a small amount of information to add to the whole clinical picture of the patient, in the same way as knowing blood pressure and temperature. Increasingly tests are being developed to play major roles in specific disease pathways. One area of clinical need for better and faster tests is in Sepsis – for every hour this serious infection is undiagnosed and treated, the mortality rate increases by 8%. Improving precision of diagnosis will assist in the battle against antimicrobial resistance too. It will allow rapid



targeted use of the right antibiotic rather than using a broad spectrum antibiotic. Cultures can be made to identify pathogens in the traditional way microscopically, but this can take several days – time which these patients may not have. A major global IVD provider, Abbott Laboratories, has developed a system which couples PCR technology to mass spectrometry to allow

Emergency departments were under huge pressure and hospital beds were full. Point of Care tests in the community can help reduce unnecessary admissions by allowing people, particularly those with multiple chronic conditions, to be helped in the community. In Abingdon, Oxfordshire, Dr Dan Lasserson, a primary care clinician with extraordinary energy, has developed a successful model

will have been examined and had point of care testing performed allowing a rapid and accurate diagnosis. Many can be treated and sent home. Data

than if they had been admitted straight from the community.

As well as saving hospital bed use this centre is seeing much better outcome for what are

*“Hospitals are dangerous places, and it is vital to avoid unnecessary admissions and develop better services for older people in the community and in their own homes”*

*The King's Fund, March 2012*



The pictures show the benefit of identifying a patient which can be treated with the right drug. This 38-year-old man had *BRAF* mutant melanoma and miliary, subcutaneous metastatic deposits. Photographs were taken (A) before initiation of vemurafenib, and (B) after 15 weeks of therapy.

identification of pathogens and actionable results from a 5ml blood sample within six hours. This system, Iridica, has been available to the NHS from March 2015.

This winter, the NHS Accident &

of care over the past four years. Either paramedics or GPs can refer unwell people to his Emergency Multidisciplinary Unit (EMU).

Within a mean of 61 minutes from receiving the call, a patient

show this service is reducing hospital admissions from these patients by 85%. Where patients do need hospitalisation, they can be sent directly to the appropriate ward, allowing treatment to begin more quickly

often frail and elderly people. In 2011/12 the savings to the NHS from the Unit were £1.9 million (source: Oxford University Dept. of Primary Care). The Abingdon EMU has proved so successful that a second EMU has been opened in Witney with two further Units planned in Banbury and Oxford itself.

These three examples are just a few of the ways that diagnostic tests underpin healthcare. They create wealth for the economy. The IVD industry sector employs more than 8,000 people in the UK with exports contributing more than any other medical technology sector – £1 billion annually and increasing. Better use of IVDs also benefits society as they reduce time lost in attending hospital appointments and enable people to return to fulltime employment more quickly.



Some of the simple point-of-care equipment which allows rapid testing of patients in a community setting.

# THE FUTURE OF LIFE SCIENCES IN THE UK



Dr Malcolm Skingle CBE  
Director, Academic Liaison,  
GlaxoSmithKline plc

**The UK science base attracts more than its fair share of Pharmaceutical R&D funding. If you consider the UK Pharma R&D spend as a proportion of the total Global Pharmaceutical R&D spend it equates to 9% and yet the UK percentage share of the world prescription market is just around 2% of the market. The UK Life Sciences sector is already punching well above its weight, underpinned by a strong academic science base. In the coming years, as the science bases in other countries gain ground, Government and industry must work together in partnership to ensure that UK science base remains strong.**

The pharmaceutical sector has experienced well-documented pressures, one of which is the cost of medicines, especially as the ageing population increases. Governments want to reduce healthcare costs. The USA currently has a little over a third of the world's prescription sales and yet it only has 4.4% of the world's population. The Americans are currently

diseases in places like Africa, as more control is taken of infection, and attention is turning to non-communicable disease such as diabetes, cardiovascular disease and cancer. The pharma industry will need to collaborate and work with these developing science bases to be able to run effective clinical trials, and to help patients.

Vaccines will become increasingly important in combating global disease. Many diseases have been eradicated from parts of the world following extensive vaccination programmes. Diphtheria, polio and smallpox have been eradicated and the incidence of other killer diseases dramatically decreased. We still face challenges in the developing world and it has been calculated that 22 million children are without access to vaccines. Around 19,000 children under the age of 5 die every day from largely preventable diseases.

Vaccines represent 2-3% of the total Pharma sales but this market has rapidly expanded from a \$5 billion market in 2000 to \$24 billion in 2013. The WHO estimate that it will be \$100 billion by 2025. The UK is well placed to undertake much of this pioneering research. GSK currently produces more than 25% of the

*... The pharma industry will need to collaborate ...*

spending a little under 18% of GDP on healthcare (the figure for the UK is 9.4%). Further rising healthcare costs are not sustainable.

China and India have a combined population of more than 2.5 billion people. As their economies get stronger their respective populations are demanding better healthcare treatments. We are already moving beyond communicable

## PREVENTION VS CURE

Encouragingly, Life Science research in the non-communicable diseases will increasingly focus on prevention rather than cure. For example, fitness and dietary considerations will be taken into account whereby governments will work with food manufacturers to address the obesity epidemic caused in part by the amount of sugar in food and drink.



world vaccines; around 2 million doses every day and distributing to 170 countries. It has 16 vaccines in development including an Ebola vaccine in clinical trial.

## MONITORING HEALTH

The continuum from wellness to illness will be better tracked through careful pheno & genotyping as individuals take greater responsibility for their own healthcare. Health status, in the future, will be monitored using electronic technologies, allowing us to track our health status using sophisticated Apps to measure physiological

*... GSK currently produces more than 25% of the world vaccines ...*

parameters and level of fitness. We already have heart rate monitors and pedometers on our mobile phones; these Apps will become more commonplace and will be used to measure routinely a range of physiological parameters including blood pressure, body fat, forced expiratory volume, blood glucose and pO<sub>2</sub>. Ultimately individuals will have their electronic health records, genetic profile and current physiological parameters on a portable device, possibly a wristband or smart watch. This will enable clinicians to make a more rapid and accurate diagnosis when a patient attends the clinic or indeed is assessed from a remote location.

## CONVERGENCE

There will be further convergence of technologies in healthcare. We are already using, in certain disease states, diagnostic technology to define more precisely patient

populations in clinical trials and post-approval to ensure that the patient gets the right drug at the right time. In parallel we are also exploring how the body can respond to electrical impulses in real time in order to bring about a local physiological response. The term electroceuticals has been coined for this evolving area of science and we have an active programme where we are collaborating with several academic groups.

All of the above healthcare innovations will require research from multi disciplinary teams and we are well placed in the

UK to lead much of this research. Pharmaceutical R&D investment accounts for 22% of the total industrial R&D in the UK; which is more than any other sector and indeed the next two nearest sectors, automotive (11%) and ICT (10%), put together.

## AN AGEING POPULATION

With improved sanitation and the use of antibiotics and cardiovascular drugs people are living longer. As a result we are seeing an increased incidence of chronic degenerative diseases associated with ageing eg

*... using genomics and proteomics to identify drugs ...*

dementia and cancer. Medicine has advanced dramatically over the last 100 years and we have seen several waves of new therapeutic innovations resulting in a step change in how we practise medicine. For example, the cost of gene sequencing

has come down dramatically since the human genome was first sequenced and reported back in 2001. With new technology, some developed here in the UK, it is now quicker and cheaper to genotype

*... individuals will have their electronic health records ...*

individuals and this is allowing us to stratify patient diseases in a way which has not previously been possible. GSK have recently set up a collaboration with the European Bioinformatics Institute and the Sanger Centre at Hinxton to systematically mine biological data. We intend to tap into the expertise in these centres and combine it with our own to use the large data sets that are publicly available to help us validate therapeutic targets. It is our belief that using genomics and proteomics to identify drugs

*... The term electroceuticals has been coined ...*

against targets identified from disease genes will yield novel medicines. Advances in genetics have helped us to identify and monitor several diseases which were previously very poorly treated.

The pharmaceutical industry has made some significant health advances over the last 20 years. For example HIV/AIDS has been transformed from a death sentence to a chronic condition with the new therapies. This has resulted in

an 80% reduction in death rates over this period. Similarly new therapies to treat cancer have contributed to a 20% decline in cancer deaths such that today, 2 out of 3 people diagnosed with cancer will survive at least 5 years.

New treatments have also been developed for multiple sclerosis and rheumatoid arthritis; and rather than focusing on the symptoms of the disease, as was previously the case, we are now focusing on the underlying aetiology of the disease in order to slow progression and drive patients into remission.

The net effect of several factors spanning health and welfare is that we are keeping people alive for longer at a time when the world population is expanding. The population has grown almost 4 billion since I was born. The current world population is 7.3 billion with a forecast of 9.1 billion by 2050. From a pharmaceutical company perspective this represents both a threat and an opportunity. Only by working with our academic collaborators and “fleet of foot” biotech companies will the pharmaceutical industry be able to innovate to develop desperately needed new medicines. With the continued support of the UK government, the UK academic base is ideally placed to underpin a vibrant life sciences industry in the UK.

**Professor Guy Poppy**, Chief Scientific Adviser, Food Standards Agency, also spoke at the meeting. A summary of his talk will appear in the next issue.

# DEVELOPING LOW-FIELD NMR SPECTROSCOPY FOR TACKLING FOOD FRAUD



Dr Kate Kemsley  
Institute of Food Research, Norwich



Dr David Williamson  
Oxford Instruments, Tubney Woods,  
Oxford

**In 2012, the Institute of Food Research began a three-year collaboration with Oxford Instruments to develop a new analytical technology – ‘bench-top’ NMR spectroscopy – aimed at use in industrial settings.**

The project was supported by Innovate UK and the Biotechnology and Biological Sciences Research Council. The first application targeted was the measurement of saturation and unsaturation in vegetable oils. A few months into the project, the horsemeat scandal broke, and the team made a timely discovery about the potential of the NMR approach for meat analysis and authentication.

## **BENCH-TOP NMR – AN EMERGING TECHNOLOGY**

Nuclear magnetic resonance (NMR) spectroscopy is a well-respected analytical technique used in chemistry laboratories worldwide. Oxford Instruments (OI) is a British manufacturing company that designs and produces analytical tools for industry and academia; OI pioneered the super-conducting magnets employed in NMR spectroscopy and a related technique, magnetic resonance imaging (MRI). Shared features of these technologies are that they are large and expensive, relying on super-cooled magnets and highly trained personnel to run them. With this in mind, OI recently launched a new benchtop NMR spectrometer, Pulsar™, aimed at making NMR spectroscopy accessible for

routine testing. In contrast to their high-field cousins, low-field (60MHz) ‘bench-top’ spectrometers are based on permanent magnets and ease of operation.

To expand the market for bench-top NMR, key applications needed to be identified. Since 2012, OI has been working with the Institute of Food Research (IFR) to develop applications of interest to the food industry. IFR is the UK’s only publicly-funded research institute that focuses on the underlying science of food and health, addressing challenges that include food safety, security and waste. The project is supported by Innovate UK (formerly the Technology Strategy Board) and the Biotechnology and Biological Sciences Research Council (BBSRC), with OI developing the instrumentation and IFR the statistical analysis and software tools. The first samples selected by the team for study were edible oils and fats, exploiting the ability of 60MHz NMR to produce high quality spectra quickly and easily from substances composed mainly of triglycerides. The spectra can be used to determine certain compositional values, such as the amount of mono- or poly-

unsaturated fatty acids present in the sample, in a quick and accurate analysis. Distinguishing oils from different seeds and nuts is also possible<sup>1</sup>.

## **A “KILLER APP” ...**

Early in 2013, a news story broke which dominated the headlines: the discovery of horse meat in beef burgers sold in the UK and Ireland. In the days that followed, undeclared horse meat was detected in a range of other processed meat products, leading to millions of pounds worth of food being recalled from supermarket shelves across Europe, and substantial brand damage to the companies involved. The crisis exposed the potential vulnerability of the meat supply chain to fraud, and highlighted gaps in testing regimes.

Currently favoured methods of verifying the source animals in meat products are based on DNA testing. But there are disadvantages to these methods: they can be prone to contamination and give false positive results; they are not reliably quantitative, and are relatively slow and expensive. DNA methods work by distinguishing one meat from another based on the distinct genetic profiles of each species.



However, animals differ not only in their DNA; there are other compositional factors amenable to measurement which may also provide means of identifying species. For example, it is common knowledge that beef, lamb and pork fat are very different from one another. This is mostly due to dissimilarities in their fatty acid compositions, arising in turn from differences in their diets, digestive systems and metabolism.

This reasoning led the OI and IFR teams, in the wake of the horsemeat crisis, to carry out a series of experiments. The fat components of a range of meat samples – including fresh horse meat – were isolated using a simple solvent extraction, and spectra acquired using the Pulsar. The results obtained were striking and convincing: each of the different meats examined produced clearly different spectra. Over the following months, the method was refined and repeated on hundreds of meat samples across separate laboratories at OI and IFR, and the initial findings were confirmed.

In the case of beef and horse, the spectral profiles were found to be entirely distinct (figure 1). Even with natural variation, no



The Pulsar bench-top spectrometer running the IFR-developed beef authentication software

overlap between the two types was found - the test was 100% accurate in determining whether an extract originated from a piece of horse or a piece of beef. The team recently reported their results in *Food Chemistry*<sup>2</sup>.

Easy-to-use software to carry out mathematical analysis of the spectral data was developed at IFR, providing a complete system with which to authenticate beef, in a test that takes ten minutes from start to finish. A patent on this approach to meat speciation is currently pending<sup>3</sup>. The method is rapid and low cost; dozens of samples can be analysed per day, taking 10-15 minutes per test. This

makes it an ideal and affordable approach for high-throughput screening, or for pre-screening ahead of more time-consuming and expensive DNA testing. The next step will be to transfer the technology into use within the food sector. In its current form, the test is suitable for key points in the supply chain, for example at meat wholesalers and processors, where the incoming raw materials are in the form of frozen blocks of trimmings. Trials of the system have recently been carried out in this kind of industrial setting, with the results now undergoing evaluation.

## IN CONCLUSION

High-field NMR spectroscopy has long been recognised as a powerful analytical tool, but the equipment to carry it out has historically been too expensive and technically complicated to allow deployment anywhere apart from specialist laboratories. The advent of benchtop NMR looks set to change this landscape. The food sector applications developed by OI and IFR have demonstrated how useful the low-field modality can be, particularly for the analysis of

fat-containing samples. The team are anticipating further collaboration on industrially important challenges as the capabilities of the Pulsar continue to evolve.

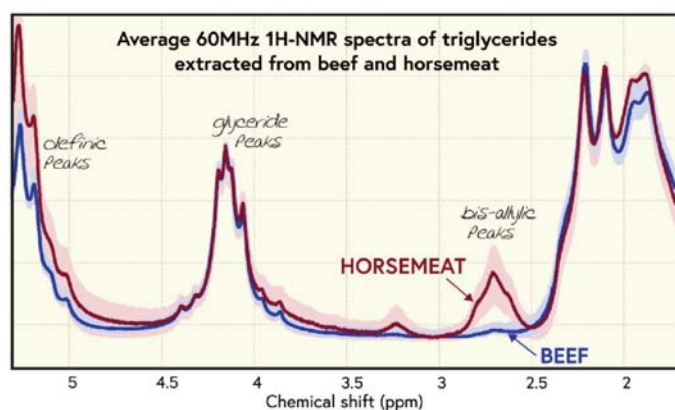
Find out more on our websites:

Institute of Food Research:  
<http://www.ifr.ac.uk/>

Oxford Instruments:  
<http://www.oxford-instruments.com/>

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1. Low-field NMR spectra of triglyceride extracts of raw beef and horse meat. The shaded areas indicate the range of natural variation found: note that there is no overlap for certain of the spectral bands, e.g. the unsaturated bis-allylic features.

# SUPPORTING TECHNOLOGICAL INNOVATION IN BRITISH INDUSTRY



Nigel Williams  
Secretary of the Royal Commission  
for the Exhibition of 1851

**The Royal Commission for the Exhibition of 1851 has operated at the intersection of industry and design for well over a century and a half. Established by Queen Victoria in 1850, the Commission's initial remit was to organise the Exhibition of the Works of Industry of All Nations; now better known as the Great Exhibition of 1851.**

The Exhibition was the world's first international trade fair, assembling 100,000 exhibits in the iconic Crystal Palace and attracting over 6 million visitors – equivalent to a third of the population of Britain at the time. The Exhibition was a tremendous success, but exposure to international competition proved something of a rude awakening for the British manufacturing industry. We were upstaged by the French in terms of design flair, the Germans in terms of precision engineering, and the Americans in terms of large-scale manufacturing. Prince Albert, the Commission's first

President, was determined to do something about it.

When the Exhibition closed in October 1851, the Royal Commission was therefore established as a permanent body, tasked with managing the substantial profits to increase the

Kensington for the twin purpose of enlightenment and education. The Royal Albert Hall, Royal Colleges of Art and Music, Imperial College London, the V&A, the Natural History and the Science Museum all arose as a result of the Commission's early work, helping to inspire people

*... twin purpose of enlightenment and education ...*

means of industrial education and extend the influence of science and art upon productive industry.

