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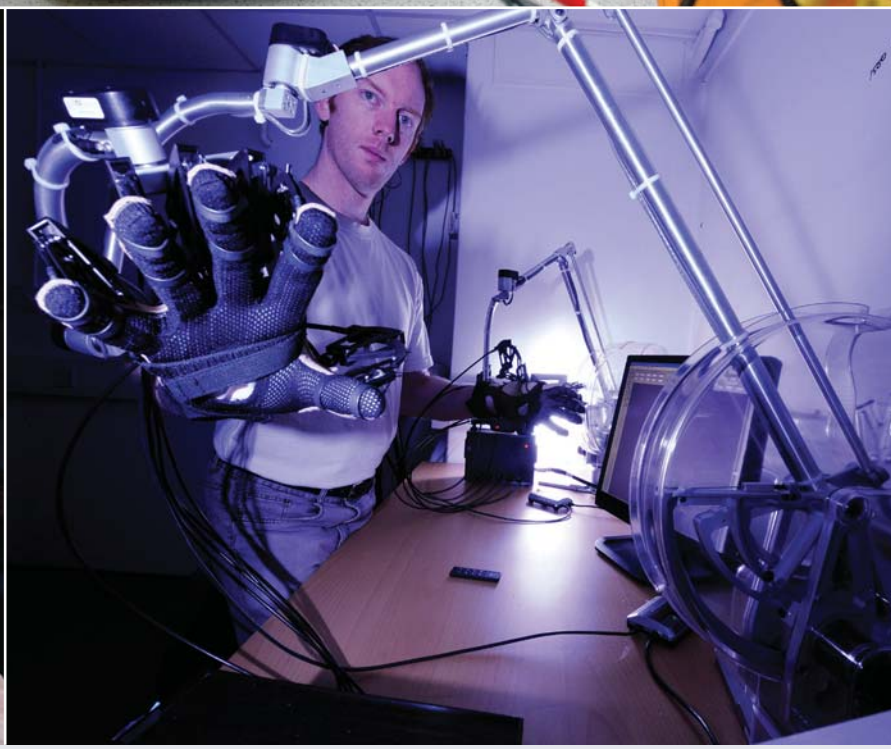
AUTUMN 2012

A proton collides with a proton

The Higgs boson appears at last

The Journal of the Parliamentary and Scientific Committee

www.scienceinparliament.org.uk



Physics for All

Science and engineering students are important for the future of the UK

IOP wants to see more people studying physics

www.iop.org

IOP Institute of Physics

Last years's winter of discontent was indeed made glorious summer by several sons and daughters of York. So many medals in the Olympics were won by scions of Yorkshire that the county claimed tenth place in the medals table, something hard to accept on my side of the Pennines! As well as being fantastic athletic performances the Olympics and Paralympics were stunning demonstrations of the efficiency of UK engineering, and the imagination of British science.

Surely we have good reason to be all eagerly awaiting the announcements from Stockholm of this year's Nobel Prizes? Surely the Higgs boson will be recognised? John Ellis recently eloquently described the "legacy" of the hadron collider and we would be missing an important opportunity if we didn't use it to help inspire the next generation. This point was not missed by John Wormersley, Chief Executive of the Science and Technology Facilities Council, in the excitement of the 4th July announcement.

Meanwhile back in Whitehall, David Willetts has made available some funding for the TSB, and also to help universities to meet the costs associated with open access publishing.

However, within a few weeks we will start to understand what effect on science admissions the crippling increase in tuition fees has had. Let us hope that the salaries offered by future employers will enable graduates to meet their obligations!

Andrew Miller MP
Chairman, Parliamentary and Scientific Committee

SCIENCE IN PARLIAMENT

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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.

The Parliamentary and Scientific Committee

Science in Parliament has two main objectives:
1. to inform the scientific and industrial communities of activities within Parliament of a scientific nature and of the progress of relevant legislation;
2. to keep Members of Parliament abreast of scientific affairs.

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MARS – A HAPPY LANDING

Professor John Zarnecki
Professor of Space Science, Planetary & Space Sciences Research Institute, The Open University

The successful landing of NASA's Curiosity Rover, or Mars Science Laboratory (MSL) mission to give it its full name, on August 6th 2012 was truly a great feat of space engineering. Why, you may ask, as landers and rovers have been delivered to the surface of Mars since as far back as 1975. Well, the answer, at least partly, lies in the size and weight of the MSL. It weighs in at a total of 899 kg, only about 10% less than my car! Previous rovers, for example, delivered to the surface of Mars have ranged from a mere 10.5 kg for the Mars Pathfinder up to 185 kg each for the highly successful Spirit and Opportunity rovers (although the total "landed" masses in all cases was slightly greater than the rover mass). The "traditional" technique for delivering a package to the surface of Mars involved an atmospheric braking at the top of the atmosphere followed by a parachute descent and finally, if required, a fall cushioned by airbags which are inflated around the precious payload during the last stages of descent. This works well but there is a limit to the mass (and therefore size) of payload which can be delivered in this way. With the proposed MSL, we had already reached that limit. So space engineers had to devise a new scheme – and what they came up with did almost seem like science fiction, even to the designers themselves! It involved an initial descent under a parachute followed by the firing of 8 retro rockets when the payload was about 1 km above the surface in order to slow down the payload further. At this point, the designers' imagination really took hold – they developed a system which involved lowering the precious payload from a height of some 8 m above the surface on three nylon ropes to a gentle landing. This technique has been dubbed the "skycrane" for obvious reasons. But why not use the retro rockets for a slow controlled final descent all the way down you might ask? Well, the exhaust from the rockets would have thrown up so much dust and debris from the Martian surface that the delicate instruments would have been damaged or even destroyed. Furthermore, the landing area would have been significantly chemically altered by the rockets – and one of the prime aims of the MSL is to carry out a detailed chemical analysis of the Martian surface.

> . . . the most sophisticated array of instruments ever . . .

> . . . carry out a detailed chemical analysis of the Martian surface. . . .

Because of the novelty of the landing system, there was real trepidation in the MSL team at NASA and the research institutes and in the worldwide Mars community. But the landing seems to have happened nearly flawlessly – a tribute to outstanding design and a meticulous test programme designed to tease out any flaws on the Earth before launch rather than during the real landing!

And what of MSL's future? It carries the most sophisticated array of instruments ever sent to the Red planet, including some never before deployed there. We want to study Mars for several reasons – it is our near neighbour, made of much the same stuff as Earth and once, in its early history, much warmer and wetter and with a thicker atmosphere than now – perhaps not too dissimilar to

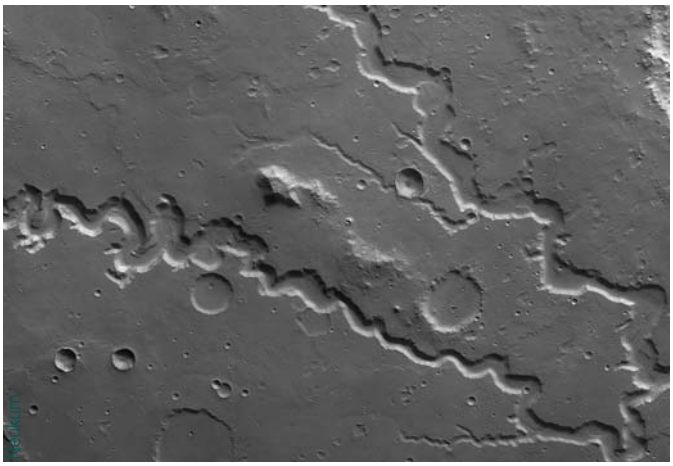
NASA/JPL-Caltech/MSSS

One of the earliest images taken by the Mast Camera on the Curiosity rover from the landing site. It shows interesting geology on the lower slopes of the nearby Mount Sharp. The region in the middle distance is believed to be an area of sand dunes which the rover will attempt to circumnavigate in order to reach the base of Mount Sharp where water is thought to have existed in the distant past.

early Earth. But somewhere along the line, the evolutionary paths of Earth and Mars have diverged to make them rather different worlds today. Why? That's just one of the questions that Planetologsts want to answer. Secondly, despite us having found exotic environments elsewhere in the Solar System, (such as certain of the moons of Jupiter and Saturn), Mars probably still presents the best chance of primitive life having existed there sometime in the past, during its wetter and warmer phase. It is not entirely impossible that life exists there today somewhere below the surface or in some niche protected from the harmful radiation which bathes the surface.

And third is the fact that one day soon (in the next 25 years?) astronauts will undoubtedly be despatched to the surface of Mars – and before we undertake that tricky task, we need to know all we can about Mars, particularly pertaining to potentially harmful aspects of the local environment.

The landing site for the MSL is an interesting story in itself. It is within the Gale Crater, a 150 km sized impact crater formed about 3.5 billion years ago as a result of an asteroid impact with Mars. But the target area was much smaller than this – it is an ellipse of 7 x 20 km at the base of a mountain within the crater. This region was selected after painstaking work by Martian experts worldwide to select the region most likely to show tangible signs of life should it ever have existed. This region shows distinctive evidence that water flowed here in the past. A further attraction of this region is the existence of layers of exposed rock which should allow a history of this region to be determined. Apart from scientific considerations, engineering and safety issues also had to be factored in – amongst these, for example, was the need to have a relatively flat and smooth region to make a safe landing more likely and to aid subsequent mobility of the Rover.



ESA/DLR/FU Berlin/G. Neukum

One of the many stunning images taken by Mars Express, the European Space Agency spacecraft currently in orbit around Mars. The image shows the Nanedi Valles valley system, probably formed in part by free-flowing water. There is plenty of evidence that significant quantities of water existed on Mars in the past. At the present time, water exists in the form of ice at the Poles, as permafrost below the surface and as vapour in the atmosphere.

If all goes to plan, MSL will explore a region extending to some 20 km or so from the landing site, employing its extensive range of instruments to address the above questions. The 12 scientific instruments can be divided into the following broad categories: cameras, spectrometers, radiation detectors, environmental sensors and atmospheric sensors. Taking up nearly half of the entire payload is the SAM (Science Analysis at Mars) instrument for the purpose of analysing elements and compounds that are associated with life. Another instrument is the ChemCam which will employ Laser Induced Breakdown Spectroscopy, a technique used in terrestrial applications but never so far deployed on another planet. This involves firing a laser pulse at a suitable rocky target up to 7 metres away and then analysing spectroscopically the light produced by the transient glowing plasma cloud that is momentarily generated to determine the composition of the rock. A great advantage of this technique is that it can be performed remotely thus allowing for example a rock face, much of which would otherwise be inaccessible, to be thoroughly analysed by MSL.

At the end of the MSL's lifetime, officially in just under two years, it is unlikely that we shall get definitive answers to many of the questions that we want answered on Mars – science rarely works like that! But because of the extent and complexity of MSL's payload, delivered in this novel and daring way, we can expect perhaps our greatest "leap forward" since Viking 1 made the first controlled landing on Mars in 1975.

At the time of writing, MSL is just coming to the end of its commissioning phase – all of the instruments and on board systems, including the robot arm, are being put through their paces. So far, almost everything is working to plan – and the Rover has taken its first tentative "steps", moving for example 15m on Sol 22 (a Sol is a Martian day).

MSL is a NASA mission with two of the instruments coming also from Russia and Spain. But UK scientists, because of their particular expertise, are well represented on the various science teams, with formal involvement as participating scientists from Imperial College London and Leicester University, and informal involvement from several other institutions.

While MSL is doing its work, European space scientists and engineers will not be idle however. Through the European Space Agency's ExoMars programme, carried out in conjunction with the Russian agency Roscosmos, they will be preparing two Mars missions for launch in 2016 and 2018; the former will involve an orbiter and small landing module while the latter will deliver a sophisticated rover. Even though we no longer see canals on Mars nor worry about invasion by Martians, Mars continues to engage and fascinate both scientists and the public alike.

. . . evolutionary paths of Earth and Mars have diverged . . .

. . . most likely to show tangible signs of life . . .

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LARGE HADRON COLLIDER COMES TO PARLIAMENT

Professor John Womersley is the Chief Executive Officer of the Science and Technology Facilities Council, one of the seven UK Research Councils. UK Particle Physics and our participation in CERN is funded by STFC.

Professor John Womersley and Ed Vaizey MP

Like me, I am sure that many of you found the news of the discovery of a Higgs-like particle on 4th July 2012 interesting – and exciting. Particle physicists have been working towards this discovery for no less than forty-eight years and it was great to celebrate our success in Parliament as the Large Hadron Collider (LHC) prepares for the next phase upgrade.

Working alongside the Institute of Physics and the Particle Physics community, the Science and Technology Facilites Council has been touring the country holding exhibitions celebrating the UK's involvement in the LHC. In the first week of September, we took our exhibit to the Houses of Parliament and held a reception to celebrate the achievements of their constituents with MPs and Peers. We will be heading to the devolved assemblies in Scotland, Wales and Northern Ireland in the coming months to do the same.

It was great to welcome many of the Parliamentarians who have actively supported the project over the years, such as Andrew Miller MP, Chi Onwurah MP, Stephen Metcalfe MP, Graham Evans MP (whose constituency includes STFC's Daresbury Laboratory), as well as our parliamentary host, Ed Vaizey MP (whose constituency includes STFC's Rutherford Appleton Laboratory). What was clear and gratifying to see from the MPs in attendance was the wider impact that the LHC was having on MPs and Peers, many of whom were being drawn to science for the first time because of it. Perhaps most pleasing to see was the presence of Parliamentarians representing constituencies away from the big university towns and cities who were enthused about science they were discussing and celebrating. In talking to Sir Peter Bottomley MP (Worthing West), Andrew George MP (St Ives), Jim Dowd MP (Lewisham West and Penge) and David Amess MP (Southend West) it was clear that the opportunity to understand blue skies science not only as a thing of intrinsic and academic value, but also as a pursuit with the capacity to produce real-life outputs and returns to the UK is something appreciated and understood.

> . . . the resurgence of science and physics in our schools . . .

While the LHC still has much to deliver, we can already point to real impacts from CERN such as the creation of MRI scanners and the world wide web, together with the inspiration for thousands of students to study STEM subjects.

We were joined at the event by representatives of our physics community, including Institute of Physics President Sir Peter Knight and Professor John Ellis who both spoke at the event. Commenting on the resurgence of science and physics in our schools, Sir Peter reported that the number of students choosing A-Level Physics has increased by 10,000 in the past year, partly because of the exciting nature of projects such as the LHC. While we still have work to do in encouraging more young females to enter the discipline, this rise is nonetheless highly encouraging. Professor John Ellis spoke

Professor John Ellis

Sir Peter Knight

passionately about securing the legacy of the Higgs boson discovery and of the UK effort that has gone into making the LHC a success – pointing out the role of British Director-General of CERN, Sir Chris Llewellyn Smith, in persuading the Member States to approve construction of the LHC project in 1994; Lyn Evans, who led the LHC construction project; and Steve Myers who now heads the team operating the LHC so successfully. Needless to say, the man whose name has been synonymous with the project, Professor Peter Higgs is claimed by both the people of Newcastle (where he was born and raised) and Edinburgh (where so much of his work has taken place) as one of their own. All of this demonstrates the UK's leading role throughout the life of this project.

Dr Lyn Evans and Ann Clwyd MP

Sir Peter Bottomley MP and Tim Bestwick

John Womersley and Gavin Barwell MP

Stephen Metcalfe MP and Royal Holloway PhD student, Tim Brooks

With the LHC now entering the final stages of its 2012 operations before it undergoes upgrade and maintenance throughout 2013, I am delighted that the project has not only delivered science results which have captivated physicists across the globe, but inspired school children to take up physics and Parliamentarians to support our cause. The connection between discovery and inspiration is set to continue.

Andrew Miller MP

Professor John Butterworth and Julie Hilling MP

Dr Beth Taylor and Andrew Miller MP

Professor Phil Allport, Andrew Miller MP and Professor John Butterworth

At the event, I invited those Parliamentarians present to register their interest in visiting CERN during its downtime in 2013 to see first-hand the awe inspiring science of the LHC. To register your own interest, please contact STFC Public Affairs on 01235 778082

FRONT COVER: Image of the result of a proton-proton collision event detected by the ATLAS experiment at the Large Hadron Collider. This is superimposed on a photograph inside the 27km circumference LHC tunnel located 100m beneath Switzerland and France, where beams of particles are accelerated to velocities close to the speed of light, at temperatures near to absolute zero, before being collided into one another.

How We Can Meet The Measurement Challenges Of The Coming Decade

Kamal Hossain
Director of Research and International at the National Physical Laboratory (NPL)

Measurement is important. It has a critical role in sustaining a fair, efficient and technological society. Whether you are developing new products, services and processes, or looking to trade successfully internationally, you will rely on measurement and an established infrastructure of traceable measurements linked seamlessly to internationally recognised standards. The UK's leading measurement laboratory, NPL, needs to assess thoroughly what the future metrology needs of our society are, and plan accurately to meet them.

In the 1950s Louis Essen led a team to develop the first atomic clock at NPL. At the time none of them could have known how far their work would impact on our everyday lives, providing timing for GPS, mobile phones and the internet more than half a century later. However, for our work at NPL to continue to underpin prosperity and quality of life in the UK, we need to make informed decisions about where we should direct our work to support UK innovation. In today's age of austerity this is essential – we need to be sure that what we are working on will help to meet the challenges of the not too distant future.

Decisions on where to focus activity are not made lightly. Our vision is based on consultations with stakeholders in Government, industry and the research community – including our own world class scientists. From these discussions we have identified that technological progress in the 2020s will be driven and constrained by the need to achieve the following:

- A sustainable low-carbon economy
- Innovation through scientific discovery
- The well-being and security of the citizen

As one of the top three National Measurement Institutes (NMIs) in the world, the work we do with academia and industry is at the cutting edge of contemporary metrology. Through this activity, NPL and its partners have an understanding of what the future needs of measurement will be. We know the state of the art across all areas of metrology and what potential there is for progression. We have an idea of the type of new technology emerging over the next 10 years and what end users will expect of it. Perhaps, most importantly, we know how all of this interacts with the metrology supply chain from the SI units to measurement systems.

What will this mean outside research laboratories like NPL? If we examine the three areas we believe will drive research into the 2020s, we can show how metrology can address these challenges through real world applications.

A SUSTAINABLE LOW-CARBON ECONOMY

Monitoring the state of the planet

Our need to monitor the Earth will drive measurements of climate and the environment. We need to be able to monitor accurately the changes in our climate, to be able to assess how policies to address this are working. Autonomous, self-calibrating and self-validating networks of sensors will help us to achieve this – measuring atmospheric and ocean composition as well as land and sea temperature.

This could include traceable data publicly accessible in real time via embedded sensors in mobile devices or cars, helping individuals to monitor and minimise their personal exposure. Also, improved measurement through the new quantum SI could provide direct traceability for Earth observation systems at uncertainties of 0.01%.

Efficient and diverse energy

More efficient energy and a more diverse supply are key to achieving ambitious targets around carbon reduction and maintaining security of supply. Measurement will ensure the reliability of these systems and provide investors with the confidence to bring about a step change in security of supply and consumption.

Measurement will help with new structural health monitoring techniques which could identify micro-scale and chemical changes – underpinning the long term accuracy and integrity of structures. Similarly, traceable measurement will provide the parameters associated with new generation fission plants, particularly in materials, temperature and neutron fluence.

SCIENTIFIC DISCOVERY, INNOVATION AND R&D INTENSIVE GROWTH

Big science

Metrology is critical to the successful delivery of large-scale basic science or high investment R&D. These will be the most ambitious projects of the future, aimed at pushing the boundaries of science and technology to meet society's challenges.

An example is deep space exploration. Accurate navigation would need atomic clocks to be stable to better than parts in 10^{17} to ensure that expensive missions safely reach their intended targets. Another example is cyber security. Through the use of single-photon measurement technologies we could enable quantum key distribution over existing fibre networks that will provide the ultimate in secure communications.

The future factory

The future factory will be a smart facility where design and manufacture integrate into a single process that enables bespoke products to be accurately fabricated on demand.

Measurement will need to assess and guarantee the fit, performance and functionality of every part. Metrology will also support the interconnection of these new factories to form an independent industrial base that merges production and R&D and achieves the lowest energy consumption and environmental impact possible.

This could result in machine tools that calibrate themselves with traceability to the SI and can be used as in-situ metrology devices for factories around the world producing parts in parallel and monitored and controlled via a customer's design department.

THE WELL-BEING AND SECURITY OF THE CITIZEN

A healthy population

Future healthcare systems will provide personalised medicine tailored to the needs of individuals. They will increase health and well-being throughout their life using point of care diagnostics, better-targeted therapies, and 24/7 assessment of critical patient parameters and health indicators.

To make personalised diagnostics that are both economically viable and clinically effective, new measurement techniques must provide the knowledge to underpin them. One example of this in practice is calibrated diagnostic devices directly connected to knowledge databases and treatment plans to provide therapeutic interventions tailored to individuals. A further example is accurate and reliable implantable multi-analyte sensors with operating lives of years rather than weeks.

Managing key resources and infrastructure

By the mid-2020s the planet's population will surpass eight billion which will present a challenge in terms of managing resources such as food and water and stretching the lifetime of infrastructure.

Measurement is critical in accurately monitoring the status of resources, and ensuring we move to a more sustainable future. Microbial and temperature sensors in food packaging using remote data acquisition could assess food quality to prolong shelf life and help reduce waste and shortage of supply. Measurements can be integrated over wide areas of soil fertility, carbon content, biodiversity, water retention capacity, and contaminants with quality of water and air to mitigate the linked risk of food shortages and climate change.

WHAT WILL THIS MEAN TO THE MEASUREMENT COMMUNITY?

Metrology in the 2020s will lead to some basic changes in how the research and capability we develop reaches users.

The services that NPL and other NMIs deliver could eventually be superseded by self-calibrating portable standards that enable in-site traceability. NMIs may move towards delivering traceable measurements to end users seeking to achieve traceable measurements in harsh or challenging situations. As a result, this will see a shift from traditional traceability models to a problem solving approach that utilises the expertise of measurement scientists.

TAKING THE VISION FORWARD

Our vision is not carved in stone. It is open for discussion and debate, and can only be developed further in partnership with our customers, stakeholders and collaborators. We welcome contributions from the parliamentary community, industry and academia to help us refine further our vision.

An online version is available for comment, together with a series of questions at: www.npl.co.uk/2020vision

THE FOUR THEMES WITHIN WHICH THE NATIONAL PHYSICAL LABORATORY (NPL) BELIEVE METROLOGY WILL DEVELOP IN THE 2020s:

1. The new quantum SI

Traceability of measurement results to National Measurement Institutes like NPL are the cornerstone of metrology. By introducing the new quantum SI we will see several units revised and redefined, removing the last physical artefacts and fixing values to fundamental physical and atomic constants enabling the chains of traceability to be substantially shortened and support research at the vanguard of scientific and technological development.