Among the Commission's first acts was setting up the great cultural estate in South

from across the UK and boosting the country's productivity.

At the same time, the Commissioners were also determined to fulfil the other part of Albert's vision, helping





fund access to a world-leading education for people across the empire of the time as well as the manufacturing centres of the North. This vision was realised in 1891 with the foundation of our science scholarships, aimed at encouraging bright, early-career scientists to continue with their research.

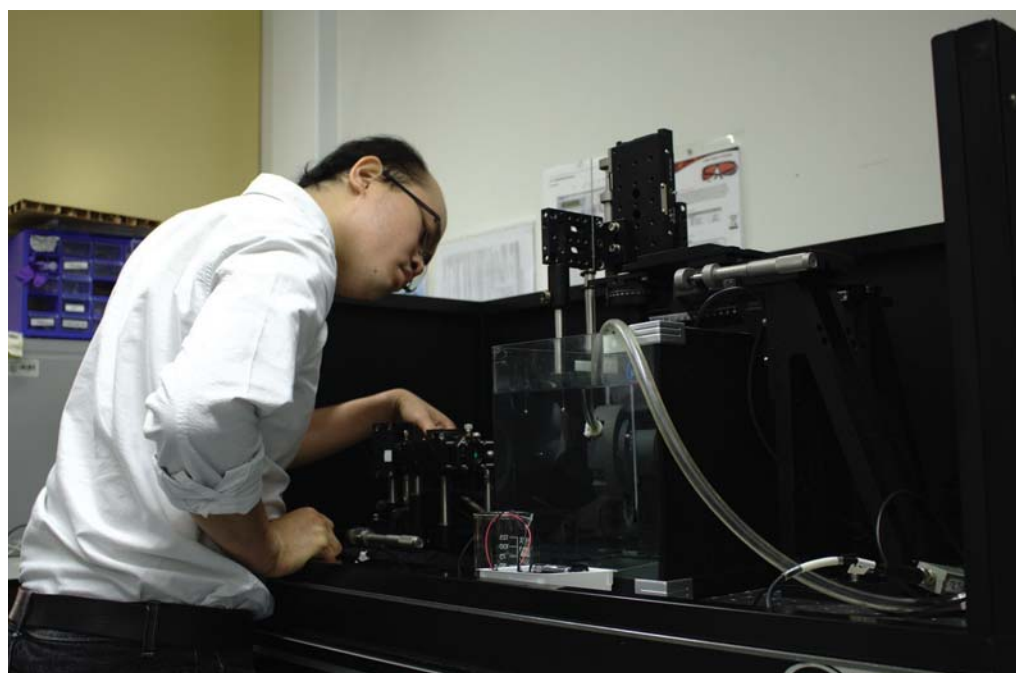
*... twelve Nobel laureates have since received early career funding ...*

The scholarships are still going strong over a century later, and have a long and illustrious list of recipients. Among the first beneficiaries of the programme was Ernest Rutherford, a young physicist from New Zealand who came to Cambridge in 1895 and whose pioneering research on the structure of matter would eventually win him the Nobel Prize for Chemistry. A total of twelve Nobel laureates have since received early career funding from the 1851 Commission scholarships, including Paul Dirac and Peter Higgs.

By the 1980s, an important priority for the Commissioners was to help businesses understand and harness the power of technology. A common complaint we were hearing from industry at the time was that although they could see the importance of investing in technology research, most did not have the resources to devote to it.

It was to help overcome these challenges that we set up the Industrial Fellowships, a scheme which allows businesses to team up with a university to conduct doctoral-level research over three years with the aim of

producing a patented product or industrial process. With a financial value of up to £80,000 a year, the Commission pays half the Fellow's salary as well as their university fees for the duration of the programme. There is also a generous annual travel allowance.



Shuning Bian

The Industrial Fellowships have already had a tremendous impact, giving businesses across all sectors the opportunity to support their brightest employees and explore the benefits of technological innovation. The importance of such a programme has been made clear by the range of companies where Fellowships have been awarded – ranging from such industrial giants as Rolls Royce, BP and BAE, to start-ups and SMEs on the brink of success.

Our 2014 Fellows, publicly announced in October last year,

cover an exceptionally broad spectrum from aerospace engine design to improved drug delivery mechanisms, by way of social media analysis and chemical engineering techniques. The Commission takes a very broad view of what constitutes 'productive industry'.

One of the most remarkable Fellows is Shuning Bian, a graduate of the University of

We are always eager to receive applications from new universities, companies and areas of research, and have continued to expand the scope of the programme year on year. Applications for our 2015 Fellowships are currently being considered; they will open again in October for 2016.

Whether in medicine or aerospace, energy or consumer

Sydney currently completing his PhD at Oxford. In his role at Lein Applied Diagnostics, he is working to speed up the development of 'microbubble' drug delivery by improving the techniques currently used to

technology, the 1851 Royal Commission aims to continue the legacy of the Great Exhibition by making a difference to the UK's manufacturing capacity. Our Industrial Fellowships have

*... a very broad view of what constitutes 'productive industry'...*

model its impact. Motivated by his personal experience of chemotherapy in 2006 for treatment of leukaemia, Bian's Industrial Fellowship project will facilitate the development of a wide variety of new medical procedures.

proven a highly successful way of encouraging industry to look ahead, investing in ideas today that will turn into the technologies of tomorrow.

# THE ACOUSTIC DESIGN OF SCHOOLS – RESEARCH AND REGULATION



Professor Bridget Shield  
Professor Emerita, London South  
Bank University and Immediate Past  
President, Institute of Acoustics

## Introduction

Poor acoustic design of a school can impede learning by making it difficult for pupils and teachers to hear and understand each other, and by causing high noise levels which affect pupils' concentration. Such problems have been recognised for well over a century, and guidance and recommendations on how to avoid them have been available in the UK for over 80 years. Research carried out during the past 50 years has demonstrated that noise and poor acoustic conditions in schools affect teachers' health and pupils' wellbeing, development and academic achievements. Despite this

### *... acoustic conditions that were not suitable ...*

knowledge, until the new millennium many school buildings still had acoustic conditions that were not suitable for teaching and learning. For this reason, in 2003, the acoustic design of new school buildings in England and Wales became subject to the Building Regulations. The acoustic standards for new school buildings to be met in order to comply with the Building Regulations were contained in Building Bulletin 93: The Acoustic Design of Schools (BB93), published by the Department for Education and Skills. The standards have recently been updated to reflect recent experience of designing and building schools, and the

current state of knowledge concerning the effects of poor acoustics on pupils and teachers. In addition to complying with the Building Regulations, meeting the standards in BB93 also provides a means of satisfying the 2012 Schools Premises Regulations (SPR), which apply to school buildings when in use, and the 2013 Independent Schools Standards.

### **What is required to provide a good acoustic environment in a school?**

In a school it is essential that pupils are able both to hear and understand their teacher, that is, the acoustic environment must provide good 'speech

exacerbated in open plan teaching areas. Furthermore, high noise levels and/or too much reverberation make rooms difficult to speak in, leading to a high risk of voice damage among teachers. In severe cases this may cause extended periods of sick leave or even early retirement.

The main requirements are therefore low background noise levels and low levels of reverberant sound. To keep noise levels as low as possible it is necessary to control the amount of internal noise from sources such as heating and ventilation systems and equipment within a teaching space. Noise from external sources such as road traffic can be reduced through good sound insulation of the building façade. Internal walls and partitions, floors and ceilings must also provide effective insulation to prevent noise being transmitted from other areas within the school, for example from music rooms to classrooms.

Hard reflective surfaces such as glass increase the quantity of

intelligibility'. It is also important that teachers can speak easily without forcing their voices which can lead to vocal damage.

Speech intelligibility depends upon the level of noise and amount of reverberation, or reflected sound, in a room. If noise levels are too high or a room is too reverberant speech

### *... control the amount of internal noise ...*

intelligibility is reduced and pupils have difficulty hearing and understanding their teacher and their peers. Noise inside the classroom or transmitted into the classroom from other areas can also interfere with teaching and learning and distract pupils. These potential problems are

reflected sound in a space, leading to a high level of reverberant sound. The level of reverberation can be controlled by ensuring that there is not an excessive amount of sound reflection within a space. This can be achieved through the installation of sound absorptive



material such as acoustic tiles on the ceiling, absorptive panels on the walls or carpet on the floor.

### Evidence for the effects of noise and poor acoustics

An impetus for the original publication of Building Bulletin 93, and its subsequent revision, was the increasing body of evidence concerning the effects on pupils and teachers of noise and poor acoustic conditions<sup>1</sup>. Studies carried out worldwide over the past 50 years have shown that noise from both external sources and inside the classroom can cause annoyance and distraction to pupils and, for younger children, reduced number, letter and word recognition<sup>2</sup>.

For the past 15 years a research team from London South Bank University, the Institute of Education and the

University of Salford has been investigating the effects of noise and acoustic design in primary and secondary schools in England. This research has been funded primarily by the Engineering and Physical Sciences Research Council, but also, in the early 2000s, by the Department of Health and Defra. This has shown that pupils of all ages and their teachers are annoyed by noise; pupils as young as seven are aware that noise causes difficulties for them in hearing the teacher<sup>3</sup>. It was also found that in primary schools in London both internal classroom noise, or 'babble', and external noise from sources such as road traffic and sirens reduced schools' scores in Standardised Assessment Tests (SATs) at both Key Stage 1 (KS1, year 2, age 7) and Key Stage 2 (KS2,

year 6, age 11). These results were maintained when the data were corrected for confounding factors such as social deprivation and English as an additional language<sup>4</sup>. To illustrate these effects, Figure 1 shows the relationship between KS2 Mathematics scores and maximum noise levels of individual external events (LAmax) for one London borough; and Figure 2 shows the effects of internal classroom background noise measured in 16 primary schools in London on KS2 English scores. Testing of primary schoolchildren in arithmetic, spelling and reading in controlled classroom noise conditions also demonstrated the adverse effects of noise. A particularly important finding was that children in this age group with additional learning needs were more severely affected by

noise than their peers<sup>5</sup>. This can be clearly seen in Figures 3 and 4 which show average scores in reading and spelling tests of children with additional learning needs and their typically developing peers, when the tests were performed in quiet conditions and in classroom babble.

Similar results have been found in the research in secondary schools. Noise of classroom babble reduced the performance of students aged from 11 to 15 in reading, numeracy and memory tasks. A questionnaire survey of over 2500 students found that those with additional learning needs (including hearing impairment, speaking English as an additional language and receiving learning support) were significantly more aware of, and affected by, the

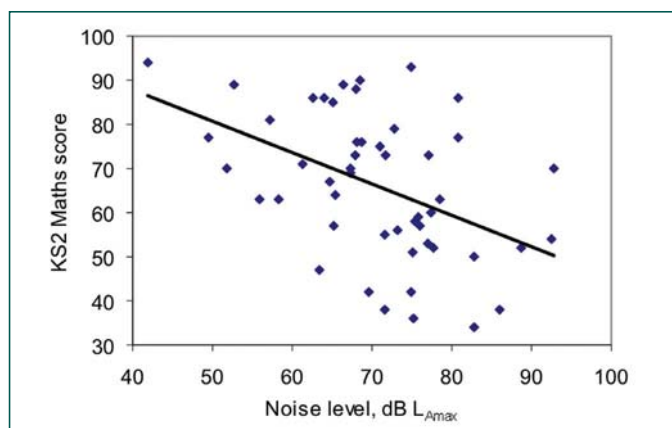


Figure 1. Scatter diagram illustrating relationship between Key Stage 2 Mathematics scores and maximum noise levels of individual events

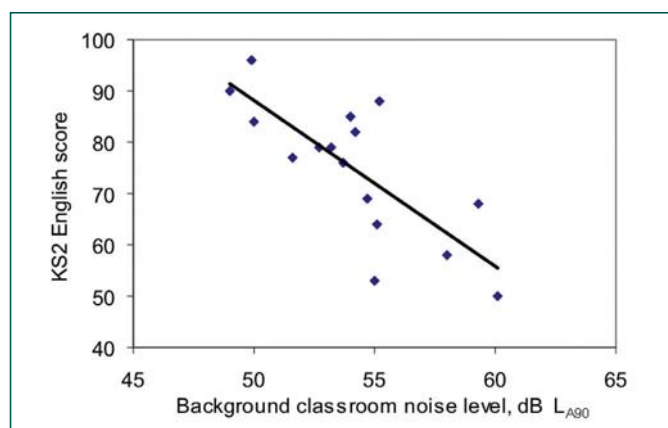


Figure 2. Scatter diagram illustrating relationship between Key Stage 2 English scores and occupied classroom background noise level.

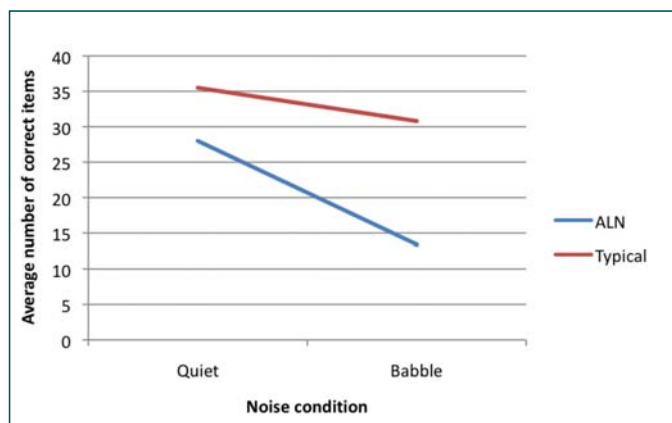


Figure 3. Effects of classroom babble on reading for pupils with additional learning needs (ALN) and typically developing pupils.

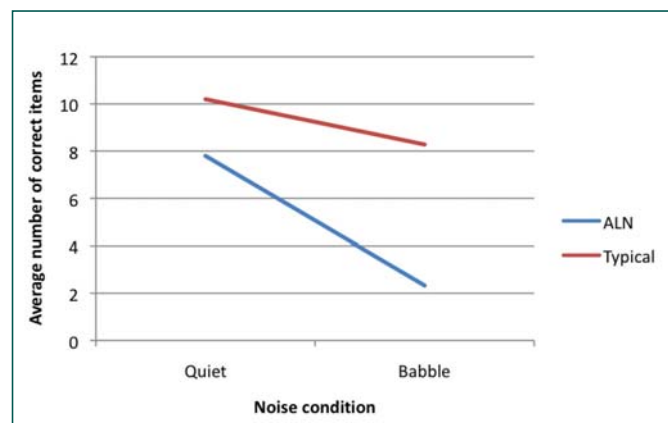


Figure 4. Effects of classroom babble on spelling for pupils with additional learning needs (ALN) and typically developing pupils

negative aspects of their school's acoustic environment than were other pupils<sup>6</sup>.

An additional finding in both primary and secondary schools was that the pupils' speed of processing information was significantly less in noise than in quiet classroom conditions.

### Open plan classrooms

Open plan classrooms originally became popular in the 1970s but fell out of favour owing to problems of noise and visual distraction. However, in the late 1990s, partly due to changing architectural and educational fashions, many new schools incorporated large open

### *... annoyance and distraction to pupils ...*

plan areas, many of which are generally unsuitable for traditional teaching and often disliked by pupils and teachers. Additional research at London South Bank University and the Institute of Education investigated the acoustics of open plan classrooms. The research led to the development of designs which could reduce the impact of noise and optimise conditions for teaching and learning in such spaces<sup>7</sup>. These strategies have been incorporated into the revised regulations and guidance on school acoustics.

### Revision of the performance standards and guidance

In order for a school to comply with Building Regulations in respect of its acoustic design, the acoustic performance standards set out in BB93 must be met. The purpose of BB93 is to ensure that school buildings provide acoustic conditions that enable effective teaching and learning, taking account of the current state of knowledge of construction techniques, building

materials and research. Throughout the drafting of the 2003 edition of BB93 and its subsequent revision the Department for Education has been advised by a panel of specialists in classroom acoustics. The panel has included academics, acoustic consultants, educationalists and audiologists, drawn mainly from the Institute of Acoustics and the Association of Noise Consultants.

BB93 gives individual minimum requirements aimed at providing appropriate levels of noise and reverberation in many different types of area within a school such as classrooms,

science laboratories, music rooms and sports halls. Standards are given for ambient noise levels (the level when a space is unoccupied), reverberation times (a measure of the amount of reverberation in a room), and sound insulation between spaces. The 2003 edition of BB93 applied only to new school buildings. However, the scope of the recent (December 2014) revision has been extended so that it now contains standards for both new and refurbished buildings.