2. Measurement at the frontiers

As science advances it naturally takes measurement with it driving the need for new capabilities that go beyond what we can currently measure. In the next 10 years this is expected to include measuring everything from the atomic to the extremely large, measuring in extreme and harsh environments, in the presence of interference and at timescales from attoseconds to millennia.

3. Smart and interconnected measurement

The availability of networked information will enable new capabilities in computing, software and communication technologies. It will be driven by new sensors developed on quantum-, bio- and nano-technologies being integrated into measurement networks, integrating data from myriad systems and enabling calibration across networks.

4. Embedded and ubiquitous measurement

New products and systems will have in-built metrology capability. This will be embedded into machines at the design stage and will be easily accessible through functionality, ensuring that critical measurement systems will be permanently on and always calibrated.

MEETING THE NEED FOR PHYSICS TEACHERS

After a longstanding shortage of specialist physics teachers, recruitment is increasing. But there's still work to be done

Professor Peter Main
Director, Education and Science,
Institute of Physics

A good teacher can be a powerful influence on students' minds, nurturing abilities that are used not only throughout the school years but also far beyond. The Institute of Physics is pleased, then, that the future is starting to look a lot brighter for the recruitment of physics teachers.

The subject had suffered a shortage of specialist teachers for a long time. Where it would have taken 450 new teachers qualifying every year just to keep the already woefully low number of active physics teachers level, only around 400 people were being recruited into physics teaching. On top of this, many leave within five years and only half of them will remain after 13 years. The situation has been compared to a bath with the plug out and the taps only half on, and it left around 500 state schools in England without any specialist physics teacher at all.

This matters. Specialists have been shown to teach higher-quality lessons, on average, compared with non-specialists. With good teaching a prerequisite for educating a future generation of physicists and engineers to maintain the UK's strong science base, and the importance of physics to the country's economy generally, this could add up to a serious problem.

Over the past five years or so, however, teacher recruitment has been on the rise. Last year saw the largest number of people starting physics-teaching courses for 30 years, and initial figures suggest that that number will be surpassed once again this year for another record number of new trainee physics teachers.

The setting of separate targets for the recruitment of physics, biology and chemistry teachers, rather than "science" teachers, may have helped, having been recently introduced by government following longstanding campaigning by the Institute. But, interestingly, this increase has not been matched in the other sciences – recruitment of biology teachers is roughly static while numbers for chemistry and for maths have fallen. Something is different in the case of physics, and we think it is the result of work by IOP along with the Teaching Agency and Department for Education.

There are several things that we believe have contributed to the growth in the number of trainee physics teachers. The first is increased marketing activity on university campuses, directly promoting physics teaching as a career choice to undergraduates in physics and engineering.

The second is the creation of new teacher-training scholarships, funded by the Department for Education and administered by the Institute. The scholarships are worth £20,000 each to graduates with a first- or upper-second-class degree, and 115 of them were offered out of 550 applicants.

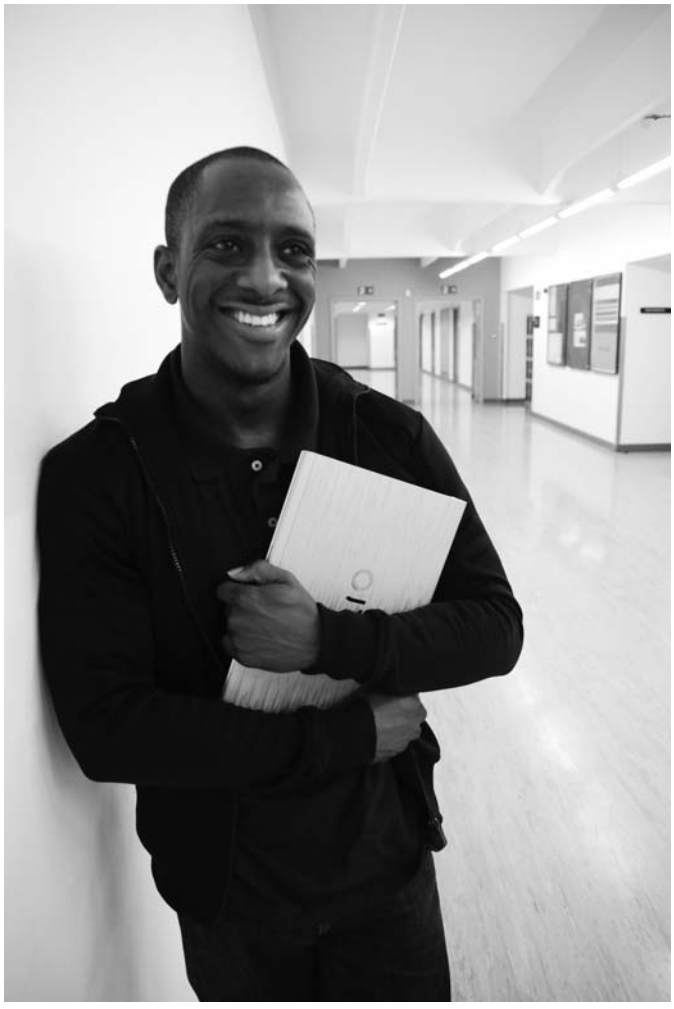
As well as increasing the number of trainee teachers, another aim of the scholarships – and one that the Institute shares with the government – was to attract more graduates with high academic achievement. They have been successful in doing so: the proportion of overall applications from graduates with these top

. . . Something is different in the case of physics, and we think it is the result of work by IOP . . .

degrees has increased from around 40% to 60%. In turn, the increase in the academic quality of applicants has helped to increase the prestige of teaching as a career – so that it is seen more and more as something that the best and brightest graduates choose to do.

Finally, the Institute has taken steps to remove one of the possible barriers to recruitment – the requirement to generalise. Because the individual disciplines of physics, chemistry and biology are lumped together under the umbrella of "science" in schools, prospective teachers of physics also have to train to teach one of the other subjects. This can be off-putting – many physicists won't have studied biology themselves since the age of 16. The exact number of potential teachers it puts off is difficult to quantify, but we do know that around a quarter of the physics graduates who enter the teaching profession choose to train as teachers of maths, for which they are eminently qualified , rather than their own subject. The solution was to allow them to train to teach physics with maths rather than with one of the other sciences and in 2012, pilot courses were launched by the Teaching Agency . Not only were these removing one factor that puts off physics graduates, but they were also designed to attract engineers, who come with a very similar set of skills to those of physics graduates – but who are usually even further from chemistry and biology in terms of their training. For the first year of these new teacher-training courses there were more than 300 applications.

. . . For the first year of these new teacher-training courses there were more than 300 applications. . .



All this work has generated a marked improvement in the recruitment of physics teachers. But there is still some way to go before we can consider it a job done. To reach teacher numbers at the same level as biology and chemistry – around 10,000 teachers of each, across England's state schools – we need to see 1000 physics teachers recruited annually. The number of new teachers is approaching that target. It will need continuing support from policymakers if it is going to be achieved. We therefore welcome the Department for Education's decision to continue funding the joint teacher-training scholarships programme for a further year. We also hope that combined physics and maths teacher-training courses are continued and developed to meet the demand which we have seen is there.

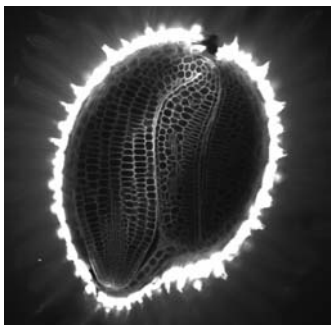
Our goal is a realistic one, and an important one. If we can raise and maintain teacher recruitment to the desired level, as we believe the recent changes will, then the UK can count on having enough physics teachers to produce a scientifically literate population, a highly skilled workforce, and a science base that is among the best in the world.

biology week 2012

The first ever Biology Week is being held on 13-19 October, organised by the Society of Biology.

Biology Week will inspire people of all ages and backgrounds with the fascinating science of biology, and give everyone the chance to get involved with life science events. These are taking place around the UK, including an attempt to set the world record for the largest memory game, and a debate on whether we should save the panda.

Biology Week will become an annual celebration of biology, and its launch is being celebrated in the House of Commons, organised by the Society of Biology, in partnership with the Biotechnology and Biological Sciences Research Council (BBSRC). MPs and Peers have been invited to the Churchill Room on 17 October from 7pm-9pm.



Arabidopsis embryo *©Ricardo Randall*

SHOULD WE SAVE THE PANDA?

As one of the world's most charismatic species, the panda is arguably one of conservation's greatest success stories. After years of decline the panda population is thought to be increasing. New reserves have been created, poaching and illegal logging have been reduced, and conservation projects have helped people and pandas coexist.

But at what price? Could the resources used to protect pandas be put to better use elsewhere? Insects and plants attract less attention, but often have a far greater impact on the health of humans and ecosystems.

In a special debate during Biology Week invited panellists and members of the public will discuss whether the panda's extinction is inevitable or whether we should continue the fight to save it.

You can have your say about whether ploughing resources into the panda is taking resources away from more worthy causes, or if the attention the panda receives, and the reserves it lives on, benefit global conservation. Cast your vote at www.societyofbiology.org/panda

HOW BIOLOGY CAN SAVE THE WORLD

Biology is at the heart of many challenges we now face, from food security, to species extinction, and from climate change to an ageing population. The Society of Biology's 2012 photography competition was themed 'how biology can save the world', and received thought-provoking photos of biological problems and solutions. The winner will be announced in an awards ceremony during Biology Week and the other shortlisted entries will be on display at the Parliamentary launch and can also be seen at www.societyofbiology.org/newsandevents/photocomp/2012winners

Water shortages and contamination are set to be huge problems globally, and biological research to reduce the

Microbial Ecology lab *©Mohammad Moniruzzaman*

impact includes development of drought-resistant crops and research into water-borne diseases. Khalid Rayhan Shawon's photo from Gabura, Bangladesh shows the villagers' solution to drinking water: rain. The village was submerged in Cyclone Aila, 2009, and since then salt has left the water undrinkable.

Gabura, Bangladesh *©Md. Khalid Rayhan Shawon*

As biologists tackle the challenge of feeding a growing population, basic research is needed into plant genetics and physiology. Ricardo Randall used fluorescence confocal microscopy to photograph an embryo of an Arabidopsis plant – a species widely used for laboratory research. Imaging seeds this way reveals information about the cellular structure of embryos lacking certain genes. This can help identify genes used to make bigger seeds, and can tell us why germination times are different in plants lacking particular genes. Germination of seeds can lead to farmers having to throw away produce.

Microbial ecology provides valuable information about the role of microorganisms in climate change, and research contributes important information to help mitigate the effects of climate change. Mohammad Moniruzzaman's photo shows a graduate student studying algae in a Microbial Ecology laboratory.

FLYING ANT SURVEY

Flying ant day is one of the greatest spectacles of the British summer, and for many people brings back memories of sunny afternoons during the school holidays. To turn people's anecdotes into a scientific study, the Society of Biology launched a flying ant survey, and the results from 2012 will be presented during Biology Week.

Most ant swarms seen in the UK are the black garden ant. Throughout the year it is common to see the workers, sterile females collecting food for the nest, but each summer there is a spectacular emergence of flying ants. These are males and young queens leaving the nest for their mating flight. Having mated, the new queens will drop their wings and found their own colony.

The survey has been designed to reveal whether flying ant day is the same across the UK, and study how it is connected to the weather. It is important that the mating flights are synchronised between nests because the ants need to maximise the chances of meeting ants from other colonies with which to mate.

Dr Adam Hart, an ecologist and insect expert at the University of Gloucestershire, is working with the Society of Biology on the survey. He says:

Black Garden Ants, *©Philip Gould*

"After such a wet summer it was wonderful to see so many flying ant reports coming in, interestingly starting at a very similar time to last year. We expect flying ant day to be different around the country, and we're really interested to learn more about this."

Despite its size, the black garden ant has a huge impact on our countryside, from improving soil fertility to pollination and pest control. Ants are also important as food for wildlife; many people are alerted to the presence of flying ants by the sound of feasting gulls and swifts.

Dr Mark Downs, CEO of the Society, commented: "The support we have had from scientists and members of the public has been amazing and we've had over 6,000 records of flying ants. We could never collect this kind of data without the help of amateur recorders."

WORLD RECORD ATTEMPT

At 2.30pm on Friday 19 October, the Society of Biology is aiming to set the record for the world's largest memory game. At venues around the UK and beyond children and adults will spend 10 minutes testing their memories, and will learn about the intricate science of the brain. In order to claim the title, the Society needs over 1,000 people from at least 10 venues to take part.

Alongside the game, resources for adults and school pupils are available on the Society of Biology's website. To learn more about how the memory works you are invited to visit www.societyofbiology.org/memorygame

REGIONAL EVENTS

Charities, learned societies, science centres, schools and universities have partnered with the Society of Biology to run their own Biology Week events. Here are three snapshots of what is going on.

In Scotland, researchers from Glasgow University and Strathclyde University will be demonstrating their exciting research at the Glasgow Science Centre. This will include interactive activities, objects to handle and the opportunity to ask lots of questions.

At the Society of Biology's offices in London, scientists and policy officers will discuss the future of research careers at an event organised with the Biochemical Society and the British Ecological Society.

Throughout the week the Marine conservation charity ORCA will be organising workshops for schools about British whales and dolphins.

To find out what is happening in your constituency please visit http://www.societyofbiology.org/newsandevents/events

Student with dolphin skull. *©ORCA*

ANIMAL EXPERIMENTATION: Are EU Regulations Adequate?

Judy MacArthur Clark CBE MRCVS
Head, Animals in Science Regulation Unit, Home Office

INTRODUCTION

Over the last four years, I and my colleagues in the Animals in Science Regulation Unit (ASRU) in the Home Office have been heavily engaged first in negotiating the new Directive (2010/63/EU) to protect animals used in research, and then in ensuring the proper implementation of that Directive into UK legislation.

The process of negotiation took two years and was completed on 10 November 2010 when the Directive came into force. Thus our new UK legislation has to be on the statute book by 10 November 2012 – no time to spare given the various steps we need to have completed to ensure the new legislation has the support not only of Parliament but also of our other stakeholders. This community covers the full spectrum of interests from those who are licensed to perform research procedures on animals to those who are morally opposed to any use of animals in research. Quite a challenge!

Since we are not attempting to make any revisions to the law other than those required by the Directive, we are able to amend the 1986 Animals (Scientific Procedures) Act as a Statutory Instrument under the European Communities Act. This involves the "affirmative resolution procedure" requiring the approval of both Houses. Since amendments to the Bill are not possible during either debate, we have to present to Parliament the best possible proposal, balanced to carry the widest support.

. . . animals do not suffer unnecessarily . . .

To achieve such regulatory balance, we follow a simple principle illustrated in the diagram.

Figure: The ASRU Regulatory Balance

On the one hand, it is essential to ensure that bureaucracy and rules do not become so burdensome as to inhibit scientists from proposing scientific projects which will address important questions. We still need to understand better diseases for which we do not yet have effective therapies. On the other hand it is important to ensure that animals do not suffer unnecessarily, and that only soundly justified projects are authorised to go ahead.

Thus the legislation needs to ensure a careful balance between the needs of the science and the needs of the animals. It is this balance between science and welfare which provides the public with confidence in the regulatory system. The public wants to benefit from scientific advances, but also to be reassured that animals are not suffering unnecessarily. Furthermore, there is strong evidence to show that good animal welfare leads to better scientific outcomes.

NO REDUCTION IN WELFARE STANDARDS

Given this need for balance, much of the new legislation will continue the strong regulatory control we currently exercise. A starting principle has been "If it ain't broke, don't fix it". Hence, regulatory processes which currently work well will remain largely unchanged. Where current UK standards are higher than those in the Directive, we have used Article 2 to retain those higher standards. However we have also sought ways to simplify the regulations where we have perceived no welfare cost in so doing.

One example is the personal licence. We have opted to retain the control which a personal licence offers but to propose significant simplification of the content. Current personal licences contain detailed lists of permitted techniques and consequently often require regular amendment. However, these lists are no guarantee of competence. By placing the responsibility for ensuring competence squarely on establishments (through the newly created role of named individuals responsible for training, supervision and competence), we have created a system which is less

. . . The public wants to benefit from scientific advances . . .

bureaucratic, more effective at a local level, and can be monitored by inspectors.

A second example is the protection for embryonic mammals, birds and reptiles which will in future be limited to the last third of gestation since there is no evidence of sensitivity prior to that point.

Many other standards will be strengthened. The ban on the use of great apes will continue. Likewise, the current upper limit on permissible severity will remain. However prohibition of both will now be part of the Act and it will not be possible to use any of the safeguard clauses in the Directive without the specific agreement of Parliament.

Special protection for cats, dogs, horses and primates will continue to be a feature of our new legislation. This will mean that any projects using these species will have to be especially justified and will be subject to retrospective assessment towards the end of the project. No use of stray cats and dogs will be permitted and this will now be prohibited by the Act. By contrast, the use of feral domestic animals may be permitted but only under very strict controls and largely for their benefit.

Many questions have been asked about the role of the Inspectorate under the new Act. The Directive introduces inspection in all Member States but at a lower minimum than we practise in the UK. We intend to continue our current approach to inspection, based on risk, and are committed to maintaining a well-resourced and professional inspectorate.

Likewise, concern has been expressed about the role and membership of the Animal Welfare Body under the Directive. We envisage this role being similar to that currently fulfilled by our Ethical Review Processes and we will retain Guidance to this effect.

The Code of Practice for housing and care of animals will retain all the current UK higher standards but it will be written in a way which clarifies those requirements which are mandatory.

Finally, we will not permit the use of neuromuscular blocking (paralysing) agents without appropriate anaesthesia and analgesia and then only by specially trained individuals.

WHAT WILL CHANGE LATER?

A few features of the new regulations can be implemented later. For example, a key aim of the Directive is to increase transparency about work which is performed under licences. Our current approach is compliant since we currently ask for lay abstracts of each authorised project. We currently have no powers to enforce this whereas, under the new Act, we will be able to require detailed non-technical summaries for all projects. We will publish these.

Nevertheless we are committed to reviewing Section 24 of ASPA (the so-called 'confidentiality clause') and to considering an extended range of penalties which can be applied. Under RESA (the Regulatory Enforcement & Sanctions Act) we may have additional sanctions available to us such as monetary fines for infringements.

Both these topics will require detailed consultation involving all stakeholders to ensure we take the right steps. We plan to do this once the current pressure for new legislation is relieved, commencing during 2013.

In addition, we are aware that documents such as a new Guidance to the Act and Code of Practice can be readily updated, using modern technology, in the light of experience and new knowledge. We therefore aim to create both these as 'living documents', accessible electronically and subject to regular review.

WHAT STILL NEEDS TO BE DONE?

In May 2012, we published the government's response to the 2011 public consultation on implementing the Directive. This outlined our proposed approach and the draft regulations, which aim to implement this approach, were published in July. We have now completed the Regulatory Impact Assessment and, also in July, it received a 'green flag' from the Regulatory Policy Committee. We will publish that assessment shortly.

Meanwhile, we are completing the draft regulations and gaining approval from the Home Affairs Committee, the Reducing Regulation Committee and the Joint Committee on Statutory Instruments. At the same time, we are drafting Guidance to the Act and will be sharing this with stakeholders shortly to seek their views.

We published a draft Code of Practice late last year and, based on the feedback, we are currently completing a final draft. We are also drawing up a working protocol for the new National Committee, based on advice from stakeholder discussions and from the Animal Procedures Committee, and we plan to appoint a Chair by the end of this year as well as some members shortly thereafter.

No debates can take place during the summer recess but these will occur soon after both Houses have returned in mid-October. Meanwhile we are working through a range of transitional arrangements to ensure that, by January 2013, existing authorities are either deemed to continue or have been amended.

Finally we are conscious of the need to communicate frequently and effectively with all our key stakeholders who will be directly affected by the new regulations. In addition to the many consultations outlined above, and our regular meetings with all our stakeholder groups, we have triggered a series of special newsletters to those holding certificates of designation to ensure that they and their colleagues are fully prepared for the changes ahead.

This is a very busy time but I am confident that, in January 2013, we will all be ready for the transition to our amended Animals (Scientific Procedures) Act. Furthermore, in answer to the question in my title, I am equally confident that the EU Directive, as it is being implemented in UK legislation, will not lead to any reduction in welfare standards. Indeed, we have successfully found ways to minimise much of the bureaucracy of our current system of authorisation while retaining our high standards of welfare.

I am grateful to all our stakeholders, as well as my colleagues in ASRU, for guiding this balance. It is through achieving this balance that we are able to reassure the public and to retain their confidence.

TRANSPOSITION OF THE EU DIRECTIVE: Backwards, Forwards or the Status Quo?

Dr Maggy Jennings OBE
Research Animals Department,
RSPCA

The RSPCA has been closely involved with the revision of the Directive and currently participates in the European Commission's expert working groups drawing up guidance for some member states on some of the more complex issues. If implemented properly, the Directive should make a positive difference for animal welfare in many member states. However, it is weaker than the UK Animals (Scientific Procedures) Act 1986 (ASPA) in places, so simple 'copying out' could reduce UK standards in a number of areas. This would be to the detriment of animal welfare, public confidence and ultimately the UK science base.

Many of the RSPCA's concerns about reducing UK standards were shared by colleagues in the scientific community. The Home Office has responded positively and we are pleased that the ASPA now appears to be retaining much of what it currently has – although we have yet to see what the final texts of the revised legislation, Codes of Practice and Guidance actually say.

We do still have concerns over specific issues such as primate use, licence amendments, increased severity levels, potential use of neuromuscular blocking agents (that paralyse animals but have no anaesthetic or analgesic effect) without anaesthesia, re-use, and the use of animals for training. However, for this paper, I will focus on areas where there is an opportunity to use the transposition process to improve on what we have.

RETROSPECTIVE ASSESSMENT OF ACTUAL SUFFERING

The Directive requires the full lifetime experience of the animal to be taken into account when predicting harms, and classifies levels of suffering into mild, moderate and severe. It also introduces a new concept – a requirement to assess and report the actual harms suffered by animals rather than the predicted harms, as is currently the case. This should encourage closer focus on individual animals' experiences and provide a driver for better recognition, assessment and hence alleviation of suffering. It will supply information to prioritise procedures for refinement, and, if done honestly, will present a much clearer picture to the public of the levels of suffering that animals experience.

EDUCATION, TRAINING AND COMPETENCE

The need for achieving, demonstrating and maintaining competence is a key requirement in the Directive and will mean additional responsibility for implementation at the local establishment level. If taken seriously, it could mean major improvements to both animal welfare and science. Although UK legislation already requires staff to be 'competent' in the procedures they undertake, there are problems in some establishments, where some scientific staff seem not to understand or accept the need to spend time gaining an appropriate level of training for the sake of their science, let alone for animal welfare.

. . . the Directive should make a positive difference. . .

The Commission wants consistent standards of training and competence across the EU. This requires definition of training objectives, learning outcomes, competence criteria, criteria for reassessment, record keeping and roles and responsibilities – a significant task, on which an EU expert working group is working, with relevant UK organisations playing leading roles.

The functions of the AWB roughly map on to the ERP, but the key issue is whether it should consider project licences before submission to the Home Office. Some have lobbied hard to have this function removed, considering it an unnecessary duplication and extra bureaucratic step in the licensing process. However, most people find the ERP extremely helpful, provided the establishment understands that the review is intended to be from a local perspective; knows what it should be trying to achieve; and sets up a well designed and efficient process that will add value. Most establishments therefore want to keep their ERPs because of the benefits, shared responsibilities and greater public accountability they bring. This will be even more important in the future, given the greater responsibility relevant to existing ERP functions that is likely to be expected at an establishment level.

. . . full lifetime experience of the animal . . .

MAINTAINING EFFECTIVE LOCAL ERPS

Probably the RSPCA's biggest concern throughout the transposition process was that the UK would lose the local Ethical Review Process (ERP) in its current form. ERPs were set up in 1998 as a local framework "…to ensure that at a local level all use of animals is carefully considered and justified; that proper account is taken of all possibilities for the 3Rs and that high standards of accommodation and care are achieved". ERPs deal with ethics, welfare, 3Rs and public accountability, provide advice and support to staff, and have an educational and awareness-raising role. They are highly valued, and when set up well, have a very positive impact at establishment level. There are similar processes in many countries in Europe and we had hoped that some form of ethics committee would be formalised in the Directive. Unfortunately, the concept of 'ethics' was lost and replaced with an Animal Welfare Body (AWB), with a reduced remit and membership, lacking the range of expertise and perspectives that enables the ERP to make its positive contribution.

. . . better define their objectives . . .

It is therefore most welcome that the government plans to "align legislation and guidance as closely as the Directive allows to current arrangements for the ERP including its membership, functions and title", although at this stage we do not know what the final text of the legislation and Guidance will say. Looking to the future, it is important that the project review function remains, with the emphasis on local issues. ERPs could better define their objectives and outcomes, and how these are monitored, and develop more challenging and constructive discussion of projects. We would like to see establishments give more thought as to how they select and train their members and to be more adventurous in selecting lay participants. ERPs would also benefit from greater focus on issues other than just project review, eg reducing severity, aseptic surgery, environmental enrichment and 3Rs activities. They will need to grapple with the reality of retrospective assessment of suffering and will also need to accommodate a completely new requirement stemming from the Directive – to communicate with the new National Committee.

. . . additional responsibility for implementation . . .

THE NATIONAL COMMITTEE

The National Committee (NC) will replace the Animals Procedures Committee (APC). The APC provides independent, strategic advice to the Secretary of State and in doing so must have regard to the legitimate requirements of science and industry and to the protection of animals against avoidable suffering and unnecessary use. Its advice covers: codes of practice, specific project licence applications, infringements, development of alternatives, enhancement of welfare and contentious issues or reports. It also has, or should have, a function in public accountability.

The role of the NC is to advise the Competent Authority and AWBs on acquisition, breeding, accommodation, care, and use of animals, which could be interpreted as similar to the APC, although it must also 'ensure sharing of best practice' which is new. It must also exchange information on operation of AWBs and project evaluation, and share best practice within the EU. The ASPA defines the APC membership, requiring at least 12 members (including those with appropriate biological qualifications, eg medics and vets, with at least one barrister/solicitor/advocate) plus the chair, but the Directive does not go into this detail, nor does it require the interests of animal welfare to be "adequately represented" as in the APC.

The APC runs on a shoestring and the Government has said it: "…assume[s] no additional resource…" for the NC. This is a pity because now is the time for a serious review of what a body like this should deliver, but progress will be stifled with insufficient resource. There are several challenges including: doing something useful that adds value in a reasonable time frame; achieving a balanced committee of people who are prepared to contribute time and energy; opening avenues of communication that do not exist (with ERPs, EU National Committees) to share best practice; deciding how to make judgements on what 'best

. . . The Commission wants consistent standards . . .

. . . information to prioritise procedures . . .

practice' is; and developing an informative and interactive public face. A well thought out 'protocol' of what it will do, and how, would be helpful.

HOME OFFICE INSPECTORATE

My last point is aside from the Directive. We are fortunate in the UK to have the Home Office Inspectorate and there is a broad consensus that it is fundamental to achieving an effective regulatory system that works. Inspectors are widely respected and play an invaluable role in reviewing licences, assessing compliance, providing expertise and advice and implementing many of the improvements for animal welfare that we want to see – not just in the UK, as their influence extends to the EU and other regions. Notwithstanding the current financial constraints, it is imperative that the UK maintains an authoritative, challenging and well resourced Inspectorate.

. . . some form of ethics committee . . .

To conclude, the UK has a good piece of legislation in the ASPA, with a history of world leadership in laboratory animal science and welfare and in establishing better standards in this field. This is a point often made by stakeholders in science, industry and government. Nevertheless, throughout the transposition process, we have seen some of those same stakeholders lobby powerfully to reduce UK legislation, ostensibly to promote a 'level playing field' within Europe. It is very hard to understand why one might want to compromise UK standards, especially since it is recognised that better animal welfare means better science and that high standards make good economic as well as scientific sense. The playing fields in Europe are never going to be level. We should look to enhance our leadership role, not reduce standards to the lowest common denominator.

ANIMAL EXPERIMENTATION: Are EU Regulations Adequate?

Dr Stephen Mitchell
Eli Lilly and Company

The EU Directive on animal experimentation, care and welfare is a very positive development as it standardises practice across many countries with wide variations in approaches and ethics. That much of the legislation is derived from the Animal (Scientific Procedures) Act 1986 speaks highly of the work done by the Home Office Inspectorate since its implementation and this will continue to have a positive impact on public confidence.

Ethically, the EU Directive is aligned with the major cornerstone of the UK's requirements and code of practice as it promotes the development, validation and implementation of alternative approaches to animal testing in line with the 3R's – Replacement, Reduction and Refinement. These include methods that avoid or replace the use of animals (eg computer modelling, in vitro methodologies), methods which minimise animal use (improved experimental design, imaging techniques, sharing data and resources), as well as improvements to scientific procedures and husbandry which minimise actual or potential pain, suffering and distress or lasting harm and/or improve animal welfare (eg using non-invasive techniques, appropriate analgesia and anaesthetic regimes for pain relief, appropriate accommodation, environmental enrichment).

. . . minimise actual or potential pain . . .

It is a requirement in the UK for those performing regulated procedures to hold an appropriate Personal Licence (PIL). The PIL essentially ensures that the holder has the necessary background and education to perform animal experimentation, and lists the

. . . speaks highly of the work done by the Home Office . . .

techniques that are to be used on a relevant Project Licence. Under the EU Directive the PIL will be replaced by one that documents a "demonstration of requisite competence". Although this is not currently a requirement per se, it is normal practice for an individual's competency to perform procedures or techniques to be monitored as part of their continuous training and development. However, the EU Directive makes it a requirement for this process to be formalised. Staff must be supervised until they become competent. All training will have to be documented, signed off and archived, and with a requirement for maintaining or checking the level of competency over time, especially if procedures are used infrequently (as yet undefined). In order to co-ordinate and monitor this process a designated Training Compliance Officer (or similar) with overall responsibility for maintaining such a record will need to be appointed. This new process makes sense ethically and scientifically, and formalises current practices. One additional benefit could be that the training records become transferrable across the EU – with the caveat that there will be a period of time to enable competency to be checked. The process should be less bureaucratic, as PIL's currently need to be sent back to the Home Office for amendment, or in order to change the designated establishment.

. . . a "demonstration of requisite competence" . . .

Under the EU Directive, Designated Establishments are required to set up an Animal Welfare Body (AWB). This is to be comprised of a minimum of only two people – a person responsible for care and welfare of animals and a designated vet, or appropriate expert. Their role is to provide advice on animal welfare, the 3R's, to establish and review internal processes and monitor projects. In the UK, current legislation requires that Designated Establishments have an ethical review process (ERP) with the operational requirements more involved and extensive than those for an AWB. For instance, local ERPs involve more people – including a lay person – and operationally, have more than just an advisory role – in particular there is a requirement from the Home Office that any project licence application or amendment has ERP approval prior to submission for authorisation. It is generally agreed that in establishing an AWB, those functions of the ERP which are beneficial and add value will be retained.

. . . functions of the ERP which are beneficial and add value will be retained. . .

The EU Directive also sets out requirements for the care and accommodation of animals kept in establishments. These differ in a number of respects to current requirements in the UK – but are generally higher, particularly with respect to living space. This may have cost and space implications where large numbers of animals – particularly rats – are bred/supplied or used, as the requirement for larger cages will reduce holding capacity. However, there are some differences in cage dimensions that may be detrimental, as the stipulated cage height is lower than current UK standards (for rats >250g), which may inhibit natural rearing behaviour.

There will be a requirement under the EU Directive for the retrospective assessment of projects involving non human primates (NHPs), using procedures that are categorised as "severe", and with the option to assess some classified as "moderate". This process is not currently a UK requirement, although it does occur for applications for the renewal of a project licence and as part of the ERP. It is also a requirement in the UK to collect and publish annual statistics on the use of animals in regulated procedures. Under the new Directive annual returns will now have to indicate the severity limit as well as the origin and species of NHPs used.

. . . This new process makes sense ethically and scientifically . . .

Currently, Designated Establishments can be visited by a Home Office Inspector at any time. The frequency of visits has in the past allowed the Inspector to establish a working relationship with care staff and licence holders alike so that advice on best practice, promotion of the 3Rs and reinforcement of compliance is maintained. However, this extremely useful relationship may have to change in the light of the EU Directive. Site visits will be based on a risk assessment and will be more formal – by appointment and run more like an audit, which could last several days. It seems unlikely that Inspectors will have the time to schedule separate consultation, training or advice sessions if the Inspectorate is not properly resourced. In my view, the benefits of the Animal (Scientific Procedures) Act 1986 have been almost entirely brought about by the direct contact between scientists and Inspectors with the latter's promotion of the 3Rs and good experimental design and analysis approaches. This needs to be maintained.

In summary, the EU Directive overall is a positive development – it strengthens the measures required to protect animals used in scientific procedures, and it promotes the development, validation and implementation of means to replace, reduce and refine animal use. It attempts to create a level playing field across the EU with respect to experimental control and animal welfare, and may be less bureaucratic. However, here in the UK we should be careful not to devalue the role of the Home Office Inspectorate and allow them the resource to maintain and cultivate close working relationships with the scientists involved.

. . . cultivate close working relationships with the scientists . . .

PARLIAMENTARY LINKS DAY 2012

This year's Parliamentary Links Day, now organised by the Society of Biology on behalf of the science and engineering community, was held in the House on 26th June. The theme was SCIENCE AND SPORT in view of the approaching Olympic and Paralympic Games.

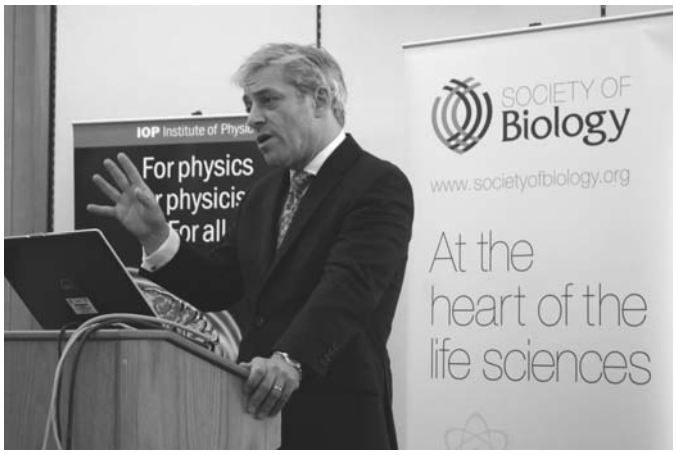
It was the biggest ever Parliamentary Links Day and around 250 MPs, Peers, Parliamentary staff, athletes and distinguished scientists from an exceptionally wide variety of scientific organisations listened to a stream of interesting presentations and networked over lunch.

The event was chaired in the Commons by Andrew Miller MP, Chair of House of Commons Science and Technology Select Committee and in the Lords by Lord Willis of Knaresborough, a member of the House of Lords Committee on Science and Technology.

The Speaker of the House of Commons, Rt Hon John Bercow MP, welcomed everyone to a packed Attlee Suite and praised the Society of Biology for its role in Links Day which exists to strengthen the dialogue between Parliament and the science community.

"I know, from my unique vantage point in the House, that Members on all sides continue to raise issues that have a scientific aspect to them. It is all the more important that every Member of Parliament should be able to benefit from non-partisan assistance of the kind offered by professional scientific bodies like the Society of Biology, the Institute of Physics, the Royal Society of Chemistry and many others with their proven commitment to public interest."

Subsequent speakers included the Science Minister, Rt Hon David Willetts MP, and Dr Julian Huppert MP (a co-sponsor of the event) along with sportsmen and sport scientists passionate about the Olympic legacy. The Minister observed that "Often the sporting environment is one of the first places where technical innovations are seen and can be tested. Sport drives innovation."



> "I know, from my unique vantage point in the House, that Members on all sides continue to raise issues that have a scientific aspect to them.
>
> Mr Speaker Bercow

Baroness Campbell, Chair of UK Sport, spoke about working with scientists to show that sport is a fundamental right for every child. Rt Hon Dame Tessa Jowell MP, Shadow Minister for the Olympics, pointed to the importance of using science in policy. She also thanked soil scientists for their work decontaminating 2000 tonnes of polluted soil and 20 million gallons of groundwater at the Olympic site, regenerating an area of wasteland the size of Hyde Park into housing, an

urban parkland and a wildlife haven with wildflower beds and boxes for roosting bats. The park later claimed the world record for the most bird boxes (525) at any Olympic Park.

In the first of two panel discussions Andy Parkinson, chief executive of UK Anti-Doping, explained how new scientific techniques meant samples from athletes could be tested over long periods – up to eight years – and that the UK was leading the way in doping detection ahead of London 2012.

Steve Ingham from the English Institute of Sport told how advances in the science of altitude training are improving the performance of UK athletes. The Institute can now consistently increase athletes' haemoglobin mass by up to 12%, where once not everyone would respond to this type of training. He reported that simple advances in warm-up techniques have recently improved 400m sprint times by up to a second.

UCL's Director of the Institute of Sport, Exercise and Health, Professor Fares Haddad, explained to the audience how

David Gordon, head of Media Events Coverage at the BBC, described the advances in digital technology that would make coverage of this year's Olympic Games more comprehensive than ever – with every sport available to watch and up to 24 events being broadcast simultaneously. Gordon also revealed that the BBC would soon be broadcasting in Super Hi-Vision, a broadcast technology 16 times higher definition than existing HD.

Dr Mark Downs, Chief Executive of the Society of Biology, commented that "Links Day was extremely successful and highlighted the many ways in which science and engineering work together to have a positive impact on the Olympics. The Games rely on the latest technologies, from

advances in medicine for elite athletes often translates into better treatment for non-athletes. The University is currently working on the 'holy grail' of knee injury prevention, the ability to repair surface cartilage.

techniques for detecting doping to ways of improving athlete performance. These technologies can have far wider effect than competitive sport. For example, nutrition for elite athletes can also be valuable for patients recovering from operations: both athletes and patients have bodies under extreme stress."

An Early Day Motion on the Order Paper congratulated the Society of Biology on organising this year's Parliamentary Links Day and welcomed the contribution that scientific societies make to assisting Parliament.

THE OLYMPIC AND PARALYMPIC GAMES

The enthusiasm of the speakers at Parliamentary Links Day paved the way for a fantastic Olympic Games. Team GB won a staggering 65 medals to secure third place in the medal table, and over 7.4 million spectators visited Olympic venues around the UK.

At the Games the UK anti-doping agency worked tirelessly to ensure that London 2012 was as clean as possible, and carried out over 6,000 tests for banned substances in athletes' blood and urine. Andy Parkinson, UK Anti-Doping Chief Executive, said: "The World Anti-Doping Agency reported that over 100 potential Olympians were stopped from competing at the Games because of doping, while the International Olympic Committee announced a number of positive tests during the course of the Games. This is good news for clean athletes around the world."

Speakers at Links Day had amazed the audience with some examples of world records – tapes along the wall and the floor of the Attlee Suite marked the world high jump record (2.45m) and long jump record (8.95m). Both those records remain. But, as expected, records were broken at the London 2012 Olympics as athlete performance continues to improve. Some striking performances included the fastest ever 800m, run by Kenyan athlete David Rudisha, and a record time for the Great Britain team in the 3km women's cycling pursuit. On behalf of the Society of Biology, Dr Mark Downs said "UK sport has received a boost from the Olympics and a boost from science. Support from across the science and engineering sector has been essential to the success of the Games. I look forward to seeing how the Olympic legacy unfolds, and for a continued relationship between science and sport."

CONCLUSION

Mr Speaker Bercow had opened Parliamentary Links Day 2012 by saying that although there is a "great distance to travel" in terms of promoting scientific understanding among MPs, there has been a great deal of progress in recent years.

The largest ever attendance for a Links Day showed the appetite that exists for scientists and MPs to share their knowledge in order to improve the use of science in policy decisions.

Science and Universities Minister, Rt Hon David Willetts MP, rightly observed that Parliamentary Links Day has become "the biggest gathering of scientists coming to Parliament".

> Parliamentary Links Day has become "the biggest gathering of scientists coming to Parliament".
>
> David Willetts

PLUGGING IN – the relative costs of new grid connections

Paul Davies
Head of Policy
The Institution of Engineering and Technology

It is well documented that the UK is facing significant challenges to its energy supply due to the combined problems of climate change and energy security. Plans are being drawn up and being implemented to install new forms of electricity generation to replace coal fired power stations and the UK's ageing nuclear fleet. Without replacements the UK faces a cold, dark future. There are many issues related to these new installations and one of the biggest is their location.

The UK's electricity supply system was designed in the 1940s to connect efficiently electricity generation (then mainly located near coalfields and industrial areas) with the main urban areas of demand. It was designed to be a resilient, one-way network. Generate – Transmit – Distribute – Use. Large electricity generating stations are connected to a national electricity grid to move the electricity around the country efficiently at high voltage. At various points this is connected to the low voltage distribution network by which the electricity is delivered to consumers. So when you flick a light switch, the light bulb is instantly connected to a generator somewhere in the UK that has to work that little bit harder.

This system works well until new types of electricity generation need to be connected. These are often sited nowhere near existing power stations, or embedded in the distribution network, or located in a place that will put extra strain on the existing grid. For example, wind farms are often sited on remote hill-tops or off-shore, and nuclear power stations are usually placed in coastal locations. Both of these might be some distance from the nearest grid circuit and the majority of electricity consumers. The answer to this problem is to join them into the existing electricity transmission grid through new connections or "circuits".

The technologies to do this are well established. Electrical circuits can be constructed using overhead wires and pylons or cables laid underground or under the sea. Choosing which technology (or mix of technologies) to employ depends upon many factors such as cost, capacity, topography, geology and environmental impact.

The planned installation of new circuits has become a hot topic in many places, with local people opposing the erection of lines of pylons across the countryside. Many of the arguments have revolved around the relative cost differences between circuit technologies and their differing environmental and visual impacts. However, direct cost comparisons are not easy, particularly when taking into account different locations, technologies, geology, capacities etc. For example, tunnelling through fractured rock in a mountainous area can be significantly more expensive than through clean clay in an easily accessible location. It was this variability that led the Infrastructure Planning Commission to ask the Department for Energy and Climate Change to produce a definitive cost comparison study.

It was important that such a study should be carried out independently and gather information from as wide a range of sources as possible. To this end, National Grid plc asked the Institution of Engineering and Technology (IET) to set up and run the study. Under the IET's guidance, the consulting firm Parsons Brinckerhoff was engaged to carry out the study. A Project Board, chaired by the IET, was created to oversee the project, and two senior IET

Fellows were recruited to review and approve the quality of the final report. The study sought data from equipment manufacturers, installers and network operators from around the world and asked for input from interested parties, including local authorities and pressure groups.

The work took five months, resulted in a 300-page report which details comparable cost estimates for overhead, underground and subsea transmission technologies. This is further broken down to estimate the costs of installing underground cables directly in the ground and in tunnels, as well as the cost of installing Gas Insulated Line (GIL) circuits. GIL is a relatively new technology but, so far, rarely used in the UK.

In the final report the costing results are presented in summary and also in considerable detail. The latter allows the reader to "flex" the estimates to get better indicative costs for real life routes and installations, as well as estimate the impact of changes to material costs, raw material prices and exchange rates.

A transmission circuit is made up of three conductors (or wires in the case of pylons), and a typical pylon supports two circuits comprising six wires in total, suspended from its six arms by ceramic insulators. Because the length and power carrying capacity of each installation has a direct bearing on the costs, each technology has cost estimates for circuits of 3, 15 and 75 km in length and low, medium and high capacities. Each of these options is further broken down to show the fixed and variable build costs along with the whole life (40 year) operating costs. Also included is an indication of the major cost sensitivities of each technology.

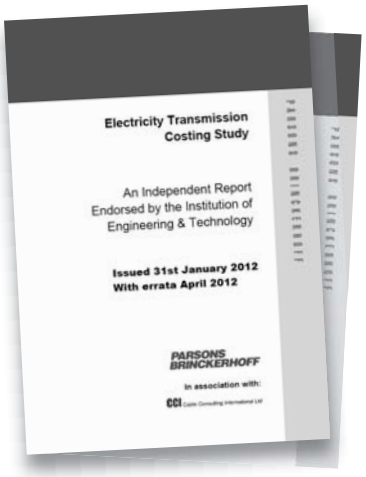
The intention of the report was not to produce a quotation checker, but to allow interested parties to gain a deeper understanding of the figures presented in planning applications, and in particular to make realistic cost comparisons between the various transmission technologies for a particular application.

The study found that an overhead line circuit (ie using pylons) is the cheapest transmission technology, with costs varying between £2.2 million and £4.2 million per kilometre. Directly buried underground cable costs vary between £10.2 million to £24.1 million per kilometre, with tunnel based underground installation and GIL technologies costing considerably more. The study did not attempt to answer whether the additional cost of burying a particular transmission circuit could be justified, as it did not seek to estimate the value of a particular landscape, or the amenity value to tourism etc. However it has set a benchmark by which the relative costs of the commonly discussed technologies can be assessed.