### *... effective in improving the acoustic quality ...*

Another change relates to the provision of suitable acoustic conditions for teaching pupils with hearing impairments and other special needs in mainstream schools. In 2003 more stringent conditions were specified for rooms used specifically by hearing impaired pupils. In the 2014 version the group of pupils to whom the more stringent standards apply has been widened to include pupils with other

communication difficulties such as auditory processing disorders, attention deficit hyperactivity disorders (ADHD), autism, visual impairments and general speech and language difficulties.

### *... additional learning needs were more severely affected ...*

The standards for these pupils are more rigorous than previously, reflecting increasing knowledge about their requirements.

Detailed guidance on how to design school buildings to meet the standards is to be published by the Institute of Acoustics and Association of Noise Consultants in the summer of 2015.

### Have the regulations and standards been effective?

The recent project on the acoustics of secondary schools provided an opportunity to examine the effectiveness of the standards introduced in 2003.

### *... Standards are given for ambient noise levels ...*

Following the introduction of regulation, the number of school buildings with acoustic conditions meeting the performance standards doubled<sup>8</sup>. This demonstrated that the regulations have been

effectiveness of the introduction of the standards in 2003 also highlight the importance of maintaining regulations on the acoustic design of schools.

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# SET FOR BRITAIN 2015

## Parliament Showcases Britain's Future

Scientists Engineers Technologists Mathematicians

On Monday 9th March 210 early-career researchers from Universities and research institutions throughout the country converged on Westminster to take part in SET for Britain 2015, the annual poster competition and exhibition, held this year in the Attlee Suite in Portcullis House. They were welcomed to Westminster by Andrew Miller MP, Chairman of the Parliamentary and Scientific Committee, and, during the course of the day, had the opportunity to show their posters and explain their research to some 70 Parliamentarians from both Houses.

Gold, Silver and Bronze winners in each category received certificates and cash prizes, with medals going to the Gold prize winners. The prizes were presented by representatives of the organisations which had generously supported the event: INEOS Group, BP, Essar Oil UK, Clay Mathematics Institute, WMG, Institute of Biomedical Science, Wiley and the Bank of England.

The competition was divided into five specialist sections: Biological and Biomedical Sciences, Chemistry, Engineering, Mathematical Sciences and Physics. Judging panels for each category were formed of distinguished scientists and engineers from the Society of Biology, The Physiological Society, the Royal Society of Chemistry, the Royal Academy of Engineering, the Council for the Mathematical Sciences and the Institute of Physics.

The judges' initial task had been to select the 210 posters for the exhibition and final of the competition from the 475 original high quality entries.

At the end of the day the winners of the five Gold medals competed for the Westminster Medal, donated by the SCI in memory of Dr Eric Wharton, founder of SET for Britain. Lord Oxburgh and Andrew Miller MP faced the challenge of deciding which of the five posters best demonstrated the presenter's skill in communicating the scientific concept. Julian Perfect, Hon Secretary, SCI London Group, and Mrs Sue Wharton presented the Westminster Medal to Robert Woodward, Department of Physics, Imperial College London, winner of the Gold Award in the Physics section.



**Westminster Medal Winner**

L-R: Lord Oxburgh, President, Parliamentary and Scientific Committee; Dr Stephen Benn, Society of Biology and a Vice-President of the Parliamentary and Scientific Committee, Master of Ceremonies on the day; Andrew Miller MP, Chairman, Parliamentary and Scientific Committee; Robert Woodward (Winner of the Gold Award for Physics and of the Westminster Medal); Julian Perfect, SCI; and Mrs Sue Wharton (widow of Dr Eric Wharton).

## PRIZE WINNERS

### BIOLOGICAL AND BIOMEDICAL SCIENCES

#### Gold Award and GW Mendel Medal

Mr Dean Lomax, University of Manchester  
A NEW SPECIES OF ICHTHYOSAURUS FROM THE LOWER JURASSIC OF WEST DORSET, ENGLAND

#### Silver Award

Miss Kinda Al-Hourani, University of Oxford  
ACTIVINS AND ANTIVIRAL IMMUNITY

#### Bronze Award

Ms Sana Suri, University of Oxford  
POOR BRAIN HEALTH IN YOUNG PEOPLE AT A GENETIC RISK FOR ALZHEIMER'S DISEASE

### PHYSICAL SCIENCES (CHEMISTRY)

#### Gold Award and Roscoe Medal

Dr Yuval Elani, Imperial College London  
ARTIFICIAL CELLS AS MICROMACHINES: THE NEXT GENERATION OF DRUG DELIVERY VEHICLES

#### Silver Award

Miss Natalie Theodoulou, GlaxoSmithKline Research & Development  
THE DEVELOPMENT OF I-BRD9: A SELECTIVE, CELL ACTIVE CHEMICAL PROBE FOR BROMODOMAIN CONTAINING PROTEIN 9

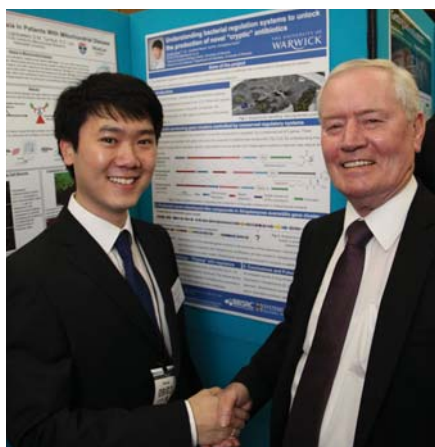
#### Bronze Award

Mr Ryan Gorman, University of York  
COPPER-CATALYSED C-H ACTIVATION: A SUSTAINABLE, EFFICIENT AND INEXPENSIVE WAY TO PREPARE MEDICINALLY IMPORTANT STRUCTURES



**Bioscience Prize Winners**

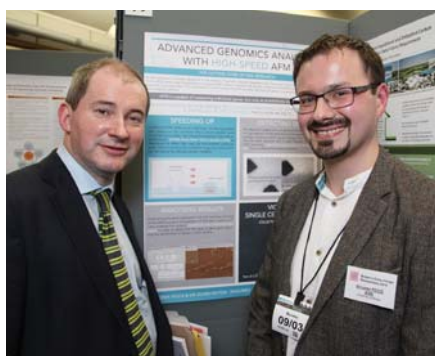
Back row: James Perham-Marchant, Wiley (Bronze sponsor); Nick Kirk IBMS (Silver sponsor); Tom Crotty, INEOS (Gold sponsor); Professor Mary Morrell, Chair, Policy Committee, The Physiological Society; Dr Laura Bellingan, Director of Science Policy, Society of Biology; Dr Stephen Benn, Director of Parliamentary Affairs, Society of Biology; Front row: Dean Lomax (Gold winner); Sana Suri (Bronze winner); Kinda Al-Hourani (Silver winner); Andrew Miller MP



Vincent Poon and Jim Cunningham MP



Nicky Morgan MP and Paul Brack



Stephen Williams MP and Dr Loren Picco



Joe Spencer and Caroline Nokes MP



Dr Thomas Woolley and Nicola Blackwood MP



**Engineering Prize Winners**

L-R: Jon Mason, Essar Oil UK (Gold Sponsor); Dr Nasrin Al Nasiri (Gold); Mr Davide Zilli (Silver); Dr Stephen Benn; Miss Agnieszka Dzielendziak (Bronze); Andrew Miller MP



## PHYSICAL SCIENCES (PHYSICS)

### Gold Award and Cavendish Medal

Mr Robert Woodward, Imperial College London  
EXPLOITING NANOMATERIALS FOR ULTRAFAST PHOTONICS

### Silver Award

Dr Elena Andra Muntean, Queens University Belfast  
DUST AND ICE: THE BIRTHPLACE OF NEW MOLECULES IN INTERSTELLAR SPACE

### Bronze Award

Mr Jason Hunt, Mullard Space Science Laboratory, UCL  
A PRIMAL VIEW OF OUR GALAXY, MADE POSSIBLE BY GAIA AND M2M MODELLING

## ENGINEERING

### Gold Award and Engineering Medal

Dr Nasrin Al Nasiri, Imperial College London  
ENVIRONMENTAL BARRIER COATING FOR SI-BASED CERAMIC COMPOSITES

### Silver Award

Mr Davide Zilli, University of Southampton  
SEE WHAT YOU CANNOT HEAR: SEARCHING FOR THE VANISHING NEW FOREST  
CICADA

### Bronze Award

Miss Agnieszka Dzielendziak, University of Southampton  
DURABILITY OF SUSTAINABLE COMPOSITES IN SHIP DESIGN FOR ENHANCED  
ENVIRONMENTAL PERFORMANCE: A MULTISCALE APPROACH



### Mathematical Sciences Prize Winners

L-R: Professor Nick Woodhouse, Clay Mathematics Institute (Gold Sponsor); Andrew Miller MP; Professor Dame Celia Hoyles, Institute of Mathematics and Its Applications; Dr Miho Janvier (Bronze); Dr Lorna Ayton (Silver); Dr Peter Buchak (Gold).

## MATHEMATICAL SCIENCES

### Gold Award and Mathematical Sciences Medal

Dr Peter Buchak, Imperial College London  
LIGHTING THE PATH: THE MATHEMATICS OF IMAGINARY NUMBERS IN VERY REAL PROBLEMS OF HOLEY OPTICAL FIBRE FABRICATION

### Silver Award

Dr Lorna Ayton, University of Cambridge  
REDUCING THE SOUND GENERATED BY AEROENGINES

### Bronze Award

Dr Miho Janvier, University of Dundee  
STATISTICAL STUDIES OF SOLAR STORM GEOMETRY FOR BETTER SPACE WEATHER PREDICTIONS

## WESTMINSTER MEDAL

### Winner of the Gold Award for Physics

Mr Robert Woodward, Imperial College London



### Chemistry Prize Winners

Back row l-r: Dr Stephen Benn, Society of Biology; Andrew Miller MP; Professor Helen Fielding, UCL (Chemistry Judge); Angela Strank BP (Gold sponsor); Front: Ryan Gorman (Bronze); Dr Yuval Elani (Gold); Miss Natalie Theodoulou (Silver).



Nick Brown MP, Dr Paola Crippa and Chi Onwurah MP



### Physics Prize Winners

Back row l-r: Anne Milton MP; Dr Stephen Benn; Dr Elena Andra Muntean (Silver); Andrew Miller MP; Angela Strank, BP (Gold Sponsor); Professor Helen Fielding, UCL; James Perham-Marchant, Wiley (Bronze Sponsor); Front row: Jason Hunt (Bronze) and Robert Woodward (Gold)



Andrew Lansley MP and Dr Ya-Chun Chen

All photos © John Deehan



# VOICE OF THE FUTURE 2015



The Speaker of the House of Commons, Rt Hon John Bercow MP, opens the event

On Wednesday 4 March the Boothroyd Room was packed with young scientists and engineers – and some sixth form science students – who were taking part in this year's Voice of the Future.

Organised by the Society of Biology on behalf of the whole science and engineering community these young scientists had a unique opportunity to sit as a special 'select committee' and question all the key Parliamentary and Governmental figures involved in science policy.

The event was opened by the Speaker of the House, Rt Hon John Bercow MP, and broadcast live on the BBC Parliament Channel as well as streamed on the Select Committee website.



Sir Mark Walport, Government Chief Scientific Adviser

The first witness was Sir Mark Walport, Government Chief Scientific Adviser, who handled a variety of Questions about the science policy-making process in Government.

Then it was the turn of the 'real' House of Commons Select Committee on Science and Technology – led by its outgoing Chair Andrew Miller MP – to respond to Questions. Asked which of the Select Committee's recommendations had been ignored by the Government, Andrew Miller cited the report on the Forensic Science Service and he also hoped Ofqual would reconsider its policy on practical science for A level and GCSEs.



Other Members of the S&T Select Committee said that many MPs struggled to understand the most basic scientific issues that came before them – especially the concept of “risk” which renders MPs liable to believe scare stories and come to the wrong conclusions. Stephen Metcalfe MP advocated a constituency-based approach by scientists seeking to raise science issue



A question from the floor

with their local MP as “that is a good way of cutting through the noise” of a “cacophony of voices on hundreds of issues”.

Concluding the packed morning session the Science Minister, Rt Hon Greg Clark MP, and the Shadow Science Minister, Rt Hon Liam Byrne MP, both talked about their respective party’s commitment to science.



Members of the Select Committee



Rt Hon Greg Clark MP



Rt Hon Liam Byrne MP



On 11 March 2015 representatives from six of the UK’s main political parties clashed over how immigration, tuition fees and fiscal policy were affecting science in a unique pre-election debate organised by the Society of Biology on behalf of the science and engineering community.

Seen here are (l-r); Rt Hon Greg Clark MP, Science Minister (Conservative); Pallab Ghosh (Chair); Rt Hon Liam Byrne MP, Shadow Science Minister (Labour); Dr Alasdair Allan, Minister for Learning and Science in Scotland (SNP). Dr Julian Huppert MP (Liberal Democrat), Dr Julia Reid MEP (UKIP) and Hywel Williams (Plaid Cymru) also took part.

## A SCIENCE LEGACY FOR THE NEXT PARLIAMENT

Meeting of the Parliamentary and Scientific Committee on Tuesday 24th February

# A SCIENCE LEGACY FOR THE NEXT PARLIAMENT



The Baroness Finlay of Llandaff

Baroness Finlay is Professor of Palliative Medicine, Cardiff University School of Medicine and is involved with the following All-Party Parliamentary Groups: Cancer (vice-chair); Clinical physiology; Global health; Carbon monoxide (co-chair); Cardiac risk in the young; Alcohol misuse; Smoking and health (vice-chair); Ovarian cancer; Brain tumours; Suicide and self-harm (vice-chair); Thrombosis; Continence; Parkinson's disease (vice-chair); Antibiotics; Surgery; Dentistry; Dying well; Hospice and palliative care (vice-chair).

**The past five years have seen some astonishing advances in science in the UK, and yet we still see even the simplest application of science failing in some communities and never reaching some of the most vulnerable, who would benefit greatly.**

The frontiers of knowledge advanced almost exponentially recently. Although some may question the investments in space exploration, the adventure of the Philae probe landing on comet 67P/Churyumov-Gerasimenko was a breath-taking moment. It also revealed that the earth's oceans' waters may have come from asteroids, making us rethink the origins of the world we now live in.

This mystery was compounded by the amazing discovery that a significant percentage of DNA (around one third) on the outside of a spacecraft can survive atmosphere re-entry after a thirteen minute low earth orbit trip. Perhaps science fiction may not be too far-fetched after all.

Then there was the discovery that Saturn's moon Enceladus has a liquid ocean beneath its icy surface and that the Milky Way galaxy can be mapped in a supercluster of 100,000 galaxies across 500 light years; this galactical cluster, Laniakea, is beyond our comprehension.

Nearer to home, the threat of water shortages and fossil fuel exhaustion has been investigated at Glasgow University, where the production

of hydrogen fuel from water is looking more viable for the future. As ocean overfishing threatens the whole of our food chain, those creatures living under phenomenal pressure in the darkest of our oceans are being investigated; a Black Sea Devil anglerfish has been filmed and captured. Is this one step towards greater respect for our fish stocks?

### DEADLY INFECTIONS

In our daily lives we have taken antibiotics for granted. Now we face the threat again of even the simplest infection proving resistant to antibiotics

*... ocean overfishing threatens the whole of our food chain ...*

and therefore potentially fatal. Our abuse of antibiotics through indiscriminate prescribing in both medicine and in veterinary science, has encouraged resistant strains of bacteria to become a widespread threat. The investment in novel infection control methods and in new antibiotic drugs is lagging behind the looming threat that might return us to the horrors of the world in the first half of the 20th century.

Vaccines, such as one that totally blocks HIV infection in monkeys, may bring new

approaches to the worldwide disease. But there will inevitably be other new deadly infections as well as the re-emergence of known ones such as Ebola, initially contracted by the child Emile Ouamouno in Guinea from tree bats.

A less known but critically important fact is that five of the fifty dedicated scientists involved in tracing the Ebola epidemic died pre-publication. The dedication of so many British healthcare professionals volunteering to care for those infected and to work to contain the epidemic has been an

amazing act of generosity in the face of great personal risk.

### SOME RECENT SUCCESSES FROM THE UK

New technology and simple novel ideas are able to transform healthcare. The next Parliament must maintain pressure for widespread adoption of such advances, particularly those developed here.

Terrible trauma from warfare is a fact of our age. Research in Sheffield is harnessing 3-D



printing to try to create nerve guidance conduits for regeneration of nerves – a process that until now has seemed unachievable. Prosthetics too are developing so the bionic3 hand, produced by RSL Steeper, is so sensitive that Sean McHugh, a user, can sign his signature with his artificial limb.

Marc Kosta's smart syringe is another UK initiative that could change the futures of millions, preventing the dangerous reuse of syringes. A WHO study found that in 2010 alone, reuse of syringes with consequential transmission of blood borne infections accounted for 1.7 million new cases of Hepatitis B, 315,000 cases of Hepatitis C and 33,800 cases of HIV.