The study considered the whole life costs of the transmission circuits, including the build and operating costs. This highlighted a possible source of confusion caused by the common practice of comparing overhead and buried cable costs in terms of simple ratios. All circuits suffer from energy losses due to the laws of physics – the electrical resistance of a wire causes the wire to heat up when an electrical current flows through it. Whilst the losses will vary between the different transmission technologies, for the levels of power typically experienced on National Grid's circuits the costs of losses are of the same order for all the technologies. However, although the annual costs of these losses are small in comparison to the build cost, when they are considered over the lifetime of the circuit they can have a considerable impact on the technology cost ratio calculation. This is because, whilst the costs of losses experienced by all technologies are similar, they are also roughly equivalent to the total cost of building an overhead line circuit. The total lifetime costs of the overhead line are thus, roughly, twice the build cost, whilst those of underground cables are only around 10% above their build costs (as their build costs are considerably higher). This significantly changes a straight cost ratio calculation, from for example 10:1 underground to overhead to 5:1. It is therefore worth being very cautious when considering arguments based simply on cost ratios.

The final report includes a comprehensive appendix which provides details on the different technologies and future developments, including explanations of terms such as superconducting cables.

The report was published in January 2012 and has been widely accepted as authoritative. It has been referenced by both National Grid and various pressure groups in documentation and in press coverage relating to transmission planning applications. The Planning Inspectorate has reported that it has found the study to be of value, although it is too early to determine its value in the context of the examination, recommendation and decision stages of a planning application. The report does of course have a shelf-life and, as both technology and the UK energy system continue to develop, it will need to be reviewed and updated at regular intervals in order to maintain its usefulness.



The report can be found on the IET website at http://www.theiet.org/factfiles/transmission.cfm

. . . the UK faces a cold, dark future . . .

. . . the whole life costs of the transmission circuits . . .

HIV/AIDS AND TUBERCULOSIS IN THE GOLD MINING INDUSTRY IN SOUTH AFRICA

Rt Hon Peter Hain MP and Martin Caton MP

Rt Hon Peter Hain MP and Martin Caton MP co-chaired a meeting held by the All-Party Parliamentary Groups on HIV/AIDS, Global Tuberculosis (TB), and Earth and Environmental Sciences, to discuss the issue of HIV/AIDS and TB in the Gold mining industry in South Africa.

From left to right – Dr Sahu Suvanand (Stop TB Partnership), Martin Caton MP (Chair, APPG Earth and Environmental Sciences Group), Rt Hon Peter Hain MP, and Jonathan Smith (Epidemiologist, researcher and film-maker)

Martin Caton opened the meeting, noting that both his constituency and Peter's neighbouring constituency in South Wales share a nickel mining history. Referring to the nickel mining and associated illnesses, he appreciated the need to ensure that the wellbeing and health of mine workers is paramount, no matter where they are. Martin introduced presentations by Peter Hain, Jonathan Smith (Yale University, Director of 'They Go to Die') and Dr Sahu (Director of TB REACH, Stop TB Partnership, Geneva). Discussion followed.

Peter Hain had recently visited South Africa with a delegation organised by Advocacy to Control TB Internationally (ACTION) partner RESULTS UK to look at the TB/HIV epidemics in South Africa, the steps being taken to address them and the challenges currently faced, including TB/HIV in gold mining. He spoke about the scale and scope of the problem and his experiences: during a site visit he learnt about the relationship between HIV and TB and was shocked to learn that South Africa has the highest rates of TB anywhere in the world, and accounts for 25% of the world's population living with HIV. Drug resistant strains of TB also present worrying challenges to TB control.

. . . South Africa has the highest rates of TB anywhere in the world . . .

South Africa is at the centre of this dual TB/HIV epidemic and data show that TB and HIV in the region are further exacerbated by conditions associated with gold mining. Despite a TB control programme in the mines following international guidelines, a significant number of mine workers develop TB every year. This is due both to the conditions in which miners live and work, and more specifically the silica content of the rocks and soil from which gold in South Africa is mined at depth rather than the more common surface mining. When silica dust is inhaled, it causes damage to the worker's lungs, which are then more susceptible to infection by TB. With the introduction of HIV amongst

The Stop TB Partnership is leading the way to a world without tuberculosis (TB), a disease that is curable but still kills three people every minute. Founded in 2001, the Partnership's mission is to serve every person who is vulnerable to TB and ensure that high-quality treatment is available to all who need it. http://www.stoptb.org/about/

many of the gold mine workers, their immune systems are further compromised allowing their bodies to be more easily affected by TB/HIV co-infection. HIV sufferers die more quickly when they also have TB and most die within 6 months of contracting TB. TB is the largest killer of people living with HIV in developing countries, accounting for 25% of all deaths.

Migrant workers all too often return to their communities without treatment, both sealing their fate and leaving their friends and families exposed to a high risk of contracting TB. The process of returning home has been titled 'being sent home to die'.

Jonathan Smith (lecturer in Global Health and Epidemiology of Microbial Diseases at Yale University) studies the epidemiology of TB and HIV in the context of migrant populations. After his presentation he showed part of his documentary film 'They go to die' (http://twitter.com/#!/TheyGotoDieFilm). The film investigates the life of four former migrant gold mineworkers in South Africa and Swaziland, who contracted drug-resistant TB/HIV while working at a gold mine, and follows the workers as they return home to their villages.

. . . TB is the largest killer of people living with HIV . . .

With or without silica, someone with HIV is more likely to contract TB as the risk factors are multiplied. HIV+ increases the affected person's risk of contracting TB four fold; Silicosis increases the affected person's risk of contracting TB four fold; Silicosis and HIV together have a multiplicative effect of 16.

Many mine workers are migrant workers from neighbouring countries, from all over Southern Africa, and also from as far as Madagascar. Mine workers, once diagnosed with TB, are deemed unfit to work and are then sent home to their communities, often without proper access to medicines and health care.

An estimated 760,000 cases annually of incident TB in the general population of sub-Saharan Africa is directly attributable to the mining industry. Each year South Africa has about 350,000 cases of TB where there is no continuation of care. TB kills with alarming efficiency, though it is fortuitous in that a quick death means that there is less time to infect others. Without treatment HIV+ patients that contract TB have an 83% fatality rate within 6 months.

Dr Sahu Suvanand (Team Leader, TB REACH, Stop TB Partnership) highlighted what is being done and what more is needed to tackle this problem. He gave an overview of the Southern African Development Community (SADC) process and TB REACH, specifically its potential to help in the response to TB/HIV in mining in South Africa.

. . . Many mine workers are migrant workers . . .

Considerable progress had been made between 1995 and 2010 including: 55 million TB patients treated; an estimated 6.8 million lives saved; and TB incidence and mortality have started to fall. He also outlined some of the challenges that remain including: 8.8 million incident cases of TB and 1.1 million deaths; a further 0.35 million deaths in those who are HIV-positive; a million TB sufferers whose whereabouts are unknown; and Millennium Development Goals (MDG) targets for TB that are unlikely to be met by the African Region. Dr Sahu Suvanand went on to explain TB REACH project funding opportunities and the benefits of fast-track short term funding and shared results of some of the projects including: 33% increase in patients detected with TB; and some plateau areas in Asia. He stressed that if innovative approaches are implemented quickly, good results can be achieved and documented.

Peter Hain ended the meeting by noting that there are signs of recognition of this problem. At a meeting of the Southern African Development Community (SADC) on 27 April 2012 in Angola, National TB Managers agreed that this issue must be addressed, and began by drafting a declaration to be signed by SADC minister of health in August 2012. He stressed that this is an issue that affects multiple stakeholders and we must therefore strive to work together to address the problem with large as well as smaller to medium-sized mining companies, the private sector, public sector and government.

RESULTS' particular focus is unique: working at a grassroots, national and international level to create the political will to end hunger and the worst aspects of poverty. At the heart of RESULTS is a network of volunteers who work together in local groups to become effective advocates for change. The RESULTS network is supported by a small staff working in coalition with parliamentarians and organisations around the world to advocate on global poverty issues. http://www.results.org.uk

. . . an issue that affects multiple stakeholders . . .

Acknowledgements:

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THE RT HON LORD MORRIS OF MANCHESTER

Lord Morris sharing a word with Arthur Butler at the Parliamentary and Scientific Committee 70th Anniversary Lunch on 15th October 2009

ALF MORRIS was one of a rare breed – an MP who genuinely changed Britain for the better.

In 1970 he successfully introduced the Chronically Sick & Disabled Persons Act which was the first legislation globally to recognise and give rights to people with disabilities.

The then premier Harold Wilson recognised his passion and commitment and in1974 Alf became the first Minister for the Disabled, not just in Britain, but anywhere.

He turned disability rights into a mainstream political issue. He followed that up with more legislation in 1991 as a ferocious activist in the campaign to recognise Gulf War Syndrome.

Many obituaries omitted that he was similarly committed as a long-time member and trustee of the Parliamentary Science and Technology Information Foundation (PSTIF), set up in 1988 by the Parliamentary and Scientific Committee (P&SC) to support the Parliamentary Office of Science and Technology. He was chairman of the P&SC from 1989 to 1992 and served on its Council until his death.

Alfred Morris, Baron Morris of Manchester (23 March 1928 – 12 August 2012) was MP for Manchester Wythenshaw from 1964 until 1997. His main front bench role was as PPS to agriculture minister Fred Peart. But that brief resumé does not reflect his impact on public life. It is a great pity that he did not live long enough to be a spectator at the London 2012 Paralympics.

His concern for the disabled started young. His father George lost an eye and a leg and was gassed while serving in World War One, and then suffered a long decline in health and eventually death arising from his injuries. His mother Irene was not entitled to a war widow's pension!

"The injustice of that confirmed me as both a socialist and a fighter," he said decades later.

It took Alf 40 years to put the matter right by changing the law affecting armed forces pensions.

His childhood proved to be one of his main motivators in life, being raised in poverty-stricken Ancoats, Greater Manchester. In 1935 the family moved to a new purpose-built housing estate on farmland in Newton Heath.

"I saw fields and cows and sunshine," he said. "I realised that life need not be grim."

He was educated at Brookdale Park School along with his fellow pupil Harold Evans, who, as editor of The Sunday Times, wrote a leader saying that: "As time ticked away to the 1970 general election, Alf Morris's Bill was the only piece of legislation worth saving."

Evans was the editor who exposed the thalidomide scandal.

Alf worked from 14 as a clerk in the local Wilson's Brewery, did national service in the army, mainly in the Middle East, from 1946-48, studied at Ruskin College, Oxford (1949-1950), St Catherine's College, Oxford (BA modern history 1953) and the Department of Education.

He became a Manchester schoolteacher and university extension lecturer in social history (1954-1956) and an industrial relations officer to the electricity industry (1956-1964).

He was created a life peer as Lord Morris of Manchester in 1997. He was a life member of the GMB union and served as President of the 1995 Co-Operative Congress.

His brother Charles Morris and his niece Estelle Morris have also served as Labour MPs, and of course Estelle is also a Peer.

He died in hospital on Sunday 12 August 2012 after a short illness, aged 84. He is survived by his wife Irene and their two sons and two daughters.

Andrew Miller MP

Acknowledgement: with thanks to Ian Hernon for background information.

HAPPY AND GLORIOUS
Thanks to some Diamond Geezers

Queen Elizabeth II is not, of course, the first lady monarch to reach a Diamond Jubilee.

Sadly, this journal was not around in 1897 to review British scientific achievements during Victoria's reign. It is safe to say that the UK could have been just as smug at the end of the 19th century about our science, as the next ten pages show we are at the beginning of the 21st.

There were no Nobel prizes to win, and no citation rankings to dominate.

Nonetheless, her reign provided many heroes, whose names are still household words.

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Michael Faraday, reproduced by courtesy of the Royal Institution of Great Britain

Michael Faraday's development of electromagnetic induction gave us the electric motor.

Patients used to die of bacterial infection, rather than their original ailment until Joseph Lister gave us antisepsis.

It is now impossible to imagine operations conducted with brandy as the anaesthetic. The chloroform introduced by James Simpson is no longer used, but a whole new science opened up.

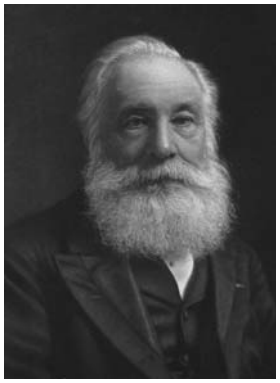
James Clerk Maxwell's analysis of waves in the ether allowed us to develop radio, television, radar, the internet and WiFi.

Brunel gave us tunnels, and bridges as well as trains and ships.

Perkin stumbled on synthetic dyes by accident, but spawned a major industry.

Darwin has been both feted and vilified for his theories.

The next few pages demonstrate clearly that Britain still has much to feel proud of when it comes to scientific innovation.


Sir William Henry Perkin © RSC library


James Clerk Maxwell © Peter Reid, FUSION: Focusing on University Science Interpretation and Outreach Needs, University of Edinburgh


Isambard Kingdom Brunel

BRITISH ACHIEVEMENT IN ENGINEERING OVER THE LAST 60 YEARS

Dr Natasha McCarthy
Head of Policy
The Royal Academy of Engineering

The Queen's Diamond Jubilee was a highlight of an Olympic year which has seen Britain celebrating and revelling in community spirit from a local to a national level. Like the Coronation, the Jubilee was a landmark in British social life, when the majority of the country was sharing a common celebration. However, there has been nothing less than a revolution in the ways that those events were experienced.

The broadcast of the Coronation was watched on black and white televisions with the whole family gathered around, often with neighbours who had no set of their own. But the coverage of the Diamond Jubilee events was enjoyed by millions on television, PCs and phones, anywhere and at any time. There was instant global reaction to what was broadcast – with a video of a hula-hooping Grace Jones at the Jubilee concert hitting YouTube within seconds of the performance, and with comments on it tweeted around the world.

The significance of these differences is that Queen Elizabeth's reign almost exactly matches the span of the digital revolution. This revolution in the way we live was enabled, inspired and shaped by engineering. British engineers have been at the heart of this revolution, and have played pivotal roles in each of its major stages. British engineers have also changed our world in many other ways over the last 60 years, by exploiting the opportunities presented by digital technologies.

Just four years before Elizabeth's coronation, 'Baby', widely acknowledged as the first modern computer, ran its initial programme at the University of Manchester where it was developed by British scientists and engineers. This ancestor of the computing devices now available bears little resemblance to the laptop or smartphone. However, from the point of Baby's invention, the development of computer science and software engineering accelerated, with developments in hardware and software occurring at pace.

A crucial aspect of the digital revolution is connectivity – communication between computers in local and global networks. In 1976, a year before the Queen's Silver Jubilee, and the year that The Royal Academy of Engineering was established, the Queen herself hit the 'send' button on an email utilising the first link between computer systems in the UK and US. The occasion was the formation of the Royal Signals and Radar Establishment, and the email utilised connectivity provided by ARPA in the US for the use of the defence community.

That initial connection was augmented by links between all continents, which have now developed into the internet, the global network of computers connected for the sharing of information. It requires no demonstration that the internet has become integral to individuals' and societies' lives and has changed many people's experience of the world. However, the reason that the networking of computers has been so impactful is due to the work of a British engineer, Sir Tim Berners-Lee FREng FRS. When working at CERN, Berners-Lee developed the basis of the world wide web. The now common concepts of Uniform Resource Locators (URLs), Hypertext Transfer Protocol (HTTP), Hyper Text Mark Up Language (HTML), were the work of Berners-Lee. These gave unique addresses for webpages so that they could be found by any user; a common means of computers to communicate information on webpages; and a common language to ensure that webpages were displayed faithfully on any machine. These devices allowed this global network of computers to share information in such a way that it can be viewed in a common format on any computer. It turned what was a system created and used by experts into a system usable by anyone with a PC, and ultimately into a movement which would change ordinary people's lives.

It was Berners-Lee's vision that ordinary people would be able to use the technology behind the world wide web, so that anyone could add information and content to the web themselves, sharing it with all users. This vision has been realised through the development and rapid adoption of social media. From Facebook to YouTube to Twitter, people are publicising their thoughts, reflections and creations to groups of friends and the world at large.

British engineering has been central to enabling this democratisation of the web, making it the accessible and constantly changing system it is now. The British-based company ARM has developed processors that power many smartphones and other mobile devices which have enabled this further stage of the digital revolution. These processors have brought computing power not just into every home, but into every pocket. Mobile computing enables connectivity everywhere,

ARM technology powers mobile devices such as smartphones - image courtesy ARM

and it has led to the development of manifold applications including those that allow just the kind of real time sharing of information and data that has enabled the uptake of social media, and which has played a crucial role in making the Jubilee and Olympic events of 2012 truly social experiences – this being the first truly 'digital' Olympics, broadcast on the web as well as television. It has created an industry of creative design of 'apps' in which the UK plays a major part.

The ethos of the internet was presented by Sir Tim Berners-Lee at the Olympic opening ceremony - image copyright Press Association

The digital revolution highlights just how closely and intimately engineering affects people's lives at an individual and societal level. However, all aspects of engineering have significant impact on everyday life, be that in the delivery of utilities such as power and water to homes and businesses, transport infrastructure, or the technologies that support modern medicine. The digital revolution has transformed, and will continue to transform, the ways in which these services are delivered and managed.

Digital technology is powering a revolution in healthcare - image courtesy ARM

Infrastructure will become increasingly 'smart' through the use of computing power. Smartness consists in collecting data about the status of a system and using that data to manage better the system, either automatically, via a human operative, or communicating it to users of the system to influence their behaviour. Transport systems are increasingly intelligent, and the separate systems which govern land, air, rail and sea can become a single system. This will be valuable to travellers to allow them to manage better journeys and will enable the better use of new transport technologies, such as electric and even driverless cars. Data can be collected about quietest routes and related directly to vehicles, to manage better the system and improve individual journeys. Analogously, a smart electricity grid is one which uses data about demands in real time to manage the way that power is distributed and used. Depending on demand at a given time, devices can be charged, switched off, or even add power to the grid. For example, electric cars could be charged when the grid is experiencing low demand, or batteries in some devices could be used as distributed storage with that stored power downloaded into the grid. This creates a more efficient system, better able to use low carbon energy, reducing carbon emissions.

The biomedical engineering sector is also utilising digital technologies to revolutionise the way that healthcare is delivered and managed. 'Telehealth' or 'e-health' exploits mobile computing to allow healthcare to be better tailored to an individual, and to allow a patient to be treated in their own home without need for frequent lengthy trips to hospitals. A patient's heart rate or blood pressure can be regularly monitored by a device on their body which relays readings to a service that tracks the patient's wellbeing, only making contact when a problem arises. Such systems are being developed by Professor Lionel Tarassenko FREng at the University of Oxford, with the aim of delivering healthcare which better serves the patient and allows them greater freedom and autonomy during their treatment.

In these ways, engineers have not only been the instigators of the digital revolution over the last six decades, but have grasped the opportunities it creates across all areas of engineering. Engineers have both initiated and stimulated the rapid development of computing technologies.

The last 60 years have without doubt seen many leaps forward by British engineers. I have not sought here to enumerate or list individual achievements but have illustrated how British engineers have had a key role in a movement that has transformed both everyday life and engineering itself. However, there is value in noting individual engineering achievements and celebrating them. For this reason, Her Majesty has lent her name to the Queen Elizabeth Prize for Engineering, which will be awarded for the first time next year. The Prize will identify and celebrate the kinds of truly life-changing technologies that have had a global benefit to humanity and will no doubt continue to change the way we live over the next 60 years and beyond. Whether it is awarded to a British or international engineering achievement, the development of the Prize shows that Britain is proud of the achievements of engineering and their capacity to change our world.

BRITISH SCIENTIFIC ACHIEVEMENT OVER THE LAST 60 YEARS

Meeting of the Parliamentary and Scientific Committee on Tuesday 10th July

SIXTY YEARS OF SUCCESS IN UK LIFE SCIENCES

Professor Dame Nancy Rothwell
President and Vice-Chancellor,
University of Manchester;
President, Society of Biology.

Since the early 1950s, the period marked by the Jubilee celebrations, Life Sciences in the UK – by which I mean all areas of biology, biomedical and medical science – has experienced a remarkable revolution. We have seen major discoveries in fundamental science, transformations in medicine and health, major impacts on food supplies with significant economic, social and health benefits. The UK is, by many measures, amongst the world leaders in this area. On one recognised measure, citations of our published work, we are second only to the USA. When this and other measures are adjusted for population or for national research spend, the UK comes top worldwide. The UK also has an impressive array of Nobel Prizes in Life Sciences – most in Physiology or Medicine, but many biological discoveries have also won the Prize in Chemistry.

The Queen's coronation coincided with what is widely recognised as the biggest breakthrough in Life Sciences of the last century.

DNA AND THE GENE "REVOLUTION"

In 1953, James Watson, Francis Crick, Maurice Wilkins – and not to forget the key role of Rosalind Franklin – published the structure of DNA. Aside from revealing the true beauty of the structure, this changed our understanding of life with the realisation that DNA is the fundamental building block of all life and is the code that determines all our proteins.

This was followed by a flood of discoveries and innovations, many in the UK. Fred Sanger discovered how to do fast and accurate sequencing of DNA, wholly new disciplines of molecular biology and genomics were born and the Sanger Centre was established in 1993. In the 1990s the genomes of important organisms such as worms and yeast were solved. Then as the new millennium dawned, the first draft of the human genome was published, jointly by researchers in the UK and the US.

A second explosion of discoveries followed, with faster and cheaper genome sequencing resulting in a better understanding of how small changes in the genome can have massive implications for disease, and opening the potential for new treatments and "personalised" medicine. Alec Jeffreys brought us DNA fingerprinting. We learnt that just one gene separates human males from females and started to discover specific mutations that cause disease. In 2000 it cost about $1 billion to sequence a genome, today it's about $10 thousand; by 2015 it will probably cost less than $1 thousand and may be a standard diagnostic in doctors' surgeries.

WIDER IMPACT OF GENOMICS

Genetically modified (GM) crops and animals is a sensitive issue, where we must inform and debate much better, not least because this is a means by which we can change global food supplies and have environmental impact. For example, genetically modified "purple tomatoes" have anti-inflammatory and anti-oxidant properties which could lead to reductions in cancer, cardiovascular disease, diabetes and other major disorders. Many such manipulations of our normal foods could have similar health benefits.

Animal health influences our farm stocks, wild animals and our pets. We have made great advances in understanding and treating diseases of animals. For example: hundreds of millions of chickens had to be killed as a result of avian flu. Genetically modified chickens developed in the UK should limit the spread of bird flu and safeguard future flocks and eggs.

Figure 1: Purple tomatoes, genetically modified to include anti-oxidant genes. Thanks to Dr Cathie Martin, John Innes Centre.

Genetically modified crops can greatly improve yields and much needed foods for desperately struggling populations and have huge societal benefits. GM crops need much less agrochemicals (pesticides and fertilizers) with massive environmental benefits.

FUNDAMENTAL DISCOVERIES WITH MAJOR IMPACT

This section could occupy literally hundreds of pages. I have chosen just three illustrative examples.

Peter Mitchell's "chemiosmotic hypothesis" showed how organisms use oxygen and energy from food to convert this in the cell compartment known as mitochondria into a "currency" of energy that can be used by all cells – stored in a molecule called ATP. Mitchell, often described as a "typical British eccentric", was the founder of this important field which led to other major UK discoveries in energetics and mitochondria and several Nobel Prizes.

As a very different example, Kathleen Drew, a "cryptogamic botanist" of my own University, devoted her life to seaweeds. She discovered a previously unrecognised stage in the life-cycle of the seaweed known in Japan as Nori. Her discovery enabled Nori to be cultivated rather than then simply collected, and the world production of this seaweed had risen from 21,000 tonnes in the

1950s to over 500,000 tonnes today. This is just one of numerous examples of the unexpected impacts of "curiosity driven" research on society.

My last example of fundamental science discoveries is "model organisms". This means using lower species, like worms and flies, to understand the biology and diseases of higher organisms, like humans. This has been a hugely successful area and none more so than the first sequencing of the genome of a worm – for which our scientists shared yet another Nobel Prize. This is close to my own area of research (on brain disease) and I often tell schoolchildren and students the story of "a small worm" where genes were first discovered that determine if cells will live or die. This is now a fundamental basis of degenerative diseases – where too many cells die, and cancer – where aberrant cells don't die.

UNDERSTANDING DISEASE AND NEW MEDICINES

It is only possible in a short space to highlight the major leads from the UK. These include modern antibiotics, histamine blockers to treat stomach ulcers, beta blockers to lower blood pressure and alleviate heart disease, therapeutic antibodies – then later personalised antibodies to target diseases. Some drugs were developed through "serendipity" which always needs the observant and prepared mind, as is illustrated by the case of Viagra!

The UK has often led on "evidence based medicine", most notably in Richard Doll's careful studies providing the clear links between smoking and cancer. We also developed randomised controlled clinical trials, and developed Cochrane collaborations that bring together the results of numerous trials to give an overall assessment of efficacy of any intervention.

The UK has also provided leadership in governance and regulatory issues, including research ethics and integrity, animal experimentation, GM organisms, the Human Fertilisation and Embryology Authority, NHS guidelines, our assessments of medical costs vs benefits (through NIHCE), and the advocacy for open access publishing.

INTERDISCIPLINARY APPROACHES

I was delighted to speak alongside leaders in physics and chemistry in highlighting UK achievements. But the reality is that it is increasingly difficult to distinguish between scientific disciplines – perhaps more so in the UK than in many countries. Interdisciplinarity is a great UK strength.

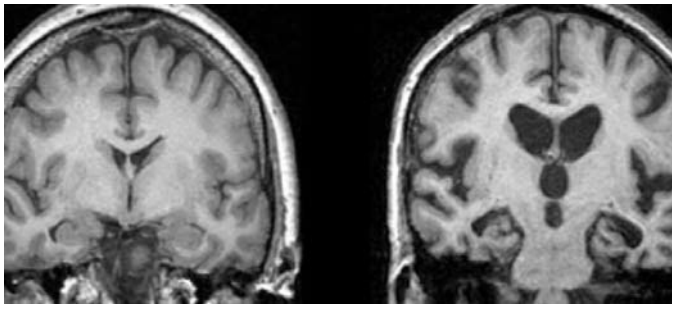


Figure 2: Magnetic Resonance Imaging developed by Sir Peter Mansfield. Reproduced with permission of the Medical Research Council.

Again the list of our successes is long. Advances in understanding biological structures (which is fundamental to understanding functions), fast genome sequencing, CAT and ultrasound scanning, magnetic resonance imaging, medical devices such as hip replacements, cochlear implants, artificial lenses, cardiac stents and prosthetics – all depend on our strengths in engineering, physics, chemistry, maths – as well as biology. Here I can't pass on the great opportunity and UK lead on graphene! This is the thinnest, strongest, most conductive (and so many more superlatives) material ever known. There are huge possibilities for Life Sciences. As a UK discovery and one of many UK Nobel Prizes, this gives us a great opportunity for future innovation.

There is always a temptation, especially in times of limited funding, to focus funding and effort on one or two areas such as life sciences or physics. This would be a grave mistake. Much of the UK's success has depended on interactions between the very best scientists across disciplines.

WHY IS THE UK SO SUCCESSFUL?

Unless we can answer this important question, we can't ensure success in the future. There are no definitive answers, but I suggest below some likely reasons for UK success, in each case followed by possible threats that we need to be aware of:

- **Outstanding training.** But we need to consider how the new University student fee regime may influence student choices and entry into postgraduate training.
- **Open challenge.** We need urgent reform of our libel laws to protect valid and valuable scientific critique.
- **Supporting "mavericks".** Many discoveries and breakthroughs challenged dogma and were made by those who "broke the rules". A worry is that we are under ever increasing "red tape" and legislation.
- **Creativity.** Fundamental discovery in science is a creative endeavour which we must continue to fund. Some feel that a push towards application and impact could have a stifling effect.
- **Interdisciplinary research.** Big breakthroughs often depend on scientists with different skills coming together. We must break "silo mentalities" and ensure funding for cross disciplinary activities.
- **The NHS and patient data.** This is a huge resource so we must ensure it is not damaged by changes in and funding of the NHS.

THE JUBILEE

Over the 60 years of the Queen's reign, life span in the UK has increased dramatically – by an average of 5 hours a day. There are a number of reasons for this, but discoveries in Life Sciences are a major contributor to the health, wealth and quality of life in the UK and more widely.

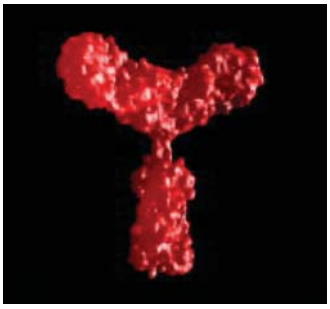


Figure 3: Therapeutic antibodies. Monoclonal antibodies were first isolated by Drs. César Milstein and Georges Köhler. Reproduced with permission of the Medical Research Council.

Acknowledgements

Thank you to my colleagues at The University of Manchester, the Society of Biology, MRC, BBSRC and the Wellcome Trust for giving me so many great examples of UK advances in Life Sciences. Sorry I could only include a small fraction.

BRITISH ACHIEVEMENT IN CHEMISTRY OVER THE LAST 60 YEARS

Professor Lesley Yellowlees MBE
President, The Royal Society of Chemistry
Professor of Inorganic Electrochemistry, University of Edinburgh

In celebrating our Queen's Diamond Jubilee it is appropriate that we reflect on the period as one of phenomenal scientific advance. From the discovery of the structure of DNA in the coronation year to the discovery of the Higgs Boson this year, all the sciences have made bold steps forward in explaining our world and improving it.

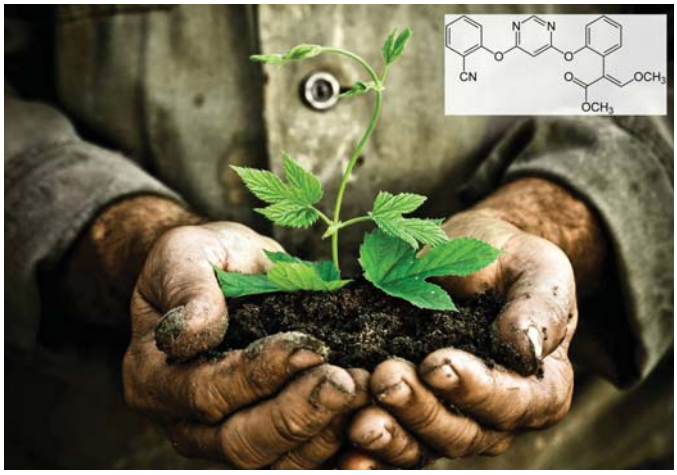
Far beyond our size, we are a nation of Nobel Laureates. For chemistry, the Queen's reign began in style with the award of the Nobel Prize, in 1952, to Archer Martin and Richard Synge for the invention of partition chromatography. They had discovered a method for the separation of substances from complicated mixtures, a new powerful tool. Thanks to their work, once hopelessly complicated problems across all the sciences were now solvable. A new era was dawning.

Since Martin and Synge, chemists have gone on to show that understanding the building blocks of the world around us is the way to build that second Elizabethan era. Chemistry is behind state-of-the-art technologies including screens and batteries in our smartphones and laptops. John Goodenough's identification and development of Lithium Cobalt Dioxide (Li_xCoO_2) as the cathode material of choice for the Li-ion rechargeable battery means I can carry my phone in my pocket everywhere and work on my laptop until too late at night. And I'm able to see all this information through a liquid crystal display, which is based on the cyanobiphenyl materials invented by Professor George Gray and colleagues at the University of Hull.

Chemistry is developing sustainable alternatives to fossil fuels and lowering carbon emissions, increasing energy efficiency in areas ranging from domestic electronic products to nuclear power stations. We need those answers – a recent report by the Committee on Climate Change showed the pace of UK emissions reductions needs to increase fourfold – and it is only technological advance that can make that happen.

Fuels. Energy. Materials. All are chemistry. And they come together in the planes that move us round the globe in a way few could have imagined. Airbus' next-generation A350 XWB aircraft will be lighter and more efficient because more than half of it will be built from lightweight composite materials that chemists constructed; a far cry from the small and slow plane that brought the new Queen back from Kenya after her father's death.

Not just a more efficient world, but also a safer world. Chemistry is working for people's security, building faster, smaller and more sensitive devices able to detect microscopic levels of explosives. And chemistry is also working for a larger, safer and better distributed food supply. Take, for example, Azoxystrobin the agricultural fungicide, developed by UK-based chemists in the last thirty years that has increased yields of more than 120 types of crop in over 100 countries.



Azoxystrobin, the leading agricultural fungicide, was developed by UK-based chemists.

And a healthier world. Blockbuster therapies which serve the needs of a wide patient population have transformed healthcare in recent decades and most are made in Britain. At least ten of the top-selling drugs worldwide have UK-trained PhD organic chemists as named inventors. Amlodipine is one of those drugs underpinned by UK chemistry patents: 2.2 million Britons take it to ease angina and this drug has reduced the number of days a patient visits hospital, cutting costs to both patient and the NHS. Or, for example, Tamoxifen, which has revolutionised breast cancer treatment. In 1957 a woman who developed breast cancer had a less than 70% chance of surviving more than 5 years, while today she now has a 90% chance of survival. An amazing turnaround.

British chemistry discoveries are everywhere transforming our world and they are central to our economy – and to economic recovery. In 2007 Chemistry-related industries supported 6 million jobs and contributed £258 billion to the UK economy – 21 per cent of GDP. Workers in the UK's chemicals industry produce £83,500 per employee, double the UK average labour productivity.

Fundamental chemistry research remains indispensable to the search for solutions to some of the most important technological and societal challenges facing us.

To tackle the big issues of the next sixty years we need to use all our talents. The Queen, our second longest-reigning monarch, is beaten only by Queen Victoria. A lesson to us all, perhaps, about the steeliness and determination of women to stick it out! I have the honour to be the first female president of the RSC in its 171-year history. But I know it won't be another 171 years because I am determined to help diversify the people who make up the science establishment. Not to squeeze out those already there, but to widen, deepen and strengthen the great British talent I see coming through my university month after month.

Of 103 Nobel laureates in Chemistry, only four are women. Of those four, only one is British: Dorothy C Hodgkin. She was awarded the rare honour of an unshared Nobel Prize in 1964 "for her determinations by X-ray techniques of the structures of important biochemical substances." Knowledge of a compound's structure is essential in order to interpret its properties and reactions, and to decide how it might be synthesised from simpler compounds. Hodgkin's contribution to the field was enormous: she carried out a large number of structure determinations primarily of substances of biochemical and medical importance. She was the first one to describe the structures of the antibiotic penicillin and of vitamin B12. The determination of structure is the crowning triumph of X-ray crystallographic analysis in respect of both the chemical and biological importance of the results. With her colleagues she unravelled the structure of insulin so that millions could manage their diabetes.

She was a great scientist first and foremost. But she was an inspirational woman too. Dorothy Hodgkin was a rare talent, but British chemistry simply cannot afford to look back sixty years from now and see her as unique for her gender as well as her talent.

To use all our talents we need policy makers and scientists working together and listening to each other. We are both the kind of people who want to change the world. And we've shown that we can do that together in the past.

Sixty years ago London was engulfed in the Big Smog. Not the first or last of the era of the peasouper. But the point at which people said something must be done. Deaths and ill health were not a price worth paying.

London itself still bears the scars to this day. The cleanup has taken sixty years. But the legislation to clean the air was quick because we already understood the chemistry to clean the air. The Clean Air Act of 1956 banned emissions of black smoke and made homes and industry move to smokeless fuels. Many thousands of lives have been saved through good science and good legislation.

We've done it before and we can do it again. With good science contributing to good legislation and a wide, diverse science base we really can make the world a better place.

It is these inspiring stories and global challenges that will bring in the next generation of Dorothy Hodgkins and Nobel laureates. At the RSC we work to inspire young people to study chemistry, and to raise the public's awareness of the importance of chemistry. We are the largest non-governmental supporter of chemistry education in the UK. In the last decade we have spent more than a quarter of a billion pounds advancing the chemical sciences. We pursue excellence in our work, with our scientific journals, our educational and public engagement activities and our work with policy makers.

To borrow a biologist's analogy, everyday we plant seeds, with fruits of success to be harvested whether that is in the next month, next year, or ten years down the line.

In order to continue to have great British scientific achievements we need proper funding of the sciences. On-going fundamental research is essential to ensure a continuing flow of scientific and technological breakthroughs. Fundamental research, like the work of Dorothy Hodgkin, is essential also to ensure that the UK maintains a highly skilled and innovative workforce. To be well placed to adopt, and advance, new ideas, to exploit successfully new technologies, and to develop new and better products and services we need the profound discoveries that come from fundamental research. As it has been done in the past decades, these will fuel our economy. They are a necessary condition for attracting inward investment to the UK – and contributing to the 21% of GDP that is in the chemical-related industries. Fundamental chemistry research remains indispensible to the search for solutions to some of the most important technological and societal challenges facing us.

The Queen's reign has been one full of great British scientific achievements. We must be proud but we must hold tight to the spirit of enquiry, challenge and thirst for new knowledge that has taken us so far. That is how science and the chemical sciences will thrive for the next sixty years.

Lithium batteries and liquid crystals are ubiquitous in today's portable electronic devices. They are both British achievements of the last 60 years.

PHYSICS – FORCES OF NATURE

This article is a transcript of the talk given by Professor Brian Cox to the Parliamentary and Scientific Committee on 10th July, prepared by Christopher White of the Institute of Physics.

Back in July we made what is one of the biggest scientific discoveries if not in the Queen's reign then of all time – the discovery of the Higgs particle.

That might seem hyperbolic – it's just another subatomic particle – but to step back and look at the story in which that particle plays a part is instructive.

The universe began in a big bang 13.75±0.11bn years ago, which in itself is a remarkable measurement – a measurement that not only was not known with that degree of precision when the Queen took the throne, but the idea that the universe had a beginning was not known to be the correct description of the universe at that time. What we now know is

. . . The universe began in a big bang . . .

that around a billionth of a second after the universe began, as it was expanding and cooling, something happened that caused a condensate to condense out of empty space. This is the Higgs particle. So the picture today is that every cubic centimetre of space is rammed full of Higgs particles that condensed out of the vacuum less than a billionth of a second after the universe began.

. . . This is the Higgs particle . . .

The LHC, where the Higgs was discovered, is a proton collider. It bangs protons together, and that's how it gets energy into small regions of space, so that we can investigate the universe as it was around a billionth of a second after the big bang. That technology is

. . . That technology is British technology . . .

British technology. One of the first two proton colliders was built in Birmingham in 1953 – the year of the coronation. That machine was looking at nuclear structure – the structure of nuclei was not well known. It also wanted to find some clues as to the nature of the force that holds the nucleus together. We didn't know about one of the four fundamental forces of the universe – the strong nuclear force.

Fast forward 60 years and we have the Large Hadron Collider. It's the same technology – it's a proton synchrotron. It accelerates beams of protons, now not slowly around something the size of a garage, but to around 99.999999% the speed of light. It collides protons together up to 600 million times every second; the proton beams themselves are less than the diameter of a human hair, but carry the energy of an aircraft carrier travelling at 30 miles an hour. Yet we can take pictures of those collisions; we can make high-precision measurements, and in July we discovered the Higgs particle.

The LHC has four giant detectors, all of which have important contributions from UK universities. The ATLAS detector is 44 metres wide, 22 metres in diameter, and at its heart there are silicon detectors, which are like CCDs in a digital camera, but in an extremely high-radiation environment. UK universities manufactured and built those silicon detectors. It is a tremendous engineering achievement. With it we can see Higgs-candidate events. We detect other particles produced by the decay of the Higgs, and if you measure the energy and momentum of those with precision, and trace them back, you find out that they came from a new particle weighing around 126 times the mass of the proton. Go back to 1953 in Birmingham, and the accelerator had the energy to make one extra proton. The Higgs particle weighs 126 times the mass of the proton, and that's why we

. . . four fundamental forces of the universe . . .

need something as big as the LHC to make it.

There has been a long road to the discovery of the Higgs. The two famous papers by Peter Higgs were published in 1964. There were also papers published by Tom Kibble, another British theoretical physicist. Two of the five theorists who contributed most to this theory are British. How was it that they were able to make this prediction? What a bizarre thing to suggest – that

. . . 126 times the mass of the proton . . .

empty space is stuffed full of Higgs particles, and we get mass by bouncing off those Higgs particles. The answer to that is the standard model of particle physics – in itself one of the greatest achievements of the 20th century. Its equations describe three of the four fundamental forces of nature – everything that we know of, other than gravity, is described by this simple equation. And it predicts the Higgs field.

It is interesting to note that the prediction was entirely mathematical. It's the best example of what the great physicist Eugene Wigner called "the unreasonable effectiveness of mathematics in the physical sciences". Higgs, Kibble and others noticed that our description of three of the four forces of nature didn't work – it was logically inconsistent; it failed mathematically – without the introduction of the Higgs field. So back in the 1960s this idea was postulated.

The standard model of particle physics is itself based on quantum mechanics, and the pivotal moment in the development of quantum mechanics was the publication of the Schrödinger equation, which showed how particles behaved as waves. That was in 1926, the year of the Queen's birth. Without doubt the best example of the use of quantum theory is the invention of the transistor, ubiquitous today. In one year there are more transistors manufactured than grains of rice have been consumed on Planet Earth since the Queen came to the throne. Transistors work because atoms talk to other atoms in a very strange way. They work because single particles won't go into the same energy level around different atoms, and when you put that in a crystal of silicon you get what's called a 'band gap' and you can use this as a switch. Without quantum theory – this most abstract of theories – the transistor could not have been invented.

. . . empty space is stuffed full of Higgs particles . . .

Where do we go next? What is the next discovery? Could there be a replacement for the transistor? The answer is yes, and it's yet another British success story. The 2010 Nobel Prize was given to University of Manchester physicists Andre Geim and Konstantin Novoselov for their discovery of graphene. One of its most exciting applications is in answer to the question of what replaces the transistor. Graphene transistors have already been manufactured: IBM manufactured one in April last year that was ten times faster than anything manufactured in silicon. In February this year, the Manchester group demonstrated the technology that allows these to be packed together – one of the big problems had been how to build graphene chips. Now we know – we did that in Manchester.

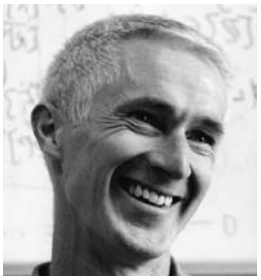
. . . the prediction was entirely mathematical . . .

This is an interesting example of a discovery that's based on esoteric physics but has immediate commercial applications. It's a 21st-century discovery in every way. And it's interesting to read Andre's observations in his Nobel Prize speech. He was talking about his history, of why he came to Manchester. He pointed out that by 2003 he'd already established a lab, as a result of seedcorn funding set up by Lord Sainsbury. But he goes on to say why he thinks the Nobel Prize was brought to Manchester and to the UK. He thanked the Engineering and Physical Sciences Research Council. This funding system – in responsive mode, he emphasises – "is democratic and non-xenophobic; your position in an academic hierarchy or an old-boys network counts for little. Also visionary ideas and grand promises to address social, cultural and economic needs play little role when it comes to peer-review. In truth, the responsive mode distributes its money on the basis of a recent track record, whatever that means in different subjects, and the funding usually goes to researchers who work both efficiently and hard. No system is perfect, and one can always hope for a better one. However, paraphrasing Winston Churchill, the UK has the worst funding research system – except for all the others that I'm aware of."

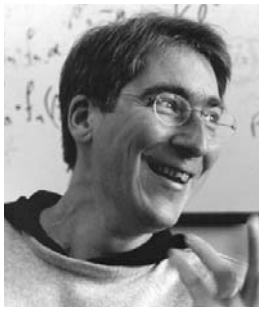
. . . showed how particles behaved as waves . . .

That's powerful and important when we decide to try and fix our research-funding system. Because Andre Geim, who used it to great effect, thinks it's the best in the world.

MATHEMATICS IN THE NEW ELIZABETHAN AGE (60 Years of British Mathematics)



Ken Brown
University of Glasgow

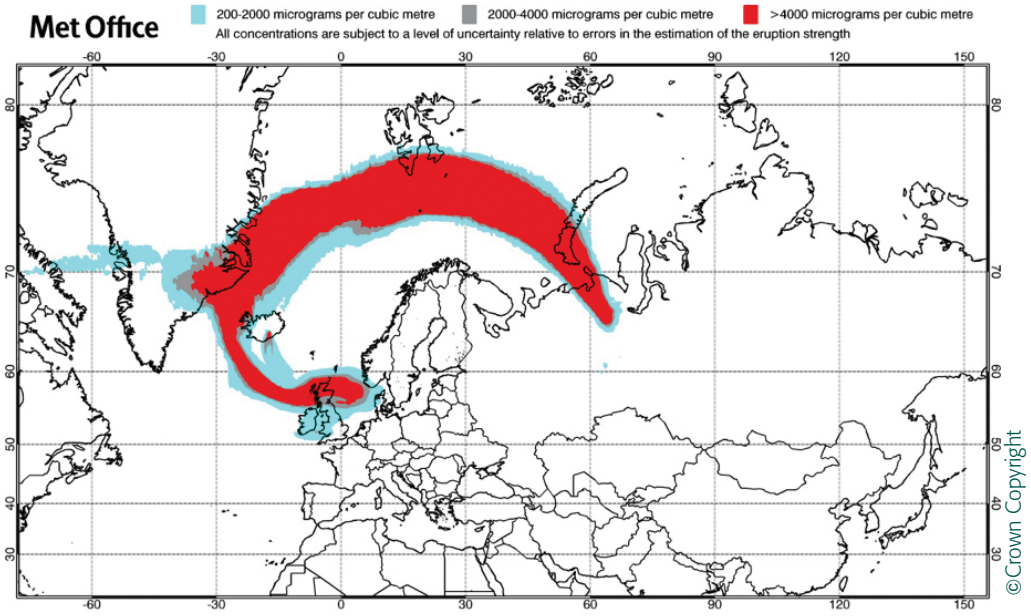


Paul Glendinning
University of Manchester

In June 1993 Andrew Wiles gave a series of seminars at the newly-created Isaac Newton Institute for Mathematical Sciences in Cambridge. In the final minutes of the last seminar he claimed to have solved a 250 year old mathematical problem: Fermat's Last Theorem. This became headline news across the world because of the romance in the story (lone British mathematician solves ancient mystery), and also because the problem itself is relatively easy to state. The interest generated by this achievement is rare for mathematics, though many other developments in mathematical science over the last 60 years are on a par with it. This is partly because mathematics is often seen as too abstruse or specialised for 'ordinary people'; and partly because major advances in applied mathematics and statistics are often sub-plots of bigger stories in biology, physics, economics or engineering.