*... scientists involved in tracing the Ebola epidemic died pre-publication ...*

## ONE-OFF SURGICAL INNOVATION TO SAVE LIFE

But there is another type of innovation in the science of medicine that occurs in the UK and must be fostered, not stifled by financial arguments about tariffs for care. With narrowly defined tariffs in the NHS, there is a risk that the care costs around lifesaving innovation will not be funded.

In a thought provoking Hunterian lecture on surgical innovation, Professor Martin Elliott discussed the ethics of risks and the difficulties of defining innovation through hope in those situations that are so rare that any standard methodologies of clinical assessment are impossible.

He explained the high risk

associated with early innovation, as was seen with early organ transplantation. He cited the case of a baby born with long segment tracheal stenosis who, at the age of 12 years, required ground breaking experimental innovative interventions as his only hope of survival. Yet after care costs of £360,000 in that year, he now lives normally and

*... high risk associated with early innovation ...*

his care costs are no higher than any other teenager, and his quality of life measures are excellent.

After the failure of Lord Saatchi's Bill, discussion is now turning to whether the medical Royal Colleges should maintain registers of innovation, both to disseminate lessons learnt and

to provide a benchmark to encourage NHS Trusts and Commissioners to fund innovation, while simultaneously guarding against quackery.

For the next Parliament to build on the achievements in medical innovation in the past five years, the transfer of clinical information will need to be revisited.

*... an era of unprecedented poisoning of our planet ...*

Public education about the reality of what can and cannot be achieved by clinicians is needed to foster realistic hope, rather than false hope, in patients. Medicine needs to define what we do and do not do. And those commissioning services need a new costing

framework to understand the true costs of failing to innovate and failing to intervene.

On the world stage the legacy of medical sciences becomes meaningless if we fail to meet the most basic pain relief needs across the globe. Currently 80% of the world's population cannot access adequate analgesia. Morphine is unavailable in many

countries because ignorance of how to prescribe it safely is linked to fears of diversion into the addiction market. This leaves many of the world's poor, both children and adults, to suffer terribly and to die in unrelieved pain.

*... Morphine is unavailable in many countries ...*

It was Cicely Saunders who said that the way a person dies lives on in the memory of those left behind. All the evidence suggests that those children who are traumatically bereaved and who have no support fare far worse in all domains. The legacy of good care is found in lower morbidity and better personal and social attainment in the bereaved.

The medical innovations of recent years have often come

about through collaborative efforts of a wide range of scientific and technological disciplines. That creative free-thinking is essential for future advances across all aspects of society; the legacy of good science is a benefit to all in our society.

Here at home, our NHS needs innovation and research to move into cost effective patterns of service delivery and lower-cost interventions and treatments with greater efficacy. Without active science in every area of medicine, health care will stagnate.

But the debate is far wider than our shores. Whoever comes into power must take a fresh look at the data around agrichemicals and their safety profiles. Worrying data are emerging on the herbicide glyphosate, which may be a carcinogen. We need to look at contamination of our food supply, our atmospheric pollution and the effects on wildlife and the food-chain.

The UK can and should lead the way in exploring safety. Failure to do this will mean our legacy will be an era of unprecedented poisoning of our planet. No amount of science will reverse that. Extinct species cannot be revived, depleted fish stocks take decades to recover and environmental pollutants will remain poisons into the next century.

Political policies towards the poorer or politically unstable nations must leave our science legacy unshared. National security will be enhanced by leading by example, through good science.

# A SCIENCE LEGACY FOR THE NEXT PARLIAMENT



Andrew Miller MP  
Chairman, Parliamentary and Scientific Committee  
Chair, House of Commons Select Committee on Science and Technology

At my last meeting of the Parliamentary and Scientific Committee I stood aside as Chair to enable me to become one of the presenters.

I wanted to cover a number of key points and to look at how Parliament handles scientific issues touching on:

- the House of Commons Select Committee,
- things that are now embedded in the annual diary such as, "SET for Britain", "Voice of the Future" and "Parliamentary Links Day",
- the role of POST,
- the P&SC,
- Parliament's engagement with learned societies,
- the Royal Society Pairing Scheme
- the House of Lords Select Committee.

## ... Relationships with the learned societies ...

On the last point I invited the audience to think about the consequences either of the House of Lords becoming a fully elected chamber, or if it were to be abolished. I argued that

election. I am not arguing against change, but making the case for determining purpose before form, something that in my experience in Parliament rarely happens!

## THE SCIENCE & TECHNOLOGY SELECT COMMITTEE IN THE COMMONS

During the current parliament the committee received written evidence from over 1900 organisations or people as part of the production of some 40 reports involving 661 witnesses, 74 inquiries and 170 meetings. A number of other things have also been done including revamping the website and piloting an (almost) paperless select committee meeting system. I think the Committee was pretty effective and has benefited from the consequence of the direct election of the

The committee produced a Legacy Report designed to leave some thoughts for our successor committee to consider, gaps that we identified, and also to look at the strength and weaknesses of the current system.<sup>1</sup>

## POST

The Parliamentary Office of Science & Technology<sup>2</sup> had an interesting genesis and I played a role in helping it become a formal part of the Parliamentary system. In the early 90s I was a member of the House of Commons Information Committee (in those days as a pressed man not a volunteer!) and it was that committee's recommendation to bring POST formally into the House. POST was created by members of the P&SC when Margaret Thatcher was the Prime Minister. She would not give the project any money but gave it her blessing and as a consequence a number of charitable foundations supported the creation of the original body. All of this was achieved by way of an intermediate charity, the Parliamentary Science & Technology Information Foundation (PSTIF). This still exists under the chairmanship of the Earl of Selborne. Its most recent significant role was to act as the funder of POST's work in Africa.

At the beginning of the 2010 parliament there was an internal POST Note *Thinking About the Next Five Years*. I challenge anyone not to recognise the importance of the issues POST raised, and point out there was not an item in the document that wasn't subject of policy

chair. I stress that is not because I was the winner, but it gives the role considerably more authority than had my predecessors. It has also been helped by having a number of committee



Recent POST documents

either would produce a science vacuum as people who have reached the peak of their career are hardly likely to stand for

members who have served throughout the parliament and have contributed significantly to its working.

discussions during the last Parliament.

## PARLIAMENTARY & SCIENTIFIC COMMITTEE

Reflecting on the role of the Parliamentary and Scientific Committee over the last 5 years I would point to improvements in *Science in Parliament* and the web site. I would also praise the team that has made SET for Britain<sup>3</sup> a formal part of the calendar. We had some amazing entries for the last competition

scientists find it invaluable to discover how Parliament actually works!

Relationships with the learned societies have gone from strength to strength. During the last Parliament leaving aside the huge benefit that comes from the energy and drive of people like Dr Stephen Benn there have been further steps forward. I would highlight improvements with the mathematics community. David Youdan and others who have driven the

### *... serious issues for the international community ...*

on 9th March. This year's SET got a very wide coverage in local, national and specialist media and, thanks to David Dent, a significant amount of social media coverage. This is a key event in the Parliamentary calendar at which MPs can

creation of the Council of Mathematical Societies<sup>5</sup> deserve a lot of credit as it is clear that a more co-ordinated approach that they now bring for mathematics has had a worthwhile impact.



Andrew with Professor Sarah Coupland, Director of the NWCR Cancer Centre at the University of Liverpool, his Royal Society "pair" in 2014.

improve connections with scientists in their own constituency as well as providing a unique setting for early career scientists to display their work.

## EXTERNAL LINKS

The Royal Society Pairing Scheme<sup>4</sup> has been in existence since 2001. This model really works and most importantly provides a means for a Member of Parliament to create a long term relationship with scientists with whom he or she is paired. I have been involved from its inception and I know that

## SCIENCE IN THE 2010-15 PARLIAMENT

Having reflected on the tools available to Parliamentarians to keep abreast of science and engineering I now pose the question, "What should we be saying to parliamentary colleagues who find themselves in this place on the 8th May this year?" Well, first of all congratulations!

Our Select Committee legacy report is going to be part of that advice. Some of the issues that we covered included really big

issues that will not go away, like anti-microbial resistance, climate science, and funding. The consequences of the Nurse Review<sup>6</sup> either side of two Triennial Reviews and alongside a Communications Review being undertaken within the Research Councils by the Cabinet Office remain for the future.



There are some serious issues for the international community. We need genuine freedom of movement amongst our top scientists. If we allow the current Daily Mail style condemnation of all migrant labour to continue we will be doing profound harm to our science base and to our universities.

### *... do more to help individual MPs ...*

Neither can we ignore some of the key science issues in education, whether it be

- the shortage of teachers with science qualifications in our primary schools,
- the number of girls going on to do A Level physics,
- the unsatisfactory way in which Ofqual are handling the whole issue around science practicals,
- funding technical apprentices,
- HE & FE.

## PUBLIC ENGAGEMENT

Alongside these challenges there are some really positive things for us to consider; how do we grow the STEM Ambassador<sup>7</sup> network; how do we give support to the Science Media Centre, CaSE<sup>8</sup>, Sense about Science<sup>9</sup>, and the British

Science Association? The need for Parliament to work with these organisations to help improve public understanding of the complex issues that we face today is overwhelming.

Finally going back to my comments in terms of the Royal Society pairing, I am passionately of the view that we need to do more to help individual MPs create their own network of contacts covering all of the key science and engineering disciplines to ensure that we are an even better informed and better equipped parliament to deal with the challenges of the next five years.

The Parliamentary & Scientific Committee is a mature organisation now past 75 years of age. Indeed we celebrated our birthday in 2014 at Buckingham Palace under the patronage of our past president HRH The Duke of Edinburgh. Nevertheless we need to continue to refresh the ways in which we work. I hope that

newly elected Members will play their part.

For my part, it has been a pleasure to chair the P&SC for the last five years. It would have been impossible without our staff, our volunteers and members, all of whom have worked so hard.

## References

- 1 This report has now been published at <http://www.publications.parliament.uk/pa/cm201415/cmselect/cmsctech/758/75802.htm>
- 2 <http://www.parliament.uk/post>
- 3 <http://www.setforbritain.org.uk/background.asp>
- 4 <https://royalsociety.org/training/pairing-scheme/>
- 5 <http://www.cms.ac.uk/>
- 6 <https://www.gov.uk/government/publications/nurse-review-of-research-councils-terms-of-reference>
- 7 <http://www.stemnet.org.uk/ambassadors/>
- 8 <http://sciencecampaign.org.uk/>
- 9 <http://www.senseaboutscience.org/>



# STAR LIGHT



Dr Rob Massey  
Deputy Executive Secretary,  
Royal Astronomical Society

**There are few more fitting topics than astronomy for 2015, the International Year of Light, and the Royal Astronomical Society is proud to be a partner in the celebration of everything our science is about. Astronomers have to make the most of every photon they detect, in the process eking out information about the universe around us, to better understand the origins and ultimate fate of the planet we live on.**

Anyone who has, even once in their life, been fortunate enough to see a night sky unsullied by light pollution will understand the power that view has to provoke soul-searching questions. Early civilisations were inspired too, placing their gods and heroes in the sky in constellations, and building stone circles to reflect the movement of the Sun and Moon.

Without the aid of modern instruments, early astronomers used light entering their eyes to speculate about the nature of the Sun, Moon, stars and planets, with various attempts made to establish the scale of the universe and whether the Earth was really at its centre. The Islamic world saw many of the best efforts, like Ulugh Beg's 15th century observatory in Samarkand, which used a giant sextant to measure the positions of the stars to high precision.

## *... using mirrors instead of lenses ...*

But the real revolution began in 1608, with the application by Dutch optician Hans Lippershey for a patent for a new instrument. He assembled two lenses into a 'telescope', extending the view terrestrial observers had of their surroundings, an invention that was rapidly adopted across Europe. Telescopes do two crucial things; they collect more light than the eye can alone, making it possible to see fainter objects, and they improve resolution, letting us see those objects more clearly.

In the UK one of these 'Dutch trunks' found its way to the traveller, mathematician and scientist Thomas Harriot, who in 1609 turned it to the night sky from his lodgings in Syon House

in what is now west London. Harriot drew the first image of the Moon and soon made a surprisingly good map of its surface through a telescope, and also recorded sunspots. Unlike the deservedly more famous Galileo, little of his work was published in his lifetime, but he nonetheless deserves recognition for his efforts.

Galileo did far more across science and engineering as a whole, and in astronomy his more elegant lunar drawings reflect his artistic training. His illustrations from those first years look crude today, but are remarkable given the poor quality and restricted field of view of the earliest telescopes. With long tubes and unwieldy mountings, astronomy at the time was hindered by more than just weather.

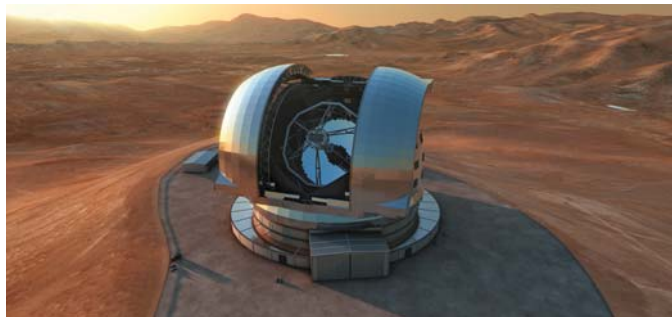
In the same century Isaac Newton and others designed

the telescopes that would improve upon those first devices, using mirrors instead of lenses to bring light to a focus. Lenses more than 1 metre across are not practical for telescopes, because they can only be held in place at their edges, whereas a mirror (supported from behind) can be built on a far larger scale. 'Reflecting' telescopes are therefore at the heart of all modern professional optical observatories. (In passing it is worth noting that William Herschel, first president of the Royal Astronomical Society, used a Newtonian reflector to discover Uranus in 1781, in the process doubling the size of the Solar System.) The issue of size is central to astronomy – seeing fainter objects more clearly is only possible by collecting more light with bigger mirrors and lenses – and this pushes astronomers and engineers to design ever larger facilities.



A Hubble Space Telescope infrared image of the Horsehead Nebula, a cloud of gas and dust in the constellation of Orion, located 1500 light years away. Credit: NASA, ESA and the Hubble Heritage Team (STScI/AURA).

As important though as the limitations of telescopes, are the weaknesses of the human eye. Our eyes see and interpret light in a complex way and for a short period of time, meaning that looking through even the largest instruments does not realise their potential. The use of photographic plates from the late nineteenth century improved this dramatically, as surveys of the sky with exposures of an hour or more revealed countless hitherto unsuspected faint stars, clouds of gas and dust (nebulae) and many more galaxies like our own – none of which were visible to the human eye simply looking through a telescope.



An artist's impression of the European Extremely Large Telescope (E-ELT) on its site on Cerro Amazonas, 3060 metres high in the Chilean Atacama Desert. With a mirror 39 metres across, E-ELT will be the largest optical/infrared telescope in the world and will start work in the next decade. Credit: ESO/L.Calçada.

In today's observatories, so-called Charge Coupled Devices (CCDs) that record up to 90% of the light that falls on them have long superseded photography. They let observatories run at maximum efficiency, wasting as little as possible of the meagre amounts of light that strikes the telescope mirror. CCDs and similar sensors have become ubiquitous in everyday life, not least in the cameras in almost every new mobile phone.

Another indispensable part of the astronomer's toolkit is spectroscopy, in which light from an object is dispersed into its constituent colours (a spectrum) by a prism or grating. For visible light these range from long wavelength red to short wavelength blue and violet. Stars and planets have characteristic patterns of dark and bright lines in their spectrum, corresponding to specific chemical elements

and molecules. With spectroscopy, astronomers can tell what an object is made of, how hot it is and also how fast it is moving towards or away from us. The power of this technique is remarkable – for example finding the signatures of oxygen and water, in the spectrum of a planet in orbit around a star, tens of light years from the Sun, could hint at the presence of life.

These days, there is a renewed push to build larger telescopes, but it is completely impractical to make single mirrors that are big enough to do the job. Engineers now make the equivalent from an array of

many hexagonal segments. The last two decades have seen the construction of a number of telescopes with mirrors 8 metres and more across, with an excellent example being the Very Large Telescope (VLT) in Chile, part of the European Southern Observatory, which collects 100,000 times as much light as Harriot's first 'trunk'. The theoretical resolution of these monster instruments is extraordinary, good enough to spot a hotel-sized building on the surface of the Moon, but unfortunately (for astronomers) the Earth's atmosphere gets in the way.

Even on the highest mountaintop sites, chosen for observatories to be above most of the cloud and much of the atmosphere, still higher turbulent air turns a sharp image of a star into a blurry, shimmering smudge. To overcome this astronomers can monitor a real

or artificial star (generated by a laser) in real time, deforming another mirror to restore a sharp image. These 'adaptive optics' systems let telescopes on the ground compete with those in space.

A more intuitive and ambitious solution is to put a telescope in space to begin with, something first suggested in 1947. This is also the only way to see many regions of the spectrum of 'light' or electromagnetic radiation, which extends far beyond what we can see with our eyes. The atmosphere stops infrared and microwave radiation from reaching the ground, along with ultraviolet, X-rays and gamma rays. Sounding rockets, balloons and planes carry instruments high enough for a temporary peek, but only satellite observatories can operate for any length of time.