In this article we want to redress this invisibility and stress the key international role played by British mathematics. Mathematics has changed enormously over the new Elizabethan age, and this has been a global effort. However, the UK has played an important role in most of these changes – a far greater role than its relative size would suggest. Thus, for the period 1998–2008, Scotland and England were respectively second and fourth in the world for citations per paper published in the mathematical sciences[1]. Although we concentrate on research in the rest of this article, it is worth remembering that most researchers are also teachers, and we rely on them to pass on the intellectual thrill of the discipline and to create the skilled workforce needed in the banking, computing, engineering and pharmaceutical industries.

The rise of computers and the ubiquity of smart technology form one of the greatest changes to our lives since 1952. The early prototypes of this technology were developed by Alan Turing and others at Bletchley Park (to decode the German ENIGMA machine) and then at the National Physical Laboratory (NPL) and the University of Manchester. Turing committed suicide in 1954, so he only just makes it into the new Elizabethan age, but his achievements in computing, logic and mathematical biology have had an immense influence. As computers began to be used to solve complex engineering problems in industries such as aeronautics, the UK contribution was key to creating a new mathematical discipline, numerical analysis, which emerged to ensure that these



A computer generated prediction by the Met Office of the position of a volcanic ash cloud.

large computations – computations that can now be done on a laptop! – were reliable. Here we mention two examples. James Wilkinson worked with Turing on the early computers at the NPL in Middlesex, where he discovered ways of analysing floating point arithmetic that enable the accuracy of computer calculations to be understood. His methods remain as valid as ever for today's largest supercomputers[2] and he went on to develop other now standard tools in algebraic manipulation. In many industrial and scientific problems some quantity needs to be optimised. In the 1970s such concerns prompted the UK mathematicians Roger Fletcher and Mike Powell to develop methods for solving optimisation problems numerically that are still the basis for many of today's techniques. UK mathematics underpins computer simulations all over the world!

The speed and memory size of computers grew rapidly and it became much easier to collect data. But while data can now be gathered on a massive scale, it is much harder to work out what to do with it. Many of the fundamental ideas behind the mathematical treatment of data sets, statistics, were formulated in the 1920s at Rothamsted by Fisher. This tradition of excellence in statistics within the UK has continued during the new Elizabethan age, making it possible to analyse the effect of new drugs, or the meaning of the human genome, much more efficiently, and also to analyse models of systems with uncertainty (financial markets, spread of epidemics, life expectancy of smokers ….). Perhaps the most influential statistical contribution of the jubilee years has been Sir David Cox's 1972 paper[3] allowing mathematical models to be built on actuarial life tables, so permitting causal inferences based on sparse data. This work has been fundamental to countless medical and actuarial studies. In a related later development, the former Director General, Knowledge and Innovation, at BIS, Sir Adrian Smith, showed how useful information could be obtained from probabilistic models[4]. This technique, called Markov Chain Monte-Carlo inference (or MCMC for short), is now ubiquitous throughout the sciences.

. . . lone British mathematician solves ancient mystery . . .

The internet and world wide web brought computers into our daily lives, with new possibilities and problems. The method used to process secure financial transactions on-line is based on number theory, specifically the difficulty of finding the prime factors of large numbers. The RSA algorithm at the heart of this method was first developed by Clifford Cocks, a number theorist working at GCHQ. Unfortunately no one at GCHQ appreciated its potential (it was filed as 'secret') and the algorithm is now known by the initials of the US-Israeli team that patented the method in 1978!

Not all new mathematics is immediately applicable, and a fundamental development of the new Elizabethan age has been the renaissance of geometry. Geometry and physics have been intertwined through most of their history, but drifted apart in the 60 years leading up to 1980. However, starting from discussions between Sir Michael Atiyah and the American physicist Ed Witten, the picture has changed greatly over the last 35 years, and now the connecting road is a motorway. Atiyah is one of the six UK Fields medallists (the mathematical equivalent of the Nobel Prize) – only France and the US have more – and has been a central figure in world mathematics during the new Elizabethan age. The maths-physics motorway is not just one-way: in the striking example of mirror symmetry from string theory, Philip Candelas, now at Oxford, and his collaborators were able to use the amazing intuition of the physicists to predict the solution of a century-old problem in classical geometry ("counting the number of rational curves in the quintic").

Mathematical physics itself (quantum theories and relativity) has also changed dramatically. Stephen Hawking and Roger Penrose, both working in mathematics departments, described the mathematical structure of black holes, stars so massive that even light cannot escape their gravitational pull. Hawking went on to show that there is a sense in which black holes actually do emit radiation! The existence of the Higgs particle that may have been observed recently and which is responsible for mass in quantum theory was predicted by Peter Higgs at the University of Edinburgh, with others including Tom Kibble at Imperial College, using mathematical arguments.

. . . ways of analysing floating point arithmetic . . .

Sir Michael Atiyah ©Marc Atkins

With advances in both methods and computing power, the scope of what mathematicians can model has expanded. This has led to changes in the way that weather forecasting is reported (using ideas from chaos theory) and the increasing use of mathematics in modelling financial markets. The sophistication of computer models is such that a model of the human heart at Oxford can be used to make predictions about heart treatments without using a living subject. Often, in such applications to the life sciences, mathematicians now work in teams with other scientists as equal partners. Mathematical modelling is also used to inform policy decisions: strategies for the foot and mouth outbreak of 2001, the distribution of vaccines, and the safety of air flights through volcanic ash clouds in 2010, were all assessed using mathematics.

So what lessons can we learn from the success of UK mathematical science in the jubilee years? Here are some observations from the chalk-face.

- Structures must be flexible enough to allow many flowers to bloom: nobody can predict what the next breakthrough will be, far less from where it will appear.
- The time between formulation of a seminal mathematical idea and its application may be brief (as in Cox's 1972 work on regression analysis) or very long (as in Turing's 1936 discussion[5] of thinking machines, now at the heart of Artificial Intelligence). It is misguided to aim to reward only a fast pay-off. Worse, even with the best intentions this

. . . mathematical models to be built on actuarial life tables . . .

policy tends to lead to incremental research rather than real innovation, which is inherently unpredictable.

- The openness and non-hierarchical structure of British culture allows new ideas to gain a foothold, new talent to find a ready audience.
- Diversity (of scale of organisation, of mode of research – solo/team, interdisciplinary/narrow, applications-focused/blue skies) is key.

All the above features of UK mathematical science have been massively aided by the dual support system for funding research, allowing new ideas to start with small first steps, new talent to develop from a wide base (it is worth remarking that the Cambridge mathematician and Fields Medallist Sir Tim Gowers has never held a research council grant).

The key message from the last 60 years is that most progress has been through glorious surprises. No one except a few crazy science fiction writers could have predicted the way computers would come to pervade our lives, nor the way that new mathematics would be needed to facilitate this. Modern statistical methods allow information to be extracted from data in previously unimagined ways. The deep interconnections between different areas of mathematics, and between mathematics and the sciences, that have emerged are similarly mysterious and could not have been foreseen in 1952.This does not mean that all future developments are unpredictable – it is clear that the mathematisation of the biological sciences will continue apace and holds some exciting prospects, and understanding climate change provides a challenge – but it does make it likely that the next real innovations will, by definition, be surprises.

The UK has been at the forefront of change over the past 60 years, and we need to ensure it remains at the cutting edge of progress for the next 60 years. Not just for the intellectual excitement of discovery, but also for its societal impact. How will the next 60 years go? All we can say is: watch this space!

Acknowledgements: We are grateful to Penny Davies, Patrick Dorey, Jerome Gauntlett, Nick Higham, Oliver Jensen, Stephen Senn, Richard Thomas and Mike Titterington for helpful guidance, some of which we ignored due to lack of space.

Footnotes

1 Figures from Thomson Reuters at http://www.timeshighereducation.co.uk/story.asp?sectioncode=26&storycode=406463 Denmark were first, the USA third.

2 J. H. Wilkinson, *Rounding Errors in Algebraic Processes*. Englewood Cliffs, New Jersey: Prentice Hall, 1963.

3 D.R. Cox, Regression models and life tables, *J Royal Statistical Society B* 34 (1972), 187-220.

4 A.E. Gelfand and A.F.M. Smith, Sampling-based approaches to calculating marginal densities, *J. American Statistical Association* 85 (1990),398-409.

5 A. Turing, On computable numbers, with an application to the Entscheidungsproblem, *Proc. London Math. Soc.*

AN UNSCIENTIFIC CAMPAIGN

Bradley Keelor
Science and Innovation Team
British Embassy Washington

Science has not traditionally taken centre field in US political campaigns and it is unlikely that this campaign will be an exception. Issues around the economy, jobs, healthcare and taxation are likely to be the battle grounds of the next few weeks.

When science does enter the campaign, it will most likely be as a supporting player in the blue touch paper issues such as climate change, other environmental policy, or stem cells. For example, early in the campaign one of Governor Romney's most frequently broadcast advertisements highlighted his promise to restart construction on the Keystone XL Pipeline – the extension to the Keystone Pipeline which currently brings crude from the Athabascan fields in Alberta to Illinois. Keystone XL would add capacity and extend the pipeline to Texan Gulf Coast refineries. Whilst President Obama approved the Cushing, Oklahoma to the Gulf Coast portion of the Keystone XL, he has delayed, pending further environmental review, the section which would cross the Ogallala Aquifer in Nebraska, one of the largest reserves of fresh water in the world.

At writing, Governor Romney's team of advisors on science is structured in much the same way John McCain's was in 2008; that is, there is no central science advisor, but small teams focusing on issues such as space, energy, and health. These teams are often populated by names familiar from President Bush's Administration. Former NASA Administrator Mike Griffin advises on space; former Missouri Congressman Jim Talent serves on the energy team; and former Environmental Protection Agency Administrator and Health Human Services Secretary Mike Leavitt is advising

. . . no central science advisor . . .

Governor Romney on health issues. Mike Leavitt would also lead the Romney Presidency's transition team following the November election and has been mentioned as a possible White House Chief of Staff. In general, Governor Romney's team is more centralized than the President's. The President, of course, can draw upon the large number of presidentially appointed positions inside the Administration and the network that comes along with the Presidency.

Recently, both candidates answered 14 questions on various issues posted to sciencedebate.org. In these questions and in their other messaging, there are three particular science areas to watch for potential differences between the candidates. The first is space. Governor Romney's advisors favour a return to a manned space exploration strategy, whereas the Administration has shown a tendency to focus on robotic missions. With the termination of the Shuttle programme in 2010 and the cancellation of the Constellation programme – which was in effect a Shuttle replacement – the same year, NASA has moved almost exclusively to unmanned missions. If President Obama is re-elected, this will probably continue. Governor Romney may try to revive a launch programme, motivated in part at least by a desire to prevent the US from relying on Russian launch services. Whichever candidate is successful, they will have to develop a Space policy under tight fiscal constraints in 2013 and beyond. Uncertainty about the direction of the US Space programme will continue for some time.

The second area is energy policy. The popular phrase for both candidates this year is "all of the above" indicating support for all types of energy production. Both campaigns have used this term and both President Obama and Governor Romney support additional drilling for oil and natural gas and the increased use of nuclear power. However, as you dig into the detail areas of difference emerge. The Republican National Committee (RNC) worked hard over the summer to keep Solyndra, the bankrupt renewable energy company funded by the Administration's Department of Energy loan guarantee programme, in the news. And an RNC policy statement decries the Environmental Protection Agency regulations developed since 2009 as 'expansive regulations

. . . creating regulatory uncertainty . . .

that will impose tens of billions of dollars in new costs on American businesses and consumers. Many of these new rules are creating regulatory uncertainty, preventing new projects from going forward, discouraging new investment, and stifling job creation' concluding that 'the most powerful environmental policy is liberty.'

. . . key scientific posts remain fairly apolitical . . .

Thirdly there is life sciences. The major difference between the President and Governor Romney is in stem cell policy. Mitt Romney has consistently opposed embryonic stem cell research since before his tenure as Massachusetts governor. President Obama who famously said 'Medical miracles do not happen simply by accident' has been clear in his support for federal funding for embryonic stem cell research and this finally paid off in August this year when the US Circuit Court of Appeals upheld a lower court decision throwing out a lawsuit that challenged federal funding for the research. At present, it has not been raised so far in the 2012 campaign but both candidates will have their arguments ready to deploy.

As much a concern for the US science community as the outcome of the November elections is the possible time lag in nominating and confirming senior science officials in the Administration: a hiatus in leadership being seen as particularly unwelcome in times of budget uncertainly. In 2001, President George Bush waited eight months after his inauguration to appoint a Chief Science Advisor. In 2009, President Obama waited over four months to nominate a NASA Administrator. President Obama did name his science advisor and a NOAA Administrator before inauguration, viewed by many in the community as a step in the right direction. However, many key scientific posts remain fairly apolitical, even though they require Presidential nominations. Directors of the National Science Foundation, National Institutes of Health, and US Geological Survey are all appointed to six-year terms, and in most cases stay on even after a change in Administration.

NORTHERN LIGHTS

Hazel Gibson
UK Science and Innovation Network, Stockholm

The UK Science & Innovation Network has three officers based in Stockholm, Copenhagen and Helsinki. UK stakeholders often tell us that they imagine the Nordic region to be, "green", "organised", "quirky", or "family friendly". All these adjectives ring true but I would add one important one to this list: "innovative". Sweden, Denmark and Finland are three out of the four "innovation leader" countries in Europe according to the EU Innovation Scoreboard in 2012.

How is the Nordic region an innovation leader? What great science is going on? What can the UK policy makers learn and who should our scientists and innovators be seeking to collaborate with?

Sweden, Denmark and Finland have their own context, priorities, and particular brands of success when it comes to science and innovation although there is also a shared agenda especially on developing greener economies and growing more sustainable economies through R&D.

Science and innovation are well respected culturally in the Nordic region and education standards are high. One spectacle in particular epitomises the region's cultural elevation of science – the annual Nobel Science Prizes awards ceremony hosted by Sweden. A five hour live television marathon of the Nobel banquet holds the nation spellbound as Sweden's science community turns out on the TV to illustrate and explain the work they are doing in labs and incubators up and down the country. It is truly an inspiration for an up and coming generation of scientists. In Finland the Millennium Tech Prize is awarded bi-annually for innovations that improve quality of life or sustainable development.

. . . most networked nations in the world . . .

Governments and businesses in the Nordic region have long maintained strong investment in science and innovation and are broadly maintaining this despite the current economic climate. Research and innovation performance also remains high. Sweden has spent around 3 per cent of GDP on R&D for a number of years already including both the business and state shares. Only Israel, Finland and South Korea allocate a higher percentage of GDP to R&D. Finland has maintained exceptionally high R&D investment rates including the business share (3.73 per cent of GDP in 2011). Denmark also nudges above the 3% mark. The Swedish Government announced in early September a doubling of its public funding for research.

Sweden, Denmark and Finland are well networked countries, both in terms of links between business and academia exemplified by the high business investment in R&D scores above, but also in terms of the way that people circulate rather easily between these worlds, often double or triple hatting in a number of roles simultaneously. They are also some of the most networked nations in the world with high ICT access and proficiency amongst their citizens. It is also relatively easy to set up a company, or innovate a new piece of Intellectual Property. On the other hand companies report a lack of cash flow in the system including venture capital. It can also be difficult to attract top international talents to research institutions on the same scale as in the UK. Innovation systems are underpinned by open, excellent and attractive research systems with a strong supply of

. . . UK looks to the Nordics on innovation policy . . .

both excellent fundamental research and support structures for industrial R&D. Copenhagen University tops the THE rankings for research in the region with all three countries boasting a number of excellent research universities.

. . . the annual Nobel Science Prizes awards ceremony . . .

In policy terms the UK has looked for inspiration towards the North on issues such as the new Catapult Centres with similar long standing models in the region such as the Finnish VTT centres and SHOKs or the Swedish Vinnvaext centres. There is good collaboration between the innovation agencies in the UK and those in Sweden, Denmark and Finland on a number of issues such as service innovation or public sector innovation. In the last few years Finland and Denmark have both gone through major reforms in their university sectors. Sweden has recently introduced fees for foreign students and is now providing more concentrated research funding to key nationally strategic research groups.

. . . Microsoft setting up an App Campus . . .

The UK is also historically interested in many aspects of energy and environmental innovation policy as the Nordic countries have led the way in many areas such as Carbon Capture and Storage, combined heat and power systems, biomass, recycling, or green transport. In Physics there is expertise here in materials technology crucial to underpin new discoveries in all areas of science including the digital revolution. There is also excellent Organic and Atmospheric chemistry. In Life sciences there is considerable expertise on forestry and agriculture. In Medical sciences there are strengths in many areas including molecular biology or oncology. The Nordics are tackling a public health agenda similar to that in the UK including elderly healthcare, chronic diseases, allergies, and MRSA/infectious diseases.

There are many industrial strengths in the Nordic region giving the countries a powerful export offering, including domestic and multinational companies for example in forestry and mining, electronics and communications (Nokia, Ericsson), agriculture and food export as well as logistics interests (Maersk), retail (IKEA) and a strong biotech sector (NovoNordisk, AstraZeneca). All three countries are experiencing growth in the Cleantech sector. Sweden maintains car manufacturing interests (Volvo and SAAB) and Finland maintains good nuclear energy capabilities.

. . . exceptionally high R&D investment rates . . .

In Finland there is a new wave of ICT, digital and creative industries spurred on by the heyday of Nokia in the 2000s with Rovio, the producer of the mobile phone games application Angry Birds the latest to emerge. Nokia and Microsoft recently injected €18million to set up an "App Campus" dubbed as the world's largest mobile acceleration programme. The next generation of entrepreneurs is being provided by the "Aalto Venture Garage" set up by entrepreneurial students at Aalto University. These developments epitomise the Finnish emphasis on renewal within its innovation system, and also the constant emphasis on innovation from the perspective of the user.

. . . investing in infrastructure . . .

In Sweden there is currently a focus on ensuring the best research infrastructures are in place to underpin national capability in a number of areas. One example of this is the new national Science-for-Life laboratory, a step change in national infrastructure to support not just research but also innovation in the areas of translational medicine. The facility has attracted significant funding already from the Swedish state and business and will receive even more in the future. This development epitomises Sweden's ability to convince national players to work together and focus on making changes that will benefit all of them in some way.

. . . exciting new energy developments . . .

In Denmark the Government, research community and companies continue to pioneer exciting new energy developments that make the country something of an energy innovation lab for the rest of Europe, such as the EcoGrid EU project, voted one of the world's "100 powerful sustainable solutions" at RIO+20. The project will integrate renewable energy and transport solutions in a smart grid with 2000 households "live" on the system and show how demand can be met safely even with a high proportion of renewable energy. All in all, the Nordics are open for business and research collaboration with the UK. These countries have a great attitude when it comes to breaking boundaries. Just think of Tetrapak, the pacemaker or in a more modern context Spotify or Angry Birds. They are prepared to tackle issues in both practical and creative ways. To anyone who is interested in the region, I would say come and explore it.

INNOVATIVE TECHNOLOGY IN EDUCATION

Dr Ellie Dommett
Department of Life, Health and Chemical Sciences, The Open University

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Baroness Professor Greenfield
Co-Chair, APPG on Scientific Research in Learning and Education

The APPG on Scientific Research in Learning and Education explores issues at the interface between scientific research and education. They recently discussed the benefits and limitations of using innovative technology in education – at all levels ranging from primary to tertiary education. Professor Swithenby (Open University) focused on the use of technology in teaching science, although he argued that any discipline which relied on computer technology in professional practice, such as design or engineering, could benefit from the same approach. In practice science uses technology to collaborate and collect data. This means that anyone with access to a computer should be able to engage with scientific research. Moreover, he proposed that to teach science without these interactions with technology would be to teach out-dated skills. Prof Swithenby demonstrated a number of excellent, innovative teaching tools including a virtual laboratory rat, a digital microscope and a programme for mapping trees across the UK called Treezilla. Engagement with these technologies could offer an authentic experience of STEM disciplines, opening up access to more people and, in the long run, changing public attitude towards STEM subjects.

Professor Michael Hammond (University of Warwick) focused on the reasons for using technology, and whether these could be realistically met. There are three main reasons for engagement with innovative technology: social/vocational, to impact on learning outcomes and as a catalyst for curriculum reform. Each of these reasons has barriers to success, for example, with difficulty in actually measuring impact on learning and the use of technology getting in the way of pedagogy. He also recognised constraints such as access to appropriate facilities and adequate teacher training to support use of technology in the classroom. However, the picture is not all bleak. He provided examples of existing technologies that are effective and suggested where technology comes into its own to support learning: allowing pupils to be creative, visualisation of difficult concepts and as a means of garnering support and feedback. The latter can also be useful for teachers in developing their practice and sharing lesson ideas. He felt that the way to progress required activity at three levels. Teachers must be proactive and put pedagogy first. Secondly, school leaders must provide suitable support and finally, policy makers must offer consistent support for developing pedagogy.

The final speaker was Christina Astin, Headteacher of King's School, Canterbury, and co-founder of the Young Scientist Journal (YSJ). The YSJ is a publication led and written by students and for students between the ages of 12-20 years. It provides an opportunity for pupils of science all over the world to publish articles on scientific topics, including original research. She suggested that the use of online media for the journal had considerable benefits beyond the obvious global collaboration: use of multimedia, opportunity for voting polls and discussion forums. For those working on the journal as editors it develops skills in team-working, decision-making and time management, but also, and perhaps most critical in the current day and age, in digital literacy.

A recurring theme was the sense of ownership that developed with engagement available through such technology. All felt that by developing a sense of ownership more effective learning would occur and may even protect against being the passive receiver of information through screen technologies. A discussion followed, with questions arising as to whether all pupils should be given ipads as a priority and whether such technologies could replace teachers. Although a brief vote suggested that the jury was still out on whether provision of ipads was a priority, there was agreement that these technologies could not replace teachers. High levels of engagement could still be gained through 'old-fashioned' interaction, for example putting on a lab coat and attempting experiments in a laboratory. Despite this, there are still strong arguments for the use of technologies, for example, where access to 'real world' resources is limited. A final note of caution: in order to make the most of these technologies, they must be produced collaboratively and their development must not leave the teachers behind.

SCIENCE AND THE DEVOLVED BODIES

SETTING THE SCENE

Science and Technology have become steadily embedded in the life of the devolved bodies over the past decade, beginning in Scotland, followed by Wales and now with real progress in Northern Ireland. The influence of scientific societies has been crucial in encouraging this process and it has been this influence that effectively created some of its key components.

The first step was to hold major events highlighting science in each devolved body. This in turn greatly contributed to the pressure on devolved administrations to take science seriously. A Chief Scientific Adviser [CSA] was first appointed in Scotland and then a few years later in Wales and both played a significant role in drawing up a science strategy for the Scottish Government and the Welsh Assembly Government. The science community in Northern Ireland is now pressing for the appointment of a CSA for Northern Ireland.

Over the years Cross Party Groups on Science and Technology have been successfully established – thanks to the initiative of the science community – in the Scottish Parliament, the Welsh Assembly and the Northern Ireland Assembly. They all comprise Members of the devolved bodies (MSPs, AMs, and MLAs) from all the major political parties and include representatives from the leading scientific societies and tend to meet about three times a year.

Major events are now held with each devolved body on an annual basis. The inaugural Science and Stormont event is scheduled for 15 October, the next Science and the Parliament on 14 November, and the next Science and the (Welsh) Assembly on 21 May 2013.

SCOTLAND

The Cross Party Group on Science and Technology is chaired by Elaine Murray MSP, closely supported by the Royal Society of Edinburgh and the rest of the science community, and has for several years been holding regular meetings in the Scottish Parliament, most recently last month (in a joint meeting with the CPG on Colleges and Universities).

The Scottish Government announced in September its intention to bring forward a Referendum Bill. As the question of Scottish independence is now on the agenda of Scottish – and British – politics the science community is now starting to address these constitutional issues. What might the consequences of full independence be for science in Scotland? Would they be beneficial or damaging? What might 'Devo Max' mean for science? How might these potential options affect the future of science in Scotland? What effects would the possibility or fact of independence have elsewhere in the UK? These questions will be debated at this year's major science event *Science and the Parliament* being held on 14 November.

WALES

The Cross Party Group on Science and Technology is chaired by David Rees AM, closely supported by the Royal Society of Chemistry and the rest of the science community, and has for many years been holding meetings in the Welsh Assembly. The Welsh CSA, Professor John Harries, spoke recently about the *Science for Wales* strategy document published in March. He also presides over the Science Advisory Council for Wales.

SACW reports directly to Professor Harries, rather than to Ministers, and has no statutory or financial responsibilities. The appointments are unpaid and it has an independent co-chair, Professor Chris Pollock. A National Science Academy has also been established and it is currently engaged in a survey of all STEM activity in Wales. Looking ahead to next year the annual major event *Science and the Assembly* will be held in May which will include an exhibition in the Senedd.

NORTHERN IRELAND

Progress in the NI Assembly has been encouraging and the All Party Group on Science & Technology was formally established this year, chaired by Basil McCrea MLA. At its autumn meeting in September it discussed the issue of 'fracking'. An inaugural *Science and Stormont* event has been planned for 15 October in the Parliament Buildings at Stormont, co-sponsored by a wide range of scientific societies, on the theme of *Innovation: How Science and Engineering can drive economic growth in Northern Ireland* including speakers from Queen's University, Bombardier Aerospace, the Nanotechnology and Integrated Bioengineering Centre, the Engineering Research Institute, Ulster University and SiSaf Ltd. Included in the programme is a Panel discussion with MLAs and an exhibition in the Long Gallery.

SELECTED DEBATES

Listed opposite (grouped by subject area) is a selection of Debates on matters of scientific interest which took place in the House of Commons, the House of Lords or Westminster Hall between 1st July and 18th September.

Aviation
Aviation 4.7.12 HoC 249WH

Defence
Defence Equipment and Support 17.7.12 HoC 845

Education
Higher and Further Education 11.9.12 HoC 203

Energy
Energy Resources 18.9.12 HoC 262WH
Energy Supply 6.9.12 HoC 137WH
Nuclear Power 4.7.12 HoC 309WH

Environment
Oceans & Marine Ecosystems 11.7.12 HoC 98WH
Protecting the Antarctic 12.9.12 HoC 136WH

Food and Health
Cosmetic Surgery 5.7.12 HoC 327WH
AIDS, Tuberculosis and Malaria 4.7.12 HoL 745
High Energy Caffeine Drinks 11.7.12 HoC 417
NHS: Specialised Services 18.7.12 HoL 293
Rickets 4.9.12 HoC 59WH

Industry
Aerospace Industry 12.9.12 HoC 105WH
International Competitiveness 6.7.12 HoL 793

Science Policy
Behaviour Change 11.7.12 HoL GC561
British Council: Funding 19.7.12 HoL 452
Science and Public Service Broadcasting 4.9.12 HoC 51WH

Transport
High Speed 2 (Heathrow) 17.7.12 HoC 223WH
Horses: Transportation 6.7.12 HoL 843
Railways: High Speed 2 11.7.12 HoL 1209

HOUSE OF LORDS SCIENCE AND TECHNOLOGY SELECT COMMITTEE

The members of the Committee (appointed 16 May 2012) are Lord Broers, Lord Cunningham of Felling, Lord Dixon-Smith, Baroness Hilton of Eggardon, Lord O'Neill of Clackmannan, Lord Krebs (Chairman), Lord Patel, Baroness Perry of Southwark, Lord Rees of Ludlow, the Earl of Selborne, Baroness Sharp of Guildford, Lord Wade of Chorlton, Lord Willis of Knaresborough and Lord Winston. Lord Lucas of Crudwell and Dingwall and Baroness Neuberger were co-opted to Sub-Committee 1 for the purposes of the inquiry on higher education in STEM subjects.

Regenerative medicine

The Committee launched an inquiry into regenerative medicine before the summer recess. The deadline for submissions was 20 September 2012. It will cover current research in regenerative medicine and potential treatments which could be developed in the next 5-10 years, barriers to translation of this research to applications and commercial products, and to compare the UK's efforts with international examples. The Committee expects to report in 2013.

Higher Education in Science, Technology, Engineering and Maths (STEM) subjects

In September 2011, the Select Committee appointed a Sub-Committee, chaired by Lord Willis of Knaresborough, to conduct an inquiry into higher education in STEM subjects. The inquiry considered how the UK can ensure that the supply of graduates in STEM subjects meets current and future needs, looked at 16-18 maths provision, and undergraduate and postgraduate education. A call for evidence was released on 13th September 2011 with a deadline for submissions of 16th December. Oral evidence sessions began in December and finished in April 2012. The Committee published its report on 24 July 2012. The report will be debated in the House following receipt of the Government's response, due in early October.

Sports and exercise science and medicine

In May 2012, the Select Committee launched a short inquiry into sports and exercise science and medicine to consider how the legacy of London 2012 can be used to improve understanding of the benefits exercise can provide, and in treating chronic conditions. The Committee explored how robust this science is and how lessons learnt from the study of athletes can be applied to improve the health of the population generally. The Committee held a seminar on 29th May 2012, and took oral evidence during the month of June from sports and exercise scientists and clinicians, UK Sport, and officials and Ministers from the Department of Health and the Department for Culture, Media and Sport. The Committee published its report on 17 July 2012. The report will be debated in the House following receipt of the Government's response which is expected in October 2012.

Science and Heritage follow-up

In December 2011, the Select Committee launched a short follow-up inquiry to its report into science and heritage in session 2005-06. The Committee wrote to Government and contributors to the original inquiry seeking an update of developments since the publication of the original report in 2006 and the update of October 2007. The deadline for written submission was 31st January 2012. Oral evidence sessions were held from February until March 2012. The Committee published its report on 11th May. The Government response was published on 16 July. It is anticipated that the report will be debated in the House in the current session.

The role and function of departmental Chief Scientific Advisers (CSAs)

In July 2011, the Select Committee launched an inquiry into the role and function of departmental Chief Scientific Advisers. This looked at a number of aspects concerning the role of CSAs including: the ability of CSAs to provide independent advice to ministers and policy makers; the extent of their influence over research spend; and their role in providing independent challenge and ensuring that departmental policies are evidenced-based. A call for evidence was released on 20th July 2011 with a deadline for submissions of 16th September. The Committee took oral evidence from October to December and published its report on 29th February 2012. The Government published their response to the report on 11th May 2012. The report will be debated in Grand Committee on 17th October at 3.45pm.

FURTHER INFORMATION

The 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 Atkinson, Committee Clerk, atkinsoncl@parliament.uk or 020 7219 4963. The Committee Office email address is hlscience@parliament.uk.

HOUSE OF COMMONS SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY

The Science and Technology Committee is established under Standing Order No 152, and charged with the scrutiny of the expenditure, administration and policy of the Government Office for Science, a semi-autonomous organisation based within the Department for Business, Innovation and Skills.

The current members of the Science and Technology Committee are:

Caroline Dinenage (Conservative, Gosport), Jim Dowd (Labour, Lewisham West and Penge), Gareth Johnson (Conservative, Dartford), 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), Hywel Williams (Plaid Cymru, Arfon) and Roger Williams (Liberal Democrat, Brecon and Radnorshire).

Andrew Miller was elected by the House of Commons to be the Chair of the Committee on 9th June 2010. The remaining Members were appointed to the Committee on 12th July 2010. Caroline Dinenage, Gareth Johnson, Sarah Newton and Hywel Williams were appointed to the Committee on 27th February 2012 in the place of Gavin Barwell, Gregg McClymont, Stephen McPartland and David Morris. Jim Dowd was appointed to the Committee on 11th June 2012 in place of Jonathan Reynolds.

CURRENT INQUIRIES

Engineering in Government: follow-up

On 14 September 2011 the Committee announced an inquiry following up its predecessor's inquiry into Engineering in Government. The Committee invited written submissions by 1st November 2011.

On 7 December 2011 the Committee took evidence from: Chris Aylett, Chief Executive, Motorsport Industry Association, and Philip Greenish, Chief Executive, Royal Academy of Engineering.

On 14 December 2011 the Committee took evidence from: Sir John Beddington, Government Chief Scientific Adviser.

The written evidence received is on the Committee's website. A Report was published on 30 April 2012. The Government response to this report was published on 17 July 2012.

The Census and social science

On 9 November 2011 the Committee announced an inquiry into The Census and social science. The Committee invited written submissions by 30th November 2011.

On 7 December 2011 the Committee took evidence from: Professor David Blane, Deputy Director, ESRC International Centre for Life Course Studies, Professor Heather Joshi, President, Society for Lifecourse and Longitudinal Studies, and Professor Les Mayhew, City University.

On 14 December 2011 the Committee took evidence from: Professor Tim Allen, Local Government Association, Aleks Collingwood, Joseph Rowntree Foundation, Professor David Martin, Royal Statistical Society, and Professor Phil Rees, Royal Geographical Society; Adrian Alsop, Director of Research and International Strategy, and Jeremy Neathey, Deputy Director of Policy, Economic and Social Research Council, Glen Watson, Census Director, and Peter Benton, Deputy Director, Office for National Statistics.

On 18 January 2012 the Committee took evidence from: Richard Bartholomew, and Jenny Dibden, Joint Heads of the Government Social Research Service.

The written evidence received is on the Committee's website. A Report was published on 21 September 2012.

Risk perception and energy infrastructure

On 9 November 2011 the Committee announced an inquiry into Risk perception and energy infrastructure. The Committee invited written submissions by 14 December 2011.

On 18 January 2012 the Committee took evidence from: Andrew Bloodworth, Head of Science – Minerals and Waste, British Geological Survey, Professor Nick Pidgeon, Director of Understanding Risk Programme, Cardiff University, and Professor David Spiegelhalter, Royal Statistical Society.

On 25 January 2012 the Committee took evidence from: Tracey Brown, Managing Director, Sense about Science, Fiona Fox, Director, Science Media Centre, and Mark Henderson, former Science Editor, The Times; Bob Brown, Corporate Director, Sedgemoor District Council, Richard Mayson, Director of Planning and External Affairs for Nuclear New Build, EDF Energy, and Dr Rick Wylie, Executive Director, Applied Policy Sciences Unit, University of Central Lancashire.

On 1 February 2012 the Committee took evidence from: Dr Paul Leinster, Chief Executive, Environment Agency, Dr Jill Meara, Deputy Director of the Centre for Radiation, Chemical and Environmental Hazards, Health Protection Agency, Geoffrey Podger, Chief Executive, Health and Safety Executive, and Dr Mike Weightman, HM Chief Inspector of Nuclear Installations and Executive Head of the Office for Nuclear Regulation.

On 19 March 2012 the Committee took evidence from: Charles Hendry MP, Minister of State for Energy, and Professor David Mackay, Chief Scientific Advisor, Department of Energy and Climate Change.

The written evidence received is on the Committee's website. The Report was published on 9 July 2012. The Government's response is awaited.

Science and international development

On 11 November 2011 the Committee announced an inquiry into Science and international development. The Committee invited written submissions by 16th December 2011.

On 1 February 2012 the Committee took evidence from: Professor Graham Furniss, Chair of the Africa Panel, British Academy, Professor Peter Guthrie OBE, Fellow, Royal Academy of Engineering, Professor Robert Souhami CBE, Foreign Secretary, Academy of Medical Sciences, and Dr Beth Taylor, Director of Communications and External Relations, Institute of Physics.

On 8 February 2012 the Committee took evidence from: Professor Anthony Costello, Professor of International Child Health and Director, UCL Institute for Global Health, Dr John Kirkland, Deputy Secretary General, Association of Commonwealth Universities, Professor Melissa Leach, Director, STEPS Centre, and Professor Andrew Westby, Director, Natural Resources Institute, University of Greenwich.

On 22 February 2012 the Committee took evidence from: Dr Jo Beall, Director Education and Society, British Council, Kate O'Shea, Deputy Director, UK Collaborative on Development Sciences, Sir Mark Walport, Director, Wellcome Trust, and John Young, Director of Impact Assessment, Partnerships and Head of the RAPID Programme, Overseas Development Institute.

On 25 June 2012 the Committee took evidence from: Professor Christopher Whitty, Chief Scientific Adviser, Department for International Development; Professor Tim Wheeler, Deputy Chief Scientific Adviser, Department for International Development and Stephen O'Brien MP, Parliamentary Under-Secretary of State for International Development

The written evidence received is on the Committee's website. A report is being prepared.

Bridging the "valley of death": improving the commercialisation of research

On 16 December 2011 the Committee announced an inquiry: Bridging the "valley of death": improving the commercialisation of research. The Committee invited written submissions by 8 February 2012.

On 18 April 2012 the Committee took evidence from: Professor Luke Georghiou, Vice-President (Research and Innovation), University of Manchester, Dr Paul Nightingale, Science and Technology Policy Research, University of Sussex, David Connell, Senior Research Fellow, Centre for Business Research/ UK Innovation Research Centre, Judge Business School, University of Cambridge, and Dr Douglas Robertson, Chair, Praxis-Unico. The Committee also heard from: Dr Ted Bianco, Director of Technology Transfer, Wellcome Trust, Dr Ian Tomlinson, Senior Vice President, Head of Worldwide Business Development and Biopharmaceuticals R&D, GlaxoSmithKline, Dr David Tapolczay, Chief Executive Officer, Medical Research Council Technology, Dr Gareth Goodier, Chair, Shelford Group (Chief Executives of ten leading Academic Medical Centres and large teaching hospitals); Chief Executive, Cambridge University Hospitals NHS Foundation Trust, and Dr Andy Richards, Biotechnology entrepreneur and business angel.

On 25 April 2012 the Committee took evidence from: Katie Potts, Herald Investment Management, Anne Glover, Amadeus Capital Partners Ltd, Matthew Bullock, and Stephen Welton, Business Growth Fund. The Committee also heard from: Dr Richard Worswick, Cobalt Light Systems, Dr Peter Dean, Cambio, Dr Trevor Francis, Technical Director, Byotrol Technology Ltd.

On 20 June 2012 the Committee took evidence from Sir David Cooksey and Sir Peter Williams; David Sweeney, Director (Research, Innovation and Skills), Higher Education Funding Council for England (HEFCE), Professor Ian Haines UK Deans of Science and Professor Nick Wright, Russell Group.

On 2 July 2012 the Committee took evidence from Rees Ward CB, Chief Executive Officer of ADS; Professor Keith Hayward, Head of Research, Royal Aeronautical Society; Henner Wapenhans, Head of Technology Strategy, Rolls Royce; Dr Ruth Mallors, Aerospace, Aviation and Defence KTN and Sir John Chisholm, Engineering the Future.

On 5 September 2012 the Committee took evidence from Tim Bradshaw, Head of Enterprise and Innovation, CBI and Tim Crocker, SME Innovation Alliance; Fergus Harradence, Deputy Director Innovation Policy, Department for Business, Innovation and Skills, Iain Gray, Chief Executive, Technology Strategy Board and Research Councils UK

On 12 September 2012 the Committee took evidence from Rt Hon David Willetts MP, Minister of State for Universities and Science.

The written evidence received is on the Committee's website. A report is being prepared.

Medical implants

On 26 March 2012 the Committee announced an inquiry: 'Regulation of medical implants'. The Committee invited written submissions by 26 April 2012.

On 23 May 2012 the Committee took evidence from: Dr Carl Heneghan (GP), Reader in Evidence-Based Medicine, Director of the Centre of Evidence-Based Medicine, Dr Thomas Joyce, Reader in Biotribology, University of Newcastle, Professor Stephen Westaby, Cardiac Surgeon, John Radcliffe Hospital and Dr Suzette Woodward, Director of Patient Safety, National Patient Safety Agency (NPSA).

On 13 June the Committee took evidence from: John Howlett, British Standards Institute (BSi) and Peter Ellingworth, Association of British Healthcare Industries (ABHI). The Committee also heard from: Jacqueline Minor, Director of Consumer Affairs, European Commission. The Committee then heard from: Sir Kent Woods, Chief Executive of Medicines and Healthcare products Regulatory

Agency (MHRA) and Lord Howe, Parliamentary Under-Secretary of State for Quality, Department of Health (DH).

The written evidence received will be available on the Committee's website in due course. A report is in preparation.

Pre-appointment hearing

The Committee held a pre-appointment hearing with the Government's preferred candidate for Chair of the Medical Research Council. The Committee's report was published on 11 July 2012.

Engineering skills

The Committee announced an inquiry into engineering skills on 30 April 2012.Terms of reference are available on the Committee's website. The Committee will start hearing oral evidence for this inquiry in October and November 2012.

Marine Science

On 4 July 2012 the Committee announced an inquiry into marine science. Terms of reference for the inquiry are available on the Committee's website. The Committee is currently accepting written evidence for the inquiry. It will start hearing oral evidence later in the year.

REPORTS

Devil's bargain? Energy risks and the public

On 9 2012 July the Committee published its First Report of Session 2012-13, *Devil's bargain? Energy risks and the public,* HC 428

Pre-appointment hearing with the Government's preferred candidate for the Chair of the Medical Research Council

On 11 July 2012 the Committee published its Second Report of Session 2012-13, *Pre-appointment hearing with the Government's preferred candidate for the Chair of the Medical Research Council,* HC 510-I.

GOVERNMENT RESPONSES

Government Response to the Science and Technology Committee report 'Engineering in government: follow-up to the 2009 report on Engineering: turning ideas into reality'

On 17 July 2012 the Committee published the Government's Response to the Committee's follow-up report on Engineering in government, HC 511.

FURTHER INFORMATION

Further information about the work of the Science and Technology Committee 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, 7 Millbank, London SW1P 3JA. Enquiries can also be e-mailed to 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 strongly recommended to obtain a copy of the guidance note first. Guidance on the submission of evidence can be found at www.parliament.uk/commons/selcom/witguide.htm. The Committee has a website, www.parliament.uk/science, where all recent publications, terms of reference for all inquiries and press notices are available.

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (POST)

RECENT POST PUBLICATIONS

Preventing Diabetes

July 2012 *POSTnote 415*

The number of people in the UK with diabetes is projected to rise from 3.1 million to 3.8 million by 2020. Managing the condition and treating its complications costs the NHS £3.9 billion a year. This POSTnote describes the causes of diabetes and the known risk factors, and examines policy options for diabetes prevention.

Drug Resistant Tuberculosis

July 2012 *POSTnote 416*

Tuberculosis (TB) is a leading cause of death globally. Progress in the control of TB is threatened by drug-resistant TB strains. This note examines the extent of, and risks posed by, drug-resistant TB. It gives an overview of national and international TB surveillance, research into treatments, and policy options to limit infections.

Energy Use Behaviour

August 2012 *POSTnote 417*

Behaviour change concerning energy use is an emerging area of research which has important implications for policy. This note

introduces the factors and interventions that can influence behaviour. It also discusses the behavioural aspects of the Green Deal and the smart meters programme.

Balancing Nature and Agriculture

September 2012 *POSTnote 418*

This POSTnote explores two approaches to managing land for balancing nature conservation with sustainable food production. *Land sharing* integrates the objectives of agriculture and benefits to wildlife on the same land. *Land sparing* on the other hand separates intensive farming areas from protected natural habitats at larger scales.

Water Resource Resilience

September 2012 *POSTnote 419*

The availability of water is fundamental for society and economic activities. This POSTnote describes the reasons for uncertainties in water availability in the medium term, and possible responses to this in the management of future supply and demand.

Advanced Manufacturing

September 2012 *POSTnote 420*

Advanced manufacturing is a key part of the Government's 'Plan for Growth'. This POSTnote looks at the opportunities for growth through advanced manufacturing and related new business models. Policy initiatives to encourage advanced manufacturing, barriers to its adoption and the skills required for the advanced manufacturing workforce are also considered.

Measuring National Wellbeing

September 2012 *POSTnote 421*

Governments and other institutions worldwide are increasingly interested in measuring and monitoring wellbeing at the individual, social group and national levels. This briefing summarises the latest research on measuring national wellbeing, its components and causes, and examines some policy implications.

CURRENT WORK

Biological Sciences – HIV, developments in prevention and treatment, Review of Stem Cell Research, Setting Limits for Drug Driving, Preventing Mitochondrial Disease.

Environment and Energy – Heat Pumps, Biodiversity in UK Overseas Territories, Environmental Planning for Nature, Biopharming.

Physical sciences and IT – Open Public Sector Data, Reporting Greenhouse Gas Emissions, Infrastructure for Machine-to-Machine Communication, Maximising Value of Recycled Materials.

Science Policy – Science, Technology, Engineering, and Mathematics (STEM) Education for 14-19 years old.

Science, Technology and the Developing World – Uncertainty in Population Projections.