The most famous of these is the Hubble Space Telescope, which celebrates its 25th anniversary this year and through our membership of the European Space Agency, the UK has been involved in Hubble from the start. This remarkable telescope has made major discoveries, including 'dark energy' (the mysterious force speeding up the expansion of



Artist's rendition of the part of the Square Kilometre Array (SKA), showing how the 15-m wide radio dishes will look when completed. Credit: SKA Organisation.

the Universe), and sent back the first pictures of forming planetary systems.

There is no sign that this quest to push the boundaries will end any time soon. The 2020s will see even more powerful telescopes on the ground and in

space. The VLT will be dwarfed by a new neighbour, the European Extremely Large Telescope, with a mirror 39 metres across, and in space the James Webb Space Telescope will take over where Hubble leaves off, observing the first stars that formed after the Big Bang using infrared light. More than a hundred thousand antennas across South Africa and Australia will make up the giant Square Kilometre Array, currently headquartered in the UK, a super-sensitive radio telescope that will have to cope with flows of data 10 times as much as that handled by the whole of the Internet put together.

We should therefore celebrate astronomy during this celebration of light. It has led to spin out companies and inventions in everything from hospital scanners to security, from analysing paintings to managing 'big data' on an enormous scale. UK astronomers are a close third in the world for the number of papers cited, have been highly regarded across the world for more than four centuries and are active in the projects that will shape the field in the next two decades.

However we should not lose sight of the passion for science and engineering that astronomy fosters. Humans are innately curious about 'star light' and what it tells us about the wider universe, and our world is a better place as a result.



# THE POWER OF LIGHT



Susie Wheeldon  
Solar Aid

**When Edison started selling electricity in 1882, over a billion people lived off grid. Today, despite huge advances in technology – breakthroughs that allow us to land space probes on comets and fight elections by hologram – that number remains unchanged<sup>1</sup>. In Africa, where the charity SolarAid operates, around 600 million<sup>2</sup> lack even the most basic lighting and energy services, more than the populations of Mexico, Canada and the US combined.**

**Yet for many, things are beginning to change. All due to the power of the simple solar light.**

## SIMPLE, SUSTAINABLE SOLUTIONS

If you were to combine a map of Africa showing areas of highest solar irradiation with one showing areas that do not receive a power supply, you would find, remarkably, that these areas overlap.

This provides us with a huge opportunity.

About six years ago three market forces came together to enable solar lights to become affordable to those living in low-income communities. Firstly the cost of solar panels came down, secondly LED technology became more efficient and thirdly, battery storage improved.

SolarAid was already working in Africa at that time, driving a wider programme including solar energy systems on schools, solar lighting products and manufacturing. But advances in small lighting technology, the reduction in price and the speed at which they could be deployed opened the door to something huge – something that could truly begin to tackle poverty and climate change simultaneously.

## THE IMPACT OF A SOLAR LIGHT

### Savings

Research shows that each solar light bought by a family in rural Africa results in the elimination of the regular use of a kerosene lamp, saving them around 10% of their annual income<sup>3</sup>. Our customers tell us that they spend their savings on food, school costs and investment in livelihoods, such as small farming inputs or, in some instances, a larger solar light they

can use to start a small business charging mobile phones.

*"I use my savings for buying soap and foods."*

Mphasto Gondwe, Malawi

### Enterprise

Nine in ten of the people we reach live under the poverty line of \$1.25 per day – so saving 10% of their income makes a staggering difference<sup>4</sup>. The knock on effects of reduced vulnerability, increased enterprise and better nutrition are difficult to quantify, but we are building research in this area and hear thousands of stories of

and opportunity. SolarAid's model, in which it has created a social enterprise to sell lights in Africa, was adopted to enable just that. By catalysing the introduction of solar markets in rural areas, rather than giving lights away, the charity not only reinvests all income into reaching more people with clean, safe light, but is creating a fledgling solar market for other organisations to join.

Kick-starting a thriving solar industry is the only way the charity will achieve its goal of eradicating the kerosene lamp from Africa by 2020.



Kerosene lamp

customers using their savings to open small businesses and their solar lights to do productive work at night.

*"Before I bought the solar I used to close my shop early but nowadays I can stay up to 9:30pm.. which has helped me to get more profits .. The customers know that I always stay for long so they always come and refer other people as well."* Charles Motoki, Kenya

Indeed, in many regions, solar entrepreneurs are now beginning to kick-start a sustainable market, creating jobs

### Health

As well as the huge economic benefits this will bring, replacing kerosene lamps with solar light also means that homes are safer due to reduced risk of fire. Even more significantly, solar lights replacing kerosene lamps reduces indoor air pollution – the 'silent killer' – that leads to 4.3 million deaths per year<sup>5</sup>.

*"I used to find soot in the noses of my children every morning when they slept in a room with kerosene, and they would complain of chest pains."* Veleidian Phiri, Zambia



Many of the parents we talk to tell us that one of the main benefits the solar light brings is an improvement in the health of their children who no longer get eye irritation or flu-like symptoms. And of course, solar lights have huge benefits for education.

### Education

Our research shows that with a solar light children can study an average of an extra hour each day<sup>6</sup>. Kerosene is often a luxury which can only be used sparingly. But with free solar light, children can do their homework, do better in exams and can write their own futures.

*"Kerosene was expensive. I did not allow [my daughter] to study at night – now she is free to study anytime."* Honoratha Elipidi, Tanzania

### Well-being and opportunity

Some of the other ways in which a solar light can benefit a family may be more difficult to

world, to become teachers, doctors, lawyers or business leaders.

*"I understand the power of energy first-hand. It transformed my life, my own life, when I was a young boy in post-war Korea. A simple light bulb illuminated a whole new world of opportunity for me, enabling me to study day and night. This memory has stayed with me such a long time, throughout my life. I want the same opportunity for all young boys and girls around the world. Widespread energy poverty still condemns billions to darkness, to ill-health, to missed opportunities for education and prosperity."* UN Secretary General, Ban Ki Moon

### Solar lights and the environment

The switch from kerosene to solar lights will have a double benefit. One relates to development. The other will enable sustainable development to mitigate climate change.



quantify, but nonetheless are valuable. Parents tell us that having light in their home at night they feel safer and no longer have to worry about leaving their children in danger of an open flame. When light is free, families can come together, and enjoy sharing time with friends and neighbours. There is less fear of standing on a snake whilst going out to the latrine (something we don't worry about in the UK!), and more hope for students with the same dreams of those around the

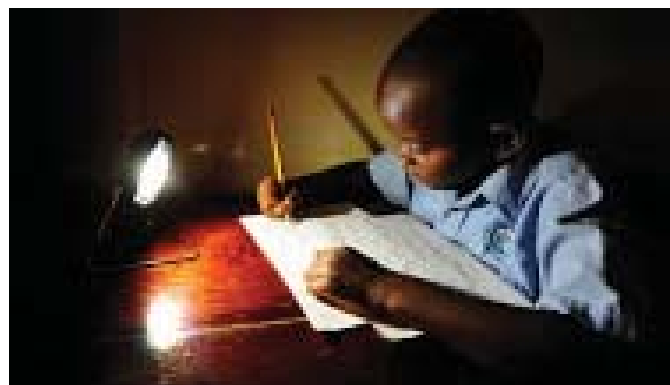
On a micro scale, each solar light replacing a kerosene lamp removes up to 200kg of CO<sub>2</sub> per year<sup>7</sup>, as well as toxic black carbon – or soot – that has a large, and immediate, impact on climate warming. On a macro scale, not only do those figures add up to create a significant whole, but the switch to solar lighting can drive low-carbon growth. We are beginning to see evidence of a clean energy ladder, where a family that has bought a small solar light, may look to buy a larger light – or even a home system.

*"I have not used the money [that I'm saving] I have kept it somewhere, [because I] am planning to buy another solar which is big."* Gladys Ombati, Kisii-Kenya

Off-grid lighting, solar home systems and mini grids can

enabled people living in some of the world's poorest countries to save over \$300 million dollars, and children to study for more than 2 billion extra hours.

Yet this is just the tip of the iceberg. SunnyMoney works in Kenya, Malawi, Tanzania, Uganda



provide a way for unelectrified rural communities to leapfrog the need for carbon intensive systems. We have seen how emerging economies moved to mobile phone technology without putting in land lines. They now lead the world in mobile enabled financial services. A similar shift could give emerging economies a clear advantage as we move towards a low carbon future.

### Getting solar lights to those who need them most

Having solar light technology is one thing, getting it where it needs to go is another. This is where SunnyMoney comes in. Unelectrified areas are often those which lack transport infrastructure, strong commerce and good communications networks. SunnyMoney works through education authorities and a network of 700 solar entrepreneurs, to reach local communities with solar lights and to build the awareness and trust needed to encourage adoption of the new technology.

The organisation has now become the biggest distributor of solar lights in Africa, having sold over 1.7 million lights, reaching 10 million people. This has

and Zambia. SolarAid's goal, however, is to develop solar markets across Africa by 2020, eradicating the toxic kerosene lamp. The educational uplift and financial savings this could bring will be astounding. Families will save billions of dollars. At government level, it will relieve pressure on already stretched resources and reduce the need for kerosene subsidies – themselves costing billions of pounds.

It is an ambitious goal. It is one we will not achieve alone. But in this UNESCO International Year of Light, we will be doing all we can to make it a reality.

For more information - or to donate or get involved, please see [www.solar-aid.org](http://www.solar-aid.org)

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# ILLUMINATING LIGHT IN MEDICAL DIAGNOSTICS AND TREATMENT



Liz Benson  
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The use of light in medicine is widespread.

**The International Year of Light 2015** gives us an opportunity to appreciate well-established practices and to increase awareness of novel techniques for diagnosis and treatment. The Clinical Scientist has a crucial role in both the development and safe use of optical techniques across wavelengths from ultraviolet (UV) to the infrared (IR). From research and development to the testing of existing and innovations in medical equipment, ensuring the safe implementation of such devices, and carrying out procedures on patients; our professional roles are varied, challenging and interesting.

signal detected by the photodiode. These measurements may be used to indicate blood vessel abnormalities such as narrowing, abnormal physiology and to provide a non-invasive measure of tissue oxygen saturation. In imaging PPG (iPPG) the pulse signals at each pixel of the camera can be used to form maps of the blood perfusion in layers of the skin.

Laser Doppler Perfusion Imaging (LDPI) can also be used for tissue perfusion mapping. A laser light is incident on the skin and penetrates to a depth governed by wavelength and power. The light is scattered by blood flowing in the tissue, the Doppler shift in the received signal indicates the degree of

pattern from a laser light illuminating skin to give information on the speed of blood flow but with the advantages of higher scan speeds and higher spatial resolution.

All objects produce infra-red or thermal radiation. This radiation may be detected using a thermal camera. In humans, higher temperatures are associated with increased blood flow. Therefore thermal imaging can be used indirectly to detect conditions indicated by abnormal levels of blood flow such as Raynaud's phenomenon, tissue inflammation, erythromelalgia, complex regional pain syndrome, and predicting the onset of foot tissue problems in patients with diabetes.

One can tell a lot by looking at a patient's hands. In capillaroscopy a microscope is used at the nail fold of the finger to look for evidence of changes to blood vessel structure ('morphology') and which might point to a connective tissue disease. Capillaroscopy is simple in concept but very powerful clinically. As well as the blood vessels, light also enables the structure of tissue to be seen and abnormalities identified. In optical coherence tomography (OCT) infra-red light is used in a similar way to ultrasound with reflections detected to produce a map of the region of interest. In this way, tissue discontinuities, micro-structures and blood

*... used to indicate blood vessel abnormalities ...*

## LIGHT FOR DIAGNOSTICS

Many diagnostic applications of light look close to the skin surface: measuring blood flow, identifying skin and blood vessel anatomy and investigating the composition of tissues. Some key examples are summarised below.

In photoplethysmography (PPG) an LED and a photodiode are used at sites such as the ear lobe, finger and toe pads. The LED light, often near infrared, is modulated by changes in blood volume in the skin and a corresponding optical pulse

blood flow present. LDPI is particularly useful in imaging burn wounds to give the clinician information about burn depth. When a perfusion image, taken in the window of 2-5 days after a burn, shows a high degree of perfusion this is consistent with good healing potential of the affected tissue. A further application of LDPI is in diagnosis of endothelial dysfunction, an exciting area which has great future potential in medicine. Using a technique similar to laser Doppler, Laser Speckle Contrast Imaging (LSCI) uses the changes in 'speckle'



vessel composition can be imaged at very high spatial resolution.

The phrase 'looking a bit off colour' is often used to describe someone who is ill. This concept is applied scientifically using spectrophotometry to measure the colour of tissue. The skin is illuminated using white light and the reflectance at different colours in the spectrum measured. One key colour range in clinical measurements is green. This method can be used to assess tissue oxygen saturation and in particular for

pigment in patches of tissue. UVB wavelength light is used to re-pigment the skin and reduce the appearance of patches.

The use of visible light in blue-light therapy is also well-established. In the treatment of jaundice, exposure to blue-light oxidises bilirubin to biliverdin, which is then excreted in bile. In the treatment of acne blue-light activates the porphyrins within the acne bacteria. These porphyrins then act to kill the bacteria and relieve the acne. Not to be forgotten, infra-red wavelengths are applied in

photons are detected and the energy exchange that has taken place indicates the state of the cell: normal, infected or cancerous. This application is used in areas that can be reached with a laser and via an endoscope, for example the skin and the urinary bladder. A map of cells in a region of interest is produced and the nature of cells and boundaries of tumours may be defined.

Cerenkov Luminescence Imaging (CLI) is also a developing technique with its first use on humans demonstrated in 2013. In CLI the  $\beta$ -emitting radionuclides used in Positron Emission Tomography (PET) are utilised. When the radionuclide collects in its target organ these  $\beta$  particles travel through tissue and cause the emission of Cerenkov Luminescence. This can be detected and is proportional to the concentration of radionuclide within an organ. The use of CLI has been demonstrated intra-

endoscope, for example skin cancer or oral cavity cancers.

Laser surgery is often carried out to remove cancerous tissue and growths. The laser is a more effective cutting implement than is a traditional scalpel. Laser beams are high precision and blood is coagulated immediately so that bleeding is reduced and there is less tissue damage, therefore healing times are lower. Lasers may also be used for excision of less accessible tumours.

## A FINAL WORD ON LIGHT

This article describes the numerous applications of light in medicine. When implementing all of these an important consideration is the safety of patients and members of staff. The health implications associated with excess exposure to UV are well documented, as are the hazards associated with the use of laser beams. One of the most important roles of the

### *... higher temperatures are associated with increased blood flow ...*

the assessment of tissue viability in leg amputation level assessments.

We can all glow ("fluoresce") in the dark! By shining light of specific colours on our tissue, typically in the UV, it can be re-emitted at slightly longer ("red-shifted") wavelengths. Knowing the fluorescence signatures of different tissues, such as collagen or haemoglobin, allows an "optical biopsy" to be made. This fluorescence spectroscopy approach is largely a research technique with great potential looking for a clinical application.

physiotherapy treatment. Infra-red light is applied directly to the injured part of the body, the radiation acts to heat the area and improve the circulation to that area. This increased circulation leads to a more rapid healing process.

Medical lasers of various wavelengths are used extensively throughout healthcare for many applications including ophthalmology, laser eye surgery, urology, gynaecology and the treatment of skin lesions.

### *... reduction of re-section and cancer recurrence rates ...*

operatively in the analysis of the removal of cancerous cells. This has implications for cancer surgery, in particular the reduction of re-section and cancer recurrence rates in breast cancer.

Photo Dynamic Therapy (PDT) is one of the most established light based cancer treatments. In PDT the patient is given a photosensitizing drug which is excreted from normal cells but remains in cancerous cells. The patient is then exposed to the specific wavelength of light which activates the drug. The drug emits active oxygen which destroys cancerous cells. This treatment is suitable for cancers in areas which can be reached with a light source either superficially or using an

Clinical Scientist is to ensure that all assessment techniques are rigorously tested prior to introduction, that clinical protocols are in place for the use of such techniques and of course that the light emitting devices within the healthcare environment are safe and fit for purpose, to ensure optimal patient treatment

There were two other speakers at the seminar: **Professor Sir David Payne**, University of Southampton spoke on **Photonics and Communication**; and **Professor Sir Colin Humphreys**, University of Cambridge, gave a presentation on **Light Emitting Diodes**. Summaries of their talks will be published in the next issue.

### *... porphyrins then act to kill the bacteria ...*

## LIGHT FOR TREATMENT

One of the most well-established applications of light for treatment is UV therapy. UV is used to treat skin conditions such as psoriasis, eczema and vitiligo. Psoriasis is caused by the fast growth of skin cells, the UV wavelength penetrates beneath the skin and slows the growth of these skin cells. UV radiation may also be used to kill the bacteria that infect the plaques associated with psoriasis. Vitiligo is an autoimmune response in which the body destroys the

## LIGHT FOR CANCER

One of the biggest challenges facing healthcare today is the diagnosis and treatment of cancer. The use of light has been applied to this problem in several areas, a selection of these are discussed here.

Raman Spectroscopy is a rapidly developing technique, used to indicate the nature of cells. A laser light is directed at the tissue of interest. As the light interacts with the tissue cells an energy exchange takes place – Raman scattering. The scattered

# THE INTERNATIONAL YEAR OF LIGHT SHEDS LIGHT ON THE 'DARK AGES'



Dr Anne-Maria Brennan

Dr Anne-Maria Brennan is Principal Lecturer in Bioscience and Forensic Biology at London South Bank University, represents the Foundation for Science, Technology and Civilisation on the Committee and also Chairs the educational charity Curriculum Enrichment for the Future

**The UNESCO International Year of Light and Light-Based Technologies is a multi-faceted celebration of light in its scientific, technological and cultural context. Central to this has been the recognition of Ibn al-Haytham as the founder of the science of optics. Dr Anne-Maria Brennan who represents the Foundation for Science, Technology and Civilisation on the Parliamentary and Scientific Committee explains why this announcement is not only timely but also sends out an important message to policy makers and scientific advisors everywhere.**

It's not every day that you get to celebrate a millennium, but 2015 represents the 1000th anniversary of the publication of *Kitab al-Manziri (The Book of Optics)*. The book was just one of over 200 written by Ibn al-Haytham which has survived and has gone on to become one of the key works in establishing the science of optics. However, there is more to the story of its writing than meets the eye, and it is for that reason that the Ibn al-Haytham initiative has become the focal point for the UNESCO International Year of Light celebrations.

culture of Medieval Europe and helped to bring about the Renaissance. In 2005 this led to the formation of its sister organisation, the aptly-named *1001 Inventions*, which specialises in global educational campaigns and award winning multi-media productions. In

965 in Basra in present day Iraq and for that reason he is sometimes referred to as *al-Basri* by reference to his origins. Little is known of his early years, however, the city of Baghdad was less than 300 miles away and was known for its House of Wisdom (*Da al-Hikmah*) – a

## ... Baghdad's position as an international crossroads ...

2010 it won the Gold Award for the best educational film at the Cannes Festival for *The Library of Secrets*, a film showcasing some of the influential figures in the history of Silk Road science.

world famous centre of learning. The library had been established by the Abbasid rulers to capitalise on Baghdad's position as an international crossroads and was an intellectual power house of the known world. Here, people of many backgrounds, beliefs and ethnicities worked together to translate documents and substantiate the facts within them.

We next find the young Al-Haytham working for the Fatimid ruler of Egypt, Kalif Al-Hakim, in the neighbourhood of the University of al-Azhar in Cairo. Al-Hakim was known for his interest in astronomy and

## ... key works establishing the science of optics ...

The Foundation for Science, Technology and Civilisation (FSTC) has been researching and celebrating this history of science for over 15 years. It has examined the important contributions of individuals and societies along the historic Silk Road, the trade route from Europe to the Far East which impacted on technology and

As a result of this and other projects, *1001 Inventions* was invited to become a UNESCO Founding Partner in the International Year of Light, with the role of spearheading the *1001 Inventions and the World of Ibn al-Haytham* initiative.

Who was al-Haytham and why is his story so relevant today? Ibn Al-Haytham was born in



International Year of Light logo – UNESCO



various technological advances and Al-Haytham worked for him on the age-old problem of the flooding of the Nile. This involved predicting and measuring flooding events whilst suggesting mechanisms for regulating them. One possibility was the construction of a dam at the site of the present day Aswan Dam. Like any good scientific advisor, Al-Haytham carefully researched the issues and evaluated his findings and reached the conclusion that the scheme would be impracticable. Legend has it that, in fear of his life because this was not the answer his employer wanted to hear, Al-Haytham feigned madness and was kept under house arrest until Al-Hakim's death in 1021.



1001 Inventions

It was during this time that he carried out experiments and wrote a number of books, including his seminal text on

### ... recognised throughout the medieval world ...

optics. He most famously constructed a *camera obscura* – a darkened room in which the outside world is projected upside down and back to front on the wall opposite a small aperture. This formed the basis of the pinhole camera and also enabled al-Haytham to explain the mechanism of the workings of the human eye. It marked a

paradigm shift in the theory of vision, as early explanations of how we see had been based on the 'theory of emanation', whereby objects were perceived by the gaze emanating from the eye. Al-Haytham demonstrated that eyes act like the *camera obscura*, with light passing through the lens and projecting the image into the eye.

Al-Haytham is also remarkable for advancing the idea of systematic and methodological experimentation. Early scientific

### ... the mechanism of the workings of the human eye...

investigation had tended to be empirical, relying on the making of observations and subsequently drawing conclusions from them.

However, al-Haytham sought to conduct experiments in which key aspects were controlled, leading to a fair test that was

reproducible. In this way he is seen as key in the development of what we now know as the Scientific Method. He also proposed an aspect of scepticism in scientific enquiry which has since become known as 'falsification', in which hypotheses are tested to destruction with the aim of discovering the truth. He

described this concept writing: *"The duty of the man who investigates the writings of scientists, if learning the truth is his goal, is to make himself an enemy of all that he reads and... attack it from every side. He should also suspect himself as he performs his critical examination of it, so that he may avoid falling onto either prejudice or leniency."* For this reason he is frequently referred to as being the first true scientist.

Not surprisingly, such advances in scientific thought and technique had a massive impact of those who followed him. His legacy was recognised throughout the medieval world and many of his works were translated into Latin. Following the convention of that time even his name was Latinised to Alhazen and he was also honoured with the title *Ptolemaeus Secundus* 'Ptolemy the Second' in recognition of

### ... problem of speaking truth to power ...

this role as a polymath. His work continued to affect the world of science long after his death, influencing both Roger Bacon and Leonardo Da Vinci as well as later thinkers such as Galileo and Rene Descartes.

Al-Haytham still serves as an example of the global reach of science. While experimenting with the *camera obscura* he used ideas and techniques that were known to both Ancient Greek and Chinese thinkers of the 7th Century. This demonstrated that scientific endeavour is international in nature and unifies a seemingly divided world. Both FSTC and *1001 Inventions* have used his

example to inspire the scientific community, and young students of science in particular, to engage as a global community. There are other valuable lessons in the story of Ibn Al-Haytham. Today, the word Basra conjures up images of war and instability yet scientific heritage shows that this was not always the case. In this way it provides a positive role model of a young scientist who, as a citizen of the world, challenged adversity in his continued pursuit of knowledge.

In declaring al-Haytham founder of modern optics and launching a campaign in his name to promote light-science for the benefit for all, UNESCO Director General Irina Bokova noted that as *"a ground-breaking scientist and humanist from a thousand years ago, the life and work of Ibn Al-Haytham have never been as relevant as they are today"*.

The legacy of al-Haytham is considerable. He literally helped revolutionise the way we view the world, and also influenced the way we undertake scientific

research. Similarly, the legend of al-Haytham's problem of speaking truth to power acts as a powerful parable for policy-makers and their scientific advisors everywhere. Happily, not all scientific advisors in the medieval world had such a tough time. Al-Idrissi, the great geographer and cartographer working in the Norman court of King Roger II of Sicily, had a much better working relationship with his employer. When he arrived in court the King, and his courtiers, would rise to his feet to greet him! But that's another story – best left for an International Year of geography!

# ELI IN THE CZECH REPUBLIC



Otakar Fojt  
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2015 coincides with many anniversaries in the history of the science of light: the works on optics by Ibn Al-Haytham (1015), Fresnel's notion of light as a wave (1815), Maxwell's electromagnetic theory of light propagation (1865), Einstein's photoelectric effect theory (1905) and general relativity (1915), and Kao's invention of fibre optics (1965). Thanks to the UK Science and Innovation Network, UK researchers are, in 2015, at the forefront of world leading discoveries in laser technologies together with their colleagues in the Czech Republic and in other parts of Emerging Europe.

In 2014, the Czech Republic spent more on science than ever before and the 1.91% of GDP it spent on R&D is a higher percentage spend than that of the UK. Czechs invested over £2bn of EU Structural funds in R&D, with a focus on top science opportunities.

The Extreme Light Infrastructure (ELI) project, is one such exciting opportunity. ELI is based in three locations of Emerging Europe (in the Czech

## £15.5m contracts for UK companies, another reason to celebrate 2015 – the International Year of Light

Republic, Hungary and Romania) with an overall budget of €920m paid from EU structural funds and national resources. It is the largest science project in new EU member states. The aim is to build a new generation of the latest laser equipment, 10 times more intense than the best currently available. ELI will provide ultra-short laser pulses of a few femtoseconds duration and give performance up to 10 PWs. It will enable the development of new techniques for medical image-display and diagnostics, radiotherapy, tools for new materials developing

### *... new techniques for medical image-display and diagnostics ...*

and testing, novel approaches in X-ray optics, and other industrial applications.

Since the project's inception in 2009, the UK Science and Innovation Network in the Czech Republic has built strong relationships both locally and in Hungary and Romania. It has maintained contact with UK stakeholders about the potential both for research collaboration and specialised R&D procurement. British commitment was underlined by the Prime Minister's visit to the ELI Beamlines facility in Prague in June 2011 with his Czech counterpart, a nuclear physicist. The PM was impressed by a renewed installation of the British Tokamak Compass D in Prague and with the UK participation on ELI laser project.

In 2012, British company Gleeds won a contract for building supervision, and the UK architects Bogle won a competition to design the ELI site. The Science and Innovation Network, working with UKTI, followed up with targeted inward and outward specialist missions. In 2014, ELI Beamlines management announced that UK companies had gained a total £15.5 million in procurement contracts. The largest contract was to the Science & Technology Facilities Council's Central Laser Facility, for the development and delivery of two diode-pumped

*collaboration and partnership in many areas of laser development and our user communities have conducted many successful experiments together."*

International collaboration plays a crucial role in the development of science and technology in the UK. It provides UK researchers opportunities to work with the best in the world, to use the best facilities in the world and to ensure science and innovation supports UK growth through international outreach. This is just one example of how the Science and Innovation Network has contributed to the success of UK science and supported UK growth. Further examples and background information on the Science and Innovation Network can be found in the recently published SIN Report (<https://www.gov.uk/government/publications/science-and-innovation-network-report>).

lasers. A further nine UK companies won smaller tenders to supply this cutting edge project.

In January 2015, the UK STFC Central Laser Facility (CLF) was awarded €250k in a successful Stage One Teaming call from the

### *... nine UK companies won smaller tenders ...*

EU Horizon 2020. The HiLASE laser facility, an adjacent project to ELI, will team up with CLF, in the development of the "next generation" laser technology based on diode pumping with significant future commercial opportunities for the UK. Professor John Collier, Director of CLF, said *"Selection of our Stage One proposal is excellent news. CLF and the Institute of Physics in Prague have a long and highly productive history of*

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# DEMENTIA HAS NO BORDERS:

## Science and Innovation Network supports the global dementia campaign

**Sara Cebrian (SIN Madrid);  
Alison MacEwen (SIN Paris);  
Dr John Preece (SIN Toronto);  
Dr Mario Rivero-Huguet (SIN Montreal)**

Dementia is a high priority for the UK. The Dementia Challenge was launched in 2012 by Prime Minister David Cameron to respond to what is one of the most important issues of the twenty first century. *"One of the greatest challenges of our time is what I'd call the quiet crisis, one that steals lives and tears at the hearts of families, but that relative to its impact is hardly acknowledged. We've got to treat this like the national crisis it is. We need an all-out fight-back against this disease; one that cuts across society".* The Foreign Secretary identified the Global Science and Innovation Network as the FCO's primary instrument to build international contact networks and promote the Dementia Challenge worldwide.

### UK SCIENCE AND INNOVATION NETWORK ACTIVITIES

As a challenge which requires innovation, collaboration and new approaches to overcome social and economic obstacles, the Science and Innovation Network was well placed to support the UK's global leadership on the dementia campaign. This took the form of several activities:

- a series of G7 Young Leaders Address Dementia workshops
- a SIN-UKTI conference on the Dementia Challenge in Madrid
- a SIN UKTI Dementia Forum in Lisbon

- a dementia hackathon in Toronto.

### YOUNG LEADERS ADDRESS DEMENTIA

In support of the UK G8 Dementia Summit, the Science and Innovation Network in Canada, France, Japan and the US hosted a series of young leaders workshops in parallel with the Global Action Against Dementia (GAAD) Legacy Events – aimed at engaging young G7 and EU experts. The workshops brought together over 120 future leaders in the field, nominated by G7 governments, patient organisations, research agencies and NGOs.



The aim of the workshops was to develop innovative ideas to inform the work of the World Dementia Council, on its priority themes of care, cure research and awareness. The recommendations were

consolidated in a declaration and a longer communiqué, hosted on UK Department of Health's Dementia Challenge website and included in the GAAD progress report. The Young Leaders' network signed a number of commitments in the Global Dementia Framework. Key areas for consideration included a focus on preventive measures (lifestyle), a need to educate young professionals, and to create a common language for all sectors to facilitate collaboration, and increase public awareness to benefit individuals living with dementia.

Six delegates from the workshops attended the First WHO Ministerial Conference on Global Action Against Dementia. The Young Leaders met the Rt Hon Jeremy Hunt to discuss their actions and thank him for leading the global initiative. The conference gave the Young Leaders the opportunity to meet with world experts and decision-makers from over 80 countries and promote this network as a key player in addressing the challenge of dementia. During the WHO conference they joined the World Dementia Council meeting to present their recommendations and four goals:

- Create a dementia challenge prize to encourage innovative, multidisciplinary and cross sector collaboration;
- Launch a competition to develop an identifiable dementia-friendly symbol for products and services;
- Expand the dementia friends campaign; as well as

- Increase the use of mobile technologies to support an integrated health and social care system at home.

These raised awareness of the UK G8 Dementia Summit and its Legacy, and created a network of G7 and European young leaders who will continue to make a contribution to the work of the UK-initiated World Dementia Council as its priorities move forward.

### DEMENTIA POLICY EVENTS IN MADRID AND LISBON

In order to support the promotion of the UK dementia challenge and collaboration beyond the G7, SIN Spain organised a conference focused on research and commercial opportunities. Outcomes of this event included Spanish company Araclon Biotech investing £200k in the Medical Research Dementias Platform (DPUK), with associated collaboration including access to DPUK research resources and data as a basis for future collaboration.

The UK company, IXICO, signed a research collaboration agreement with the Spanish R&D centre CITA and a commercial agreement with the Spanish imaging services company Grupo Eresa, both on early diagnosis. As a direct result of the conference the Consular network and UKTI Spain, in collaboration with BUPA, Tunstall and I-Spy organised an event addressing the needs of ageing British nationals living in Spain.

The Portuguese health authorities organised a



conference to discuss and build the new Portuguese National Mental Health Plan, and the UK was invited to present the Dementia Challenge. Some research and commercial outcomes were also identified: the British company IXICO and S24, their Portuguese partner, presented their partnership and the pilot project to be launched in Portugal for IXICO's Assessa technology. They will work together and also develop further R&D.

## DEMENTIAHACK

Led out of Toronto, this event brought together software

engineers, clinicians and people living with dementia to explore and create technological solutions for self- and community management. If someone living with dementia could use an app or device to self-manage, then (s)he would be able to live more independently for longer, reducing the strain on relatives, finances and the healthcare system.

SIN in collaboration with HackerNest ran a hackathon (an event where solutions have to be designed, coded and demonstrated within 24 hours)

to tap into local tech creativity, attracting around 175 people and producing 16 product pitches. The overall winner was a Web-based management tool called CareUmbrella which integrated NFC tags and mobile devices to play a video from a family member explaining how to use an appliance when a phone was placed near the appliance. CareUmbrella took home four years of hosting/support from event sponsor Linode and a business development trip to the UK for the UK HealthTech conference. They agreed a partnership with

UK-based GX Group to develop their contactless technology (creating a UK entity in the process) and met partners who may be interested in trialling the technology.

## CONCLUSION REMARKS

The Science and Innovation Network contributed to delivery of the Dementia Challenge. This model of a global thematic campaign to support and promote a priority issue for the UK, through science and innovation, will be continued this year to support other subject areas including Milan Expo, anti-microbial resistance and the low carbon economy.

## FACTS:

- Today, more than 47 million people worldwide have dementia;
- A new case is diagnosed every four seconds;
- In 2010, the total cost of dementia care was US\$ 604 billion, equivalent to 1% global GDP;
- By 2030, the minimum cost of caring for people with dementia worldwide is estimated at US\$ 1.2 trillion



# PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (POST)

## RECENT POST PUBLICATIONS

### Value Based Assessment of Drugs

January 2015

POSTnote 487

In 2010, the Government proposed moving towards a broader value-based system for assessing and pricing branded drugs. Such an approach aims to ensure that the price the NHS pays for a medicine better reflects its benefits. This outlines recent proposals to change the current assessment methods.

### The Darknet and Online Anonymity

March 2015

POSTnote 488

A small proportion of websites use sophisticated anonymity systems, which allow their operators to conceal their identity. This part of the web is commonly referred to as the darknet. The darknet helps citizens to protect their security and privacy and to circumvent censorship. It also facilitates organised crime, such as the billion dollar drug market known as Silk Road. This discusses the challenge of preventing such crimes without compromising other uses of anonymity technologies.





## Vegetative and Minimally Conscious States

March 2015

POSTnote 489

Medical advances mean that increasing numbers of people survive trauma, stroke, periods of low oxygenation and severe brain infections. Some, however, are left with substantially reduced consciousness for months to years. This discusses the medical, legal and ethical challenges associated with the care of patients in vegetative and minimally conscious states.

## Biodiversity Auditing

March 2015

POSTnote 490

Biodiversity supports the ecosystem services on which we rely for well-being and economic resources. Areas that have had an audit can make more effective use of ecological data to meet planning and conservation objectives. This POSTnote summarises the data sources used and the advantages of the audit approach for addressing biodiversity loss.

## Measuring Living Standards

March 2015

POSTnote 491

Living Standards (LS) refer to households' level of access to goods, services and recreational activities. Assessments of LS vary in how they set the thresholds that define a certain standard of living and how they measure who achieves these thresholds. This POSTnote outlines different approaches to setting and measuring thresholds and their strengths and limitations. It also summarises research on recent trends in living standards and the key factors that influence them.

## Energy Storage

April 2015

POSTnote 492

The Government lists energy storage as one of eight great technologies in which the UK can become a world leader. This briefing outlines the roles of energy storage in the electricity, heat and transport sectors and describes the technologies used from the household level up. It also discusses current barriers and policies for energy storage and potential future uptake.

## CURRENT WORK

*Biological Sciences* – Sugar and Health, Minimum Age of Criminal Responsibility, Health of Military Personnel, Anti-Ebola Treatments, Regulating Synthetic Biology, Trends in Crime and Justice, Forensic Linguistics, Cognitive Biases in Court, 100,000 Genomes.

*Environment and Energy* – Novel Food Production Technologies, Herbicide Resistance, Soils, Ecosystem Services & Food Security, Managing the UK Plutonium Stockpile, Offshore Mining, Trends in the Environment, Future of Natural Gas, Precision Agriculture, Trends in Transport.

*Physical sciences and IT* – Broadband Internet Access, Commercial Space Activities, Trends in ICT, Automation in Military Operations.

*Social Sciences* – Trends in Politics and Democracy, Trends in Education.

## CONFERENCES AND SEMINARS

### Reducing Greenhouse-Gas Emissions from Crops

On January 20th, POST hosted a working breakfast for MPs, Peers and their staff on reducing greenhouse gas emissions from crops. This briefing event brought together six experts in the field of

agriculture and emissions mitigation who spoke to the subject before answering questions. The seminar was chaired by Lord Cameron of Dillington. The speakers included: Professor Malcolm Bennett, Professor of Plant Sciences in the Plant and Crop Sciences Division, University of Nottingham; Professor Simon Blackmore, Head of Engineering and specialist in precision agriculture, Harper Adams University; Professor Dave Reay, Assistant Principal and Chair in Carbon Management & Education, University of Edinburgh; Mr Laurence Smith, Senior Sustainability Researcher, Organic Research Centre at Elm Farm and member of the Agricultural Greenhouse Gas Inventory Research Platform; Dr Luke Spadavecchia, Agricultural Greenhouse-Gas R&D Platform Coordinator, Defra; and, Mr John Williams, Principal Research Scientist, ADAS UK Ltd and Work Package Leader for the UK's Agricultural Greenhouse Gas Inventory Research Platform.

### GM Insects and Disease Control

On 10th February, POST hosted a working breakfast for MPs, Peers and their staff to discuss the science and resulting policy issues relating to the subject of controlling disease with GM insects in an intimate and informal session. This briefing event brought together eight experts who spoke on the subject before answering questions. It was chaired by Lord Naren Patel. The speakers included: Professor Andrea Crisanti, Professor of Molecular Parasitology, Division of Cell and Molecular Biology, Imperial College London; Professor Luke Alphey, Head of Arthropod Genetics Group, The Pirbright Institute; Professor John Pickett, Rothamsted Research; Professor Paulo Paes Andrade, Department of Genetics, Federal University of Pernambuco, Brazil; Professor John Mumford, Professor of Natural Resource Management, Centre for Environmental Policy, Imperial College London; Dr John Marshall, Medical Research Council Research Fellow, Faculty of Medicine, School of Public Health, Imperial College London; Professor Mike Bonsall, Professor of Mathematical Biology, Department of Zoology, University of Oxford; and, Professor Andrew Stirling, Professor of Science and Technology Policy Research Unit, University of Sussex.

### Coping with a Large Nuclear Accident

On 11th March, in conjunction with the All Party Parliamentary Nuclear Energy Group, POST hosted a seminar on strategies to mitigate the effects of a large nuclear accident. Chernobyl (1986) and Fukushima Daiichi (2011) showed that nuclear accidents can occur, even if they are very rare. This event was chaired by Ian Liddell-Grainger. A multi-university team of academics led by Professor Philip Thomas, City University London, presented work from its Engineering and Physical Sciences Research Council funded project.

## STAFF, FELLOWS AND INTERNS AT POST

### Fellows

Beth Brockett, University of Lancaster, British Ecological Society  
Lindsay Walker, University of Exeter, Natural Environment Research Council.

Stephanie Osborne, Centre for Ecology and Hydrology, Natural Environment Research Council

Claire Mawditt, Epidemiology and Public Health, University College London, Economic and Social Research Council

Samuel Murison, Social Science, Health and Medicine, King's College London, Masters intern



Daniel Slade, Geography and Planning, University of Liverpool, Economic and Social Research Council

Elo Luik, Institute of Social and Cultural Anthropology, University of Oxford, Economic and Social Research Council

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Wybo Wiersma, Oxford Internet Institute, University of Oxford, Economic and Social Research Council

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Sophie Stammers, Department of Philosophy, King's College London, Arts and Humanities Research Council

Ruth Nottingham, University of Nottingham, Biotechnology and Biological Sciences Research Council

Lorna Christie, University of Glasgow, Engineering and Physical Sciences Research Council

Harry Beeson, University of Cambridge, Engineering and Physical Sciences Research Council

Karla-Luise Herpoldt, Imperial College London, Royal Society of Chemistry

## INTERNATIONAL ACTIVITIES

On 13th February, POST collaborated with the US Government Accountability Office to host a presentation and panel discussion, Big Data: Challenges and Social Impacts, at the AAAS Annual Meeting in San Jose, USA. The panel comprised Timothy M Persons from the US Government Accountability Office, Claire Craig from the UK Government Office for Science, Dave Feinleib of The Big Data Group, George Poste from Arizona State University, Edward You from the US Federal Bureau of Investigation, and Piyushimita Thakuriah from the University of Glasgow. This wide-ranging discussion looked at how society's improved ability to collect, store, and analyse information, is creating significant opportunities across healthcare, transport, business and numerous other sectors, while raising important challenges in areas such as privacy, security and governance.

On 17th February, Dr Aaron Goater presented at a meeting of the PACITA project in Lisbon. A proposal to establish a new Parliamentary Office of Science and Technology within the Portuguese Parliament was discussed with Portuguese MPs.

On 25th-27th February, Dr Lydia Harriss, Dr Caroline Kenny and Dr Jonathan Wentworth attended a PACITA conference on 'The Next Horizon of Technology Assessment' in Berlin to speak at and chair sessions with colleagues from the European Parliamentary Technology Assessment network. These included sessions on Governance of Big Data and the Role of Technology Assessment, The Role of Research Evidence in Improving Parliamentary Democracy and Horizon Scanning: Giving Policymakers the Long View. Proceedings of the Conference will be published shortly.



# HOUSE OF COMMONS SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY

The Science and Technology Committee scrutinises the expenditure, administration and policy of the Government Office for Science, a semi-autonomous organisation based within the Department for Business, Innovation and Skills.

At the Dissolution of Parliament the Members of the Science and Technology Committee were:

Dan Byles (Conservative, North Warwickshire), Jim Dowd (Labour, Lewisham West and Penge), David Heath (Liberal Democrat, Somerton and Frome), Stephen Metcalfe (Conservative, South Basildon and East Thurrock), Andrew Miller (Labour, Ellesmere Port and Neston), Stephen Mosley (Conservative, City of Chester), Pamela Nash (Labour, Airdrie and Shotts), Sarah Newton (Conservative, Truro and Falmouth), Graham Stringer (Labour, Blackley and Broughton) and David Tredinnick (Bosworth). Andrew Miller was elected by the House of Commons to be the Chair of the Committee on 9 June 2010.

## ORAL EVIDENCE

The transcripts of these evidence sessions are available on the Science and Technology Committee's website.

On 21 January 2015, the Committee held a session on the *Science and Innovation Strategy* with Greg Clark MP, Minister of State for Universities, Science and Cities, Cabinet Office and Department for Business, Innovation and Skills, Professor Sir Mark Walport, Government Chief

Scientific Adviser, Government Office for Science. This session provided the opportunity to discuss the Government's recent science and innovation strategy. It allowed the Committee to explore what the Government expects the strategy to deliver, what the timescales on those deliverables might be, what is new in the strategy and what simply consolidates previous policy decisions and what might be missing from it.

On 25 February 2015, the Committee held a session on *The future of the Food and*

Environment Research Agency with Chris Sellers, Executive Director, Capita, Dr Dan Heard, Market Director (Science), Capita, Professor Robert Edwards, Head of the School of Agriculture, Food and Rural Development, Newcastle University; Lord de Mauley, Parliamentary Under Secretary of State for Natural Environment and Science, Department for Environment, Food & Rural Affairs. The session followed the Government's announcement on 11 February 2015, that Capita and Newcastle University had been selected to form a joint venture with the Food and Environment Research Agency (FERA), this session examined the future of FERA and how the Agency's scientific capabilities will be safeguarded.

## CURRENT INQUIRIES

If re-established in the new Parliament, the Committee will decide upon a programme of inquiries.

## REPORTS

### Advanced genetic techniques for crop improvement: regulation, risk and precaution

On 26 February 2015, the Committee published its Fifth Report of Session 2014-15, *Advanced genetic techniques for crop improvement: regulation, risk and precaution*, HC 328.

### Pre-appointment hearing with the Government's preferred candidate for Chair of the Biotechnology and Biological Sciences Research Council (BBSRC)

On 3 March 2015, the Committee published its Eighth Report of Session 2014-15, *Pre-appointment hearing with the Government's preferred candidate for Chair of the Biotechnology and Biological Sciences Research Council (BBSRC)*, HC 1087.

### Royal Botanic Gardens, Kew

On 4 March 2015, the Committee published its Seventh Report of Session 2014-15, *Royal Botanic Gardens, Kew*, HC 866.

## Current and future uses of biometric data and technologies

On 7 March 2015, the Committee published its Sixth Report of Session 2014-15, *Current and future uses of biometric data and technologies*, HC 734.

## Legacy-Parliament 2010-15

On 18 March 2015, the Committee published its Ninth Report of Session 2014-15, *Legacy-Parliament 2010-15*, HC 758.

## GOVERNMENT RESPONSES

### National health screening

On 29 January 2015, the Department of Health published the Government Response to the Committee's report on *National health screening*, Cm 8999.

### Responsible Use of Data

On 5 March 2015, the Committee published the Government's Response to its Report on *Responsible Use of Data*, HC 1086.

Responses to Reports not received by the time of Dissolution are expected to be published by Command Paper, or by Special Report after the election.

## FURTHER INFORMATION

Further information about the Science and Technology Committee or its current inquiries can be obtained from the Clerk of the Committee, Stephen McGinness, or from the Senior Committee Assistant, Darren Hackett, on 020 7219 2792/2793 respectively; or by writing to: The Clerk of the Committee, Science and Technology Committee, House of Commons, London SW1A 0AA. Enquiries can also be e-mailed to [scitechcom@parliament.uk](mailto:scitechcom@parliament.uk). Anyone wishing to be included on the Committee's mailing list should contact the staff of the Committee. Anyone wishing to submit evidence to the Committee is recommended to obtain a copy of the guidance note at [www.parliament.uk/commons/selcom/witguide.htm](http://www.parliament.uk/commons/selcom/witguide.htm). The Committee has a website, [www.parliament.uk/science](http://www.parliament.uk/science), where all recent publications, terms of reference for all inquiries and press notices are available.



# HOUSE OF LORDS SCIENCE AND TECHNOLOGY SELECT COMMITTEE

The members of the Committee, who served on the Committee for the 2014-15 session, were: Lord Dixon-Smith, Baroness Hilton of Eggardon, Lord Hennessy of Nympsfield, Lord O'Neill of Clackmannan, Baroness Manningham-Buller, Lord Patel, Lord Peston, Lord Rees of Ludlow, Viscount Ridley, the Earl of Selborne (Chairman), Baroness Sharp of Guildford, Lord Wade of Chorlton, Lord Willis of Knaresborough and Lord Winston. At the dissolution of Parliament on 30 March 2015, the Committee ceased to exist until the start of the new Parliament. The rotation rule means that nine Members are no longer eligible to serve.

## Resilience of Electricity Infrastructure

In July 2014, the Committee launched an inquiry into the resilience of electricity infrastructure. The inquiry focused on the resilience of the UK's electricity infrastructure to peaks in demand and sudden shocks. It was interested in the resilience of the system both in the short term (to 2020) and in the medium term (to 2030) as electricity generation is

decarbonised. Oral evidence concluded in January 2015. The Committee reported on 12 March 2015. A Government response will be published in the new Parliament.

## 2025: Priorities for Scientific Research

In July 2014, the Committee conducted an inquiry into the challenges that the Government's *Science and Innovation Strategy* should tackle and the UK's priorities for scientific

research. No report was produced, but evidence was taken and transcripts were published.

### Behaviour Change

In May and June 2014, the Committee took evidence from witnesses to follow up on its 2011 report into behaviour change, and assess what progress has been made in this area. This focused on the two behaviour change case studies that the Committee had investigated in its original inquiry: modal shift in transport and obesity. The Committee wrote to the Minister for Government Policy, Rt Hon Oliver Letwin MP, making a number of observations and posing a series of questions. It received a reply.

### International STEM students

In January 2014, the Committee launched a follow up inquiry to its 2012 report on higher education in science, technology, engineering

and mathematics (STEM) subjects. The inquiry focused on the effect on international STEM students of immigration policy. Many submissions were received, seven oral evidence sessions were held, and a report published on 11 April 2014. A Government response was received in July. A debate was held on 19 March 2015.

### FURTHER INFORMATION

The reports, Government responses, written and oral evidence to the Committee's inquiries mentioned above, as well as the Calls for Evidence and other documents can be found on the Committee's website. Further information about the work of the Committee can be obtained from Chris Clarke, Committee Clerk, [clarkechr@parliament.uk](mailto:clarkechr@parliament.uk) or 020 7219 4963. The Committee Office email address is [hlsceince@parliament.uk](mailto:hlsceince@parliament.uk).



## HOUSE OF COMMONS LIBRARY SCIENCE AND ENVIRONMENT SECTION



Scientists and other staff in the Science and Environment Section provide confidential, bespoke briefing to Members and their offices on a daily basis. They also provide support to Commons Select Committees, and produce longer notes and research papers which can be accessed on line at <http://www.parliament.uk/topics/topical-issues.htm>

Summaries of recently updated briefings are opposite.

For further information contact:  
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### RECENT PUBLICATIONS

#### Mitochondrial Donation

22nd October 2014 | SN06833

New mitochondrial donation techniques could provide an option for women with mitochondrial DNA mutations to enable them to give birth to healthy children. They involve using donor mitochondria in an in vitro fertilisation (IVF) treatment.

This provides a summary of the role of mitochondria, mitochondrial disease and the proposed new techniques. It also provides information on the reviews and consultations. The main safety and ethical considerations associated with the introduction of mitochondrial donation into clinical practice are discussed. Summaries of recent Parliamentary debates and a House of Commons Science and Technology Select Committee one off session are included.

The Parliamentary Office of Science and Technology has provided two annexes. They provide further information on other mitochondrial transfer methods and mitochondrial matching.

#### Shale Gas and Fracking

5th February 2015 | SN06073

Drilling for shale gas is at the exploratory phase in the UK. In North America, the rapid development of shale gas resources has transformed the world gas market.

The consensus seems to be that shale gas will not be a 'game changer' here. There is less land available on which to drill, and landowners do not own the rights to hydrocarbons beneath their

land. However, in June 2013 Centrica acquired a 25% stake in Cuadrilla's exploration licence in Lancashire, and the Government and British Geological Survey published raised estimates of the shale gas resource in Northern England. The Government is also consulting on legislation to introduce tax incentives for shale gas exploration, and has announced community financial benefits.

Provisions relating to the underground access regime were included in the Infrastructure Act 2015. Separate briefings are available on the detail of the Infrastructure Bill.

#### Religious Slaughter of Animals

19th February 2015 | SN07108

There has been a recent growth in public and parliamentary focus on methods used for religious slaughter. This includes welfare concerns about whether animals are stunned before slaughter, and which food outlets are serving halal meat as a matter of course to all customers, as well as whether all meat prepared by halal and kosher methods is being labelled.

This provides information on slaughter regulations which set minimum welfare standards at slaughter. These require all animals to be stunned before slaughter to minimise their suffering. Member States may exempt slaughter in accordance with religious beliefs from the pre-stunning requirement and the UK implements this derogation.

It details the Government position and the debate around the scientific evidence on slaughter and animal welfare.



## **Fixed Broadband: Policy and Speeds**

*3rd March 2015 | SN06643*

This describes current broadband access and coverage, and provides the Government's broadband policy. It focuses on the delivery of broadband targets and funding in England. The devolved administrations have their own delivery programmes.

It also contains data on broadband speeds and superfast availability by region, and by parliamentary constituency, including maps.

The Government's ambition is to provide everyone in the UK with access to broadband with a download speed of at least 2 megabits per second (Mbps) and to provide 95% of the UK with broadband speeds of at least 24 Mb/s ('next-generation access') by 2017.

## **Litter**

*17th March 2015 | SN06984*

Local authorities in England and Wales spend almost £1 billion per year clearing up litter, but the cost of litter goes beyond the cost of clearing it up. There are implications for health, the environment and tourism.

This outlines the cost of litter, relevant legislation and penalties for the offence of littering, forthcoming legislation and how to combat litter.

## **Planning Reform proposals**

*17th March 2015 | SN06418*

Since the Coalition Agreement, major reforms to the planning system have taken place with the introduction of the Localism Act 2011 and the National Planning Policy Framework. Changes have also been made in the Growth and Infrastructure Act 2013, aimed at speeding up the planning system.

The Infrastructure Act 2015 gained Royal Assent on 12th February 2015 and contains changes to making and modifying development consent orders for nationally significant infrastructure projects. It also provides the basis of a new system for deemed discharge of planning conditions. Further information is set out in the Library standard note, Infrastructure Bill: Planning Provisions, SN06909.

As well as these Acts a number of other announcements on planning reform have been made: in Budget 2014, the Technical Consultation on Planning July 2014, Consultation: planning and travellers, September 2014, National Infrastructure Plan 2014 and Autumn Statement 2014, December 2014. Together these include:

- allowing further changes of use to residential use without requiring planning permission;
- reforming the system of permitted development rights;
- amending the definition of "travellers" for planning purposes;
- proposals to get more brownfield land back into use;
- steps to speed up section 106 negotiations; and
- proposed reform of the compulsory purchase regime.

Most of the proposals would apply only to England.

This provides information about the key planning proposals.

For information about stimulating housing supply see Library standard note, "Stimulating housing supply".

## **Smoking in Public Places**

*27th March 2015 | SN04414*

This note outlines the provisions of the smoking ban in England that came into effect in 2007. It includes developments such as the

introduction of regulations in 2015 regarding smoking in private vehicles.

It is now against the law to smoke in a private vehicle when children are present.

## **ACTIVITIES**

2015 has led to a flurry of activity leading up to the dissolution of Parliament.

In addition to providing bespoke briefings for MPs, and publishing briefing papers, the section has prepared debate packs, containing briefing and supporting press and parliamentary material, for debates on: Energy; Contaminated blood; North sea oil and gas industry employment; Financial support available for restoration of opencast coal sites; Compensation for victims of badly installed cavity wall insulation; Dairy industry; Effect of national infrastructure projects on local redevelopment; Pubs and planning legislation; E-petition relating to ending non-stun slaughter to promote animal welfare; Epilepsy; Low carbon electricity generation; Harvey's law; County Durham plan; Management and delivery of broadband; Planning and the national planning policy framework; and Reform of the Vaccine Damage Payment Act.

The Science and Environment Section was pleased to have one of its Research Papers shortlisted for the EU Commission's Common Agricultural Policy (CAP) Communication Awards 2014 in the "Communication to stakeholders" category. The paper, CAP reform 2014-2020; EU Agreement and Implementation in the UK and in Ireland (updated) was prepared by the Commons agriculture specialist, Emma Downing, and the agriculture specialists in the Devolved Administrations' and Irish (Oireachtas) research services.

The team was not selected as finalists, but were invited to Brussels by the Commission to attend a conference on communicating the CAP. The awards were presented by Agriculture Commissioner Phil Hogan. The project summary and impact can be viewed at: [http://ec.europa.eu/agriculture/cap-communication-network/best-practices/index\\_en.htm#project\\_23](http://ec.europa.eu/agriculture/cap-communication-network/best-practices/index_en.htm#project_23)

Five Library Clerks from the Science Section spent two days at the Scottish Parliament catching up with their opposite numbers and joining some of their training talks from speakers including Jason Leitch, Clinical Director at the Scottish Government. This was an excellent opportunity to share knowledge as well as current working practices.

Dr David Hirst coordinated training for Montenegrin Parliament researchers as part of a British Embassy funded project led by DeFacto Consultancy entitled: "Strengthening capacities of Parliament's administration to prepare and evaluate public policies based on data analysis". He also spoke at a public conference entitled: Making data available for the purpose of creating public policies in Montenegro, where I spoke about "Science communication for non-experts: Using data in the UK Parliament"

David Hough visited the EU Parliament where he attended sessions by the UK National Parliament Representatives to the EU, the Director-General of the European Parliament Research Service and met specialists dealing with climate change and energy.

The Section has made contributions to the Library publication: Key Issues for the Parliament which will be published in hard copy and online shortly after the election.

## 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.

## EPSRC

Pioneering research and skills

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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.



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Alzheimer's Research UK is the UK's leading dementia research charity. Currently, we support 132 projects worth over £26.4m and have committed over £60m to research since the charity began. As research specialists, we fund pioneering research at leading universities across the UK and the globe with the goal of defeating dementia. Our expertise brings together leading dementia scientists to share ideas and understanding. We work with people with dementia to reflect their concerns and firmly believe that science holds the key to defeating dementia.

## 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

## AIRTO



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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.

## AMPS

AMPS

The Association of  
Management and  
Professional Staffs.

Contact:  
Tony Harding  
07895 162 896 for all queries whether for  
membership or assistance.  
Branch Office Address:  
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Website: [www.amps-tradeunion.com](http://www.amps-tradeunion.com)

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

We also have a section for Professional Divers working globally. We represent a broad base of both office and field based staff and use our influence to improve working conditions on behalf of our members.

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



BIOCHEMICAL  
SOCIETY

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The Biochemical Society exists for the advancement of the molecular and cellular biosciences; both as an academic discipline and their impact on areas of science including biotechnology, agriculture, and medicine. We achieve our mission through our publications and journals, scientific meetings, educational activities, policy work, awards and grants to scientists and students. The Biochemical Society is the largest discipline-based learned society in the biosciences with 7000 members.

## The British Ecological Society



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Ecology & Policy Blog  
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Twitter: @BESPolicy

The British Ecological Society's mission is to generate, communicate and promote ecological solutions. The Society has over 5,000 members worldwide, publishes five internationally renowned scientific journals and organises the largest scientific meeting for ecologists in Europe. Through its grants, the BES supports ecologists in developing countries, public engagement and research. The BES informs and advises Parliament and Government on ecological issues and is committed to ensuring that policy-makers have access to the best available evidence. The BES welcomes requests for assistance from parliamentarians.

## 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.

## British Nutrition Foundation



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[www.foodafactoflife.org.uk](http://www.foodafactoflife.org.uk)

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

Today's science, tomorrow's medicines

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The British Pharmacological Society is the primary UK learned society concerned with research into drugs and the way they work. Our 3000+ members work in academia, industry, regulatory agencies and the health services, and many are medically qualified. We cover the whole spectrum of pharmacology, including laboratory, clinical, and toxicological aspects. Enquiries about the discovery, development and application of drugs are welcome.



## The British Psychological Society



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The British Psychological Society is an organisation of 50,000 members governed by Royal Charter. It maintains the Register of Chartered Psychologists, publishes books, 11 primary science Journals and organises conferences. Requests for information about psychology and psychologists from parliamentarians are very welcome.



The British Society for  
Antimicrobial Chemotherapy

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[www.bsac.org.uk](http://www.bsac.org.uk) | [www.antibiotic-action.com](http://www.antibiotic-action.com)  
[www.e-opat.com](http://www.e-opat.com) | [www.nas-pps.com](http://www.nas-pps.com)  
[www.appg-on-antibiotics.com](http://www.appg-on-antibiotics.com)  
[www.bsacsurv.org](http://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



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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.

## British Society of Soil Science



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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.

## Brunel University London



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

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

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

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

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

## Cavendish Laboratory



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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



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[www.thefactsabout.co.uk](http://www.thefactsabout.co.uk)

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

## Clifton Scientific Trust



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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

## The Council for the Mathematical Sciences



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

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

## Eli Lilly and Company Ltd



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Lilly UK is the UK affiliate of a major American pharmaceutical manufacturer, Eli Lilly and Company of Indianapolis. This affiliate is one of the UK's top pharmaceutical companies with significant investment in science and technology including a neuroscience research and development centre and bulk biotechnology manufacturing operations.

Lilly medicines treat schizophrenia, diabetes, cancer, osteoporosis, attention deficit hyperactivity disorder, erectile dysfunction, depression, bipolar disorder, heart disease and many other diseases.

## Energy Institute



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The Energy Institute (EI) is the chartered professional body for the energy sector, supporting over 20,000 individuals and 250 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.

## Fera



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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.

## First Group



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FirstGroup is the leading transport operator in the UK and North America.

Our services help create strong, vibrant and sustainable local economies and our opportunity is to be the provider of choice for our customers and communities. During the last year around 2.5 billion people relied on us to get to work, to education, to visit family and friends and much more.

## GAMBICA Association Ltd



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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.

## The Geological Society



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The Geological Society is the national learned and professional body for Earth sciences, with 11,500 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.

## Glass and Glazing Federation



Glass and Glazing Federation

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The GGF is the main representative organisation for companies involved in all aspects of the manufacture of flat glass and products and services for all types of glazing, in commercial and domestic sectors.

Members include companies that manufacture and install energy efficient windows, in homes and commercial buildings, the performance glass used in every type of building from houses to high-rise tower blocks and the components that are used to manufacture every type of glazing.



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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.

## 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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Reg Charity number: 269815

The Institute of Measurement and Control provides a forum for personal contact amongst practitioners, publishes learned papers and is a professional examining and qualifying organisation able to confer the titles Eurlng, CEng, IEng, EngTech; Companies and Universities may apply to become Companions. Headquartered in London, the Institute has a strong regional base with 15 UK, 1 Hong Kong and 1 Malaysia Local Section, a bilateral agreement with the China Instrument Society and other major international links.

## IOP Institute of Physics

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The Institute of Physics is a leading scientific society. We are a charitable organisation with a worldwide membership of more than 50,000, working together to advance physics education, research and application.

We engage with policymakers and the general public to develop awareness and understanding of the value of physics and, through IOP Publishing, we are world leaders in professional scientific communications.

In September 2013, we launched our first fundraising campaign. Our campaign, Opportunity Physics, offers you the chance to support the work that we do.

Visit us at [www.iop.org](http://www.iop.org), follow us @physicsnews



## 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 40,000 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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## Institution of Civil Engineers



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Established in 1818 and with over 85,000 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 150,000 members in 127 countries with offices in Europe, North America, and Asia-Pacific.

## Institution of Mechanical Engineers



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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.



## LGC



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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*

## L'ORÉAL UK AND IRELAND

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L'Oréal employs more than 4,000 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.

## Met Office



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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.

## National Physical Laboratory



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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.

## Natural History Museum



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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.

## NEF: The Innovation Institute



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The Innovation Institute aims to drive innovation and growth in science, technology and engineering to achieve growth, prosperity and wellbeing in the UK. Our partners, clients and stakeholders include:

- Businesses
- Education providers
- Government bodies

New Engineering Foundation, our charitable arm, focusses on SciTech skills development. NEF work in vocational training and further education is supported by a Panel drawn from key industries.

Our Institute of Innovation and Knowledge Exchange is a professional body and a "do tank", led by the Innovation Council to support the role of innovation in society.



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The University of Northampton is a Top 50 UK University\*. We are 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.

(\*Guardian University Guide 2015)



**The University of  
Nottingham**

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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.

## 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.



**The  
Physiological  
Society**

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Physiology is the science of how molecules, cells and organs work in the body. Representing over 3000 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.

## Prospect



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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.



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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.



**risksolutions**  
leave nothing to chance

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Risk Solutions provide decision-support where there is a high degree of complexity, uncertainty or risk. A small highly motivated and client focused team we deliver:

- policy design, appraisal and decision support
- strategy development and asset management
- training, coaching and guidance
- evaluation assurance and organisational review, and
- risk assessment and research.

We tailor solutions to clients' needs, combining traditional qualitative and quantitative methods with cutting-edge participative modelling and decision analysis. We work with clients from across Government departments and agencies.



**ROYAL  
ACADEMY OF  
ENGINEERING**

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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.

**Royal Botanic  
Gardens, Kew**



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

Kew's strategic priorities for science are:

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

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



**The Royal Institution  
Science Lives Here**

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

## The Royal Society

THE  
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SOCIETY

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The Royal Society is the UK academy of science comprising 1400 outstanding individuals representing the sciences, engineering and medicine. It has had a hand in some of the most innovative and life-changing discoveries in scientific history. 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.



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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.

## Society for Applied Microbiology



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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.



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The Society for General Microbiology 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.

## 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 Biology



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The 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.

## SCI



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SCI is an inclusive, multi-disciplinary forum connecting scientists and business people to advance the commercial application of chemistry and related sciences for public benefit. SCI is open to all to join and share information, ideas, innovations and research. Members can network with specialists from sectors as diverse as food and bio-renewables, water, waste and environment, energy, materials, manufacturing and health.

## 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.

## Society of Maritime Industries



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The Society of Maritime Industries 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 & gas, maritime security & safety, marine science and technology and marine renewable energy.



## STEMNET



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STEMNET is an independent charity which enables young people to meet inspiring role models, understand real world applications of STEM and experience practical activities that bring learning and career opportunities to life. We do this through three core programmes:

- STEM Ambassadors - We run the UK network of STEM Ambassadors: over 29,000 inspiring volunteers
- STEM Clubs Programme - We provide free, expert advice and support to all schools which have set up or plan to develop a STEM Club
- Schools' STEM Advisory Network (SSAN) - We deliver free impartial advice to teachers and use our business links and partnerships to enhance the STEM curriculum in secondary schools in the UK

## Universities Federation for Animal Welfare



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Registered in England Charity No: 207996

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

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



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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

## THE PARLIAMENTARY AND SCIENTIFIC COMMITTEE

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Tuesday 16 June 17.00

### Annual General Meeting

followed at 17.30 by Discussion Meeting

### The Future of Road Transport

Speakers: The Lord Borwick;  
Rob Wallis, Chief Executive Officer, Transport Research Laboratory;  
Steve Yianni, Chief Executive Officer, Transport Systems Catapult

Tuesday 14 July 17.30

### Nanotechnology

Discussion Meeting

## SOCIETY OF BIOLOGY

Tuesday 23 June 10.00-16.00

### Parliamentary Links Day 2015

Science and the New Parliament  
Attlee Suite, Portcullis House  
Organised by the Society of Biology on behalf of the scientific and engineering community

## THE ROYAL SOCIETY

Details of all events can be found at  
[www.royalsociety.org/events](http://www.royalsociety.org/events)

## THE ROYAL INSTITUTION

Details of future events can be found at  
[www.rigb.org](http://www.rigb.org)  
Booking is essential. For more information and to book visit [www.rigb.org](http://www.rigb.org)  
There is a charge for tickets. Members go free.

## PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY

For details of events organised by POST visit  
<http://www.parliament.uk/mps-lords-and-offices/offices/bicameral/post/post-events/>

## THE INSTITUTION OF MECHANICAL ENGINEERS

For details of events visit:  
[www.imeche.org/events](http://www.imeche.org/events)

## THE LINNEAN SOCIETY OF LONDON

For details visit: [www.linnean.org](http://www.linnean.org)

More information on P&SC members' events can be found at: [www.scienceinparliament.org.uk/members-news](http://www.scienceinparliament.org.uk/members-news)



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**Inside:** The University of Nottingham has been selected as one of only four new University Enterprise Zones in the UK. Read about the work that Nottingham is doing to create new jobs and foster innovation through developing spin-out businesses, nurturing new enterprises and supporting the next generation of entrepreneurs.

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# Stephen Metcalfe MP and Chi Onwurah MP

invite you to attend

## Parliamentary Links Day 2015

An annual event to strengthen the dialogue between the scientific community, MPs and Peers organised by the Society of Biology on behalf of the whole science and engineering community

# Science and the New Parliament

Tuesday 23 June 2015 10:00 – 16:00

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