CONFERENCES AND SEMINARS

Bioenergy

On 10th July, POST and NERC organised a parliamentary seminar to discuss bioenergy, the use of renewable natural material for electricity, heat and liquid fuels. Currently, the UK sources approximately 3% of its primary energy from bioenergy feedstocks. Its cost-effectiveness compared with other renewable technologies makes it an attractive option for contributing towards the delivery of energy targets, such as those set by the EU Renewable Energy Directive. However, growth of bioenergy both in the UK and abroad is reliant on the availability of affordable, sustainably-sourced biomass, as well as the development and uptake of second generation technologies. Sustainable approaches to producing bioenergy on existing cropland include using waste, by-products and dedicated energy crops. Intensification of agriculture and changes to forestry practice can also yield the necessary biomass. However this may have negative impacts if not appropriately regulated to ensure sustainability, such as a net gain in greenhouse gas emissions from land use change. The event was chaired by Lord Oxburgh. Presentations were made by: Jo Howes, Strategy and Emerging Issues Adviser, BP Biofuels; Caroline Season, Senior Policy Adviser, Bioenergy, Department of Energy & Climate Change (DECC); Hugh Whitall, Director of Nuffield Council on Bioethics; and Ian Tubby, Principal Adviser, Business & Markets, Forest Services, Forestry Commission, England.

ICT for Disabled People

On 5th July, POST and the All-Party Parliamentary Group on Disability held a seminar with leading experts about the potential for ICT to improve the quality of life of users with disabilities, how the accessibility of ICT can be improved and what is currently standing in the way of progress. As Information and Communication Technologies (ICT) underpin so many aspects of modern life, it is vital that the 10 million disabled people in the UK have access to them. However, there are barriers which can make the use of ICT challenging – for example, almost half of all disabled people do not access the internet regularly. Attendees also had the chance to view exhibits and network with representatives from charities, academia, government and business. The event was chaired by Anne McGuire MP, Chair of the All-Party Parliamentary Group on Disability. Presentations were made by: Léonie Watson, Director of Accessibility, Nomensa; Graeme Whippy, Senior Manager of Disability Program, Lloyds Banking Group; and Robin Christopherson, Head of Digital Inclusion, AbilityNet.

Science for MPs' Researchers

On 5th July, POST and the House of Commons Library Science and Environment Section (SES) held an event for MPs Researchers to:

- advise them of the range of science advice and resources available in Parliament for Members and their staff;

- meet staff from POST and SES and tell them about the science and technology issues that matter to their MP and constituency; and,
- have the opportunity to suggest areas of research and future POSTnote topics based on the concerns of their MP and constituency.

The event was chaired by the POST chairman, Adam Afriyie, MP for Windsor. Presentations were made by Dr Chris Tyler, Director of POST; Dr Patsy Richards, Head of SES and MPs' Researchers.

STAFF, FELLOWS AND INTERNS AT POST

Fellows

Ian Passmore, Cambridge University, Biotechnology and Biological Sciences Research Council

Laura Harrison, Leeds University, Natural Environment Research Council

Lisette Sibbons, University of Hertfordshire, Science and Technology Facilities Council

Kathryn Wills, University of Bath, Engineering and Physical Sciences Research Council

James Lawrence, University College London, Institution of Chemical Engineers/Ashok Kumar Fellowship

Victoria Charlton, Imperial College MSc Course on Science Communication.

Staff

Dr Stephen Allen, the POST Energy Adviser, left POST to join an energy consultancy in Bristol (www.sustain.co.uk) on 5th September. A replacement is being recruited.

INTERNATIONAL ACTIVITIES

POST African Parliaments Programme

POST's programme of capacity building work in the Parliament of Uganda comes to a close at the end of September. A three month evaluation will start in October and the results will be presented at a parliamentary seminar in early 2013. POST has obtained a Commonwealth Professional Fellowship for Ms Charity Alesi, a researcher at the Parliament of Uganda, for 3 months from January 2013.

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

Opposite are summaries of some recently updated published briefings.

For further information contact Dr Patsy Richards Head of Section Tel: 020 7219 1665 email: richardspa@parliament.uk

Higgs Boson SN/SC/6375

Scientists at CERN have announced the discovery of a new subatomic particle, thought to be the Higgs Boson. Postulated in the 1960s, the Higgs Boson would explain why some particles have substance and thus fill a gap in the standard model of particle physics. The latter describes the behaviour of matter and energy since the Universe was about a hundredth of a billionth of a second old.

Scrap Metal Dealers Bill Research Paper 12/39

Incidences of metal theft are thought to have grown in recent years with rising global metal prices. Metal theft is estimated to cost the UK economy some £220-260 million per year – although the total costs could be up to £800 million.

The Government has introduced a range of measures to tackle the problem. However, it believes that additional regulatory controls on scrap metal dealers are required to reduce the opportunities for metal thieves to sell stolen material.

These controls will be taken forward by the Scrap Metal Dealers Bill 2012, Richard Ottaway's Private Member's Bill. The Bill extends to England and Wales. The Bill passed its Second Reading on 13 July 2012.

Richard Ottaway said that the Bill will "empower local authorities with a more robust and enforceable licence regime for all those who deal and collect scrap metal".

The Green Deal SN/SC/5763

The Green Deal is the Government's "flagship

piece of legislation, which will deliver energy efficiency to homes and buildings across the land". It will start to come into effect from October 2012, although the full package including financing will not be available until January 2013.

Through the Green Deal, energy customers in England, Wales and Scotland will receive loans to make energy efficiency improvements. The repayments will attach to the energy bill at a property, rather than to an individual, passing to any new occupier or bill payer.

The "golden rule" is that the instalment payments should not exceed the savings on an average bill, but because this is on an average bill, there is the chance that in some cases, a household's energy bill savings may not cover the cost of the Green Deal package. This, together with concerns about the interest rate to be charged on Green Deal loans, has led to concern about Green Deal take up.

A new energy company obligation (ECO) will underpin the Green Deal for 'those most in need' and for measures that do not fit the golden rule. This will take over from current energy supplier obligations due to end in 2012. It will have three elements, "Affordable Warmth", the "Carbon Saving Obligation" and the "Carbon Saving Communities Obligation".

The Green Deal was provided for by the Energy Act 2011, and following a consultation, the Government published its final proposals and impact assessment on 11 June 2012. During July 2012 the implementing statutory instruments were approved by both Houses.

Deepwater and Arctic oil drilling SN/SC/5981

This note outlines examples of how previously inaccessible sources of hydrocarbons are starting to be exploited. It covers deepwater drilling, drilling in the Arctic Circle, and potential future exploitation of methane hydrates.

The UK regulatory regime is probably second only to the Norwegian system in terms of stringency. However, as exploration moves to increasingly fragile ecosystems and difficult environments, the European Commission is seeking a role in regulating offshore activity in the North Sea. The Environmental Audit Select Committee has just called for a moratorium on Arctic drilling until regulatory regimes are improved. Lloyd's/Chatham House have highlighted the potential for increased exploration in the Arctic as sea ice retreats and oil prices rise.

The Antarctic Bill SN/SC/6388

The original proposal for an Antarctic Bill was put forward by the previous Government who published a consultation and Draft Bill in December 2009. This Bill would implement a new annex to the Antarctic Treaty that was agreed in 2005. The Annex, on Liability Arising from Environmental Emergencies, requires anyone undertaking activities in Antarctica to ensure measures are in place to prevent any environmental damage, together with contingency plans to deal with any damage that might occur.

The current Antarctic Bill is a hand-out Bill which has been taken up by Neil Carmichael MP, who will take it through the House of Commons as a Private Member's Bill. The Bill has Government support and is due to have its Second Reading on 2 November 2012. It will be based on the Bill consulted on by the previous Government, although it will not contain what was Part 2 of the original Bill covering the requirement for contingency and safety planning for all British operators.

4G Spectrum SN/SC/6383

Like 2G and 3G networks used by mobile phones and other devices, 4G (fourth generation) networks rely on the transmission of radio waves. Different services operate at different frequencies to avoid interference. Ofcom is responsible for allocating the frequencies from what is referred to as the radio spectrum to different mobile network operators. There are currently four UK mobile network operators: Vodafone, Telefonica O2 (known as O2), Hutchison 3G (known as Three) and Everything Everywhere (which resulted from the merger of Orange and T-Mobile).

The allocation of spectrum is managed by means of licences – effectively licences to transmit radio waves over defined frequency ranges. Ofcom intends to auction radio spectrum in the 800 MHz (megahertz) and 2.6 GHz (gigahertz) frequency bands to provide spectrum for new mobile services in the UK. Some estimates are that the auction could raise between £2bn and £3bn for the Government. As Ofcom notes, this spectrum is essential to meet the UK's rapid increase in mobile traffic, fuelled by the growth of smartphones and mobile broadband data services such as video streaming, email, messenger services, mapping services and social networking sites. All of these services depend on spectrum.

The new spectrum will provide much needed capacity for the fourth generation (4G) of mobile technology, set to deliver faster mobile broadband services such as internet access – at speeds approaching those available today down copper telephone lines.

The spectrum in the 800 MHz band is becoming available as a consequence of digital television switchover. Digital television broadcasts are more efficient than the traditional analogue ones they supersede so less radio spectrum is required to carry these services. One current issue, which Ofcom is investigating, is the potential for 4G services interfering with digital television reception.

0845 numbers SN/SC/6235

The use of non-geographic telephone numbers, such as those beginning 0845, has been controversial – particularly in the context of the delivery of public services by bodies such as HM Revenue and Customs.

Ofcom is consulting on detailed proposals for new tariff principles which are expected to be fully implemented by 2014.

SCIENCE DIRECTORY

DIRECTORY INDEX

Mathematical Sciences
Council for the Mathematical Sciences:
- Institute of Mathematics and its Applications
- London Mathematical Society
- Royal Statistical Society
- Operational Research Society
- Edinburgh Mathematical Society

Medical and Biomedical Research
ABPI
Academy of Medical Sciences
Biochemical Society
British Pharmacological Society
British Society for Antimicrobial Chemotherapy
CABI
Eli Lilly and Company Ltd
LGC
Medical Research Council
MSD
The Physiological Society
The Royal Institution
Society for Applied Microbiology
Society of Biology
UFAW
The Welding Institute

Motor Vehicles
Institution of Engineering Designers
The Welding Institute

Oceanography
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Institute of Marine Engineering, Science & Technology
Met Office
National Physical Laboratory
Natural Environment Research Council
Royal Society of Chemistry
Society of Biology
Society of Maritime Industries

Oil
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Institution of Chemical Engineers
LGC
The Welding Institute

Particle Physics
Institute of Physics
STFC

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The Chartered Institute of Patent Attorneys
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Society of Biology
Royal Society of Chemistry

Pharmaceuticals
ABPI
AMPS
British Pharmacological Society
British Society for Antimicrobial Chemotherapy
Eli Lilly and Company Ltd
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LGC
MSD
PHARMAQ Ltd
Royal Botanic Gardens, Kew
Royal Society of Chemistry
Society of Biology

Physical Sciences
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EPSRC
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Marine Biological Association
National Physical Laboratory
Royal Society of Chemistry

Physics
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Institute of Physics
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National Physical Laboratory
STFC

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Natural Environment Research Council
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Society for Applied Microbiology
Society of Biology
Society of Maritime Industries
The Welding Institute

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The British Ecological Society
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British Society for Antimicrobial Chemotherapy
Economic and Social Research Council
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The Physiological Society
Prospect
Royal Society of Chemistry
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LGC
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The Welding Institute

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Institution of Engineering and Technology
LGC
Society of Biology

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Biochemical Society
The British Ecological Society
British Nutrition Foundation
British Pharmacological Society
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CABI
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Marine Biological Association
Medical Research Council
NESTA
National Physical Laboratory
The Physiological Society
Prospect
Research Councils UK
The Royal Academy of Engineering
Royal Botanic Gardens, Kew
The Royal Institution
The Royal Society
Royal Society of Chemistry
STFC
Society for Applied Microbiology
Society of Biology
UFAW

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Institution of Engineering and Technology
STFC
Society of Maritime Industries
The Welding Institute

SSSIs
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The Linnean Society of London
Royal Botanic Gardens, Kew
Society of Biology

Statistics
Economic and Social Research Council
EPSRC
EngineeringUK

Surface Science
STFC

Sustainability
The British Ecological Society
CABI
EPSRC
The Food and Environment Research Agency
The Geological Society
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Institution of Chemical Engineers
Institution of Civil Engineers
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Royal Botanic Gardens, Kew
Royal Society of Chemistry
Society of Biology
The Welding Institute

Technology Transfer
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CABI
The Food and Environment Research Agency
Institute of Measurement and Control
Institution of Engineering and Technology
LGC
NESTA
National Physical Laboratory
Research Councils UK
Royal Society of Chemistry
STFC
Society of Biology
The Welding Institute

Tropical Medicine
The Linnean Society of London
Natural History Museum
Royal Botanic Gardens, Kew
Society for Applied Microbiology
Society for General Microbiology
Society of Biology

Viruses, Fungi and Bacteria
ABPI
The Linnean Society of London
Society for Applied Microbiology
Society for General Microbiology
Society of Biology

Water
The Geological Society
Institute of Measurement and Control
Institution of Chemical Engineers
Institution of Civil Engineers
LGC
Marine Biological Association
Royal Society of Chemistry
Society for Applied Microbiology
Society for General Microbiology
Society of Biology
Society of Maritime Industries

Wildlife
The British Ecological Society
The Food and Environment Research Agency
The Linnean Society of London
Marine Biological Association
Natural History Museum
Royal Botanic Gardens, Kew
Society of Biology
UFAW

The Academy of Medical Sciences

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The Academy of Medical Sciences promotes advances in medical science and campaigns to ensure these are converted into healthcare benefits for society. The Academy's Fellows are the United Kingdom's leading medical scientists and scholars from hospitals, academia, industry and the public service. The Academy provides independent, authoritative advice on public policy issues in medical science and healthcare.

Association of the British Pharmaceutical Industry

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The ABPI is the voice of the innovative pharmaceutical industry, working with Government, regulators and other stakeholders to promote a receptive environment for a strong and progressive industry in the UK, one capable of providing the best medicines to patients.

The ABPI's mission is to represent the pharmaceutical industry operating in the UK in a way that:
- assures patient access to the best available medicine;
- creates a favourable political and economic environment;
- encourages innovative research and development;
- affords fair commercial returns

AIRTO

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AIRTO – The Association for Independent Research and Technology Organisations – is the foremost membership body for organisations operating in the UK's intermediate research and technology 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 £2Bn from clients both at home and outside the UK, and employ over 20,000 scientists, technologists and engineers.

AMPS

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Website: 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 to promote and support the Molecular and Cellular Biosciences. We have over 6000 members in the UK and abroad, mostly research bioscientists in universities or in industry. The Society is also a major scientific publisher. In addition, we promote science policy debate and provide resources, for teachers and pupils, to support the bioscience curriculum in schools. Our membership supports our mission by organizing scientific meetings, sustaining our publications through authorship and peer review and by supporting our educational and policy initiatives.

The British Ecological Society

The British Ecological Society
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Tel: 020 7685 2500 Fax : 020 7685 2501
Website: www.BritishEcologicalSociety.org
Ecology into Policy Blog
http://britishecologicalsociety.org/blog/

The British Ecological Society's mission is to advance ecology and make it count. The Society has 4,000 members worldwide. The BES publishes five internationally renowned scientific journals and organises the largest scientific meeting for ecologists in Europe. Through its grants, the BES also supports ecologists in developing countries and the provision of fieldwork in schools. The BES informs and advises Parliament and Government on ecological issues and welcomes requests for assistance from parliamentarians.

British In Vitro Diagnostics Association (BIVDA)

Contact: Doris-Ann Williams MBE
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Website: www.bivda.co.uk

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

British Nutrition Foundation

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Websites: www.nutrition.org.uk
www.foodafactoflife.org.uk

The British Nutrition Foundation (BNF) was established over 40 years ago and exists to deliver authoritative, evidence-based information on food and nutrition in the context of health and lifestyle. The Foundation's work is conducted and communicated through a unique blend of nutrition science, education and media activities.

BRITISH PHARMACOLOGICAL SOCIETY

Today's science, tomorrow's medicines

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The British Pharmacological Society has been supporting pharmacology and pharmacologists for over 80 years. Our 3,000+ members, from academia, industry and clinical practice, are trained to study drug action from the laboratory bench to the patient's bedside. Our aim is to improve quality of life by developing new medicines to treat and prevent the diseases and conditions that affect millions of people and animals. Inquiries about drugs and how they work are welcome.

The British Psychological Society

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The British Psychological Society is an organisation of over 48,000 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 welcome.

British Science Association

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Our vision is a society in which people are able to access science, engage with it and feel a sense of ownership about its direction. In such a society science advances with, and because of, the involvement and active support of the public.

Established in 1831, the British Science Association is a registered charity which organises major initiatives across the UK, including National Science and Engineering Week, the British Science Festival, programmes of regional and local events and the CREST programme for young people in schools and colleges. We provide opportunities for all ages to discuss, investigate, explore and challenge science.

British Society for Antimicrobial Chemotherapy

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Founded in 1971, and with 800 members worldwide, the Society exists to facilitate the acquisition and dissemination of knowledge in the field of antimicrobial chemotherapy. The BSAC publishes the *Journal of Antimicrobial Chemotherapy* (JAC), internationally renowned for its scientific excellence, undertakes a range of educational activities, awards grants for research and has active relationships with its peer groups and government.

CABI

Science and development organization

www.cabi.org

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Website: www.cabi.org

CABI is an international not-for-profit development organization, specializing in scientific publishing, research and communication. We create, communicate, and apply knowledge in order to improve people's lives by finding sustainable solutions to agricultural and environmental issues.

We work for and with universities, national research and extension institutions, development agencies, the private sector, governments, charities and foundations, farmers, and non-governmental organizations. We also manage one of the world's largest genetic resource collections: the UK's National Collection of Fungus Cultures.

Cavendish Laboratory

UNIVERSITY OF CAMBRIDGE

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

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

The research programme covers the breadth of contemporary physics

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

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

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

Chartered Institute of Patent Attorneys

Founded 1882 Royal Charter 1891

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Fax: 020 7430 0471
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Clifton Scientific Trust

CLIFTON SCIENTIFIC Trust

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Clifton Scientific Trust
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E-mail: eric.albone@clifton-scientific.org
Website: www.clifton-scientific.org

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

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- bringing school science added meaning and notivation, from primary to post-16
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The Council for the Mathematical Sciences

The Council for the Mathematical Sciences

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CMS Secretariat
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57-58 Russell Square, London WC1B 4HS
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Fax: 020 7323 3655
Email: cms@lms.ac.uk
Website: www.cms.ac.uk

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:

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- engaging with government, funding agencies and other decision makers;
- raising public awareness; and
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Lilly

Answers That Matter.

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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, severe sepsis, depression, bipolar disorder, heart disease and many other diseases.

EngineeringUK

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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.

The Food and Environment Research Agency

fera

The Food and Environment Research Agency

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The Food and Environment Research Agency's over arching purpose is to support and develop a sustainable food chain, a healthy natural environment, and to protect the global community from biological and chemical risks.

Our role within that is to provide robust evidence, rigorous analysis and professional advice to Government, international organisations and the private sector.

GAMBICA Association Ltd

GAMBICA

AUTOMATION INSTRUMENTATION & CONTROL LABORATORY TECHNOLOGY

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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 10,000 Fellows (members) worldwide. The Fellowship encompasses those working in industry, academia and government, with a wide range of perspectives and views on policy-relevant science, and the Society is a leading communicator of this science to government bodies and other non-technical audiences.

Institute of Food Science & Technology

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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.

The Institute of Measurement and Control

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The Institute of Measurement and Control provides a forum for personal contact amongst practiioners, publishes learned papers and is a professional examining and qualifying organisation able to confer the titles EurIng, 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 promoting physics and bringing physicists together for the benefit of all.

It has a worldwide membership of around 40,000 comprising physicists from all sectors, as well as those with an interest in physics. It works to advance physics research, application and education; and engages with policymakers and the public to develop awareness and understanding of physics. Its publishing company, IOP Publishing, is a world leader in professional scientific publishing and the electronic dissemination of physics. Go to www.iop.org

Institute of Physics and Engineering in Medicine

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(Robert Neilson retired 31st July)

IPEM is a registered, incorporated charity for the advancement, in the public interest, of physics and engineering applied to medicine and biology. It accredits medical physicists, clinical engineers and clinical technologists through its membership register, 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.

IChemE

ADVANCING CHEMICAL ENGINEERING WORLDWIDE

The Institution of Chemical Engineers

With over 33,000 members in 120 countries, IChemE is the global membership organisation for chemical engineers. A not for profit organisation, we serve the public interest by building and sustaining an active professional community and promoting the development, understanding and application of chemical engineering worldwide.

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Kuala Lumpur | London | Melbourne | Rugby | Shanghai | Wellington

Institution of Civil Engineers

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ICE aims to be a leading voice in infrastructure issues. With over 80,000 members, ICE acts as a knowledge exchange for all aspects of civil engineering. As a Learned Society, the Institution provides expertise, in the form of reports, evidence and comment, on a wide range of subjects including infrastructure, energy generation and supply, climate change and sustainable development.

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.

The Institution of Engineering and Technology

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The IET is a world leading professional organisation, sharing and advancing knowledge to promote science, engineering and technology across the world. Dating back to 1871, the IET has 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

Setting standards in analytical science

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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 and the US.

The Linnean Society of London

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The Linnean Society of London is a professional learned body which promotes natural history in all its branches, and was founded in 1788. The Society is particularly active in the areas of biodiversity, conservation and sustainability, supporting its mission through organising open scientific meetings and publishing peer-reviewed journals, as well as undertaking educational initiatives. The Society's Fellows have a considerable range of biological expertise that can be harnessed to inform and advise on scientific and public policy issues.

A Forum for Natural History

Marine Biological Association

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For over 125 years 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 has extensive research and knowledge exchange programmes and a long history of providing evidence to support policy. It represents its members in providing a clear independent voice to government on behalf of the marine biological community.

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. 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.

MSD

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MSD is a tradename of Merck & Co., Inc., with headquarters in Whitehouse Station, N.J., U.S.A.

MSD is an innovative, global health care leader that is committed to improving health and well-being around the world. MSD discovers, develops, manufactures, and markets vaccines, medicines, and consumer and animal health products designed to help save and improve lives.

The National Endowment for Science, Technology and the Arts

NESTA Making Innovation Flourish

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NESTA is the National Endowment for Science, Technology and the Arts – an independent organisation with a mission to make the UK more innovative. It operates in three main ways: by investing in early-stage companies; informing and shaping policy; and delivering practical programmes that inspire others to solve the big challenges of the future. NESTA's expertise in this field makes it uniquely qualified to understand how the application of innovative approaches can help the UK to tackle two of the biggest challenges it faces: the economic downturn and the radical reform of public services.

National Physical Laboratory

NPL 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

The Science of Nature

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We maintain and develop the collections we care for and use them to promote the discovery, understanding, responsible use and enjoyment of the natural world.

We are part of the UK's science base as a major science infrastructure which is used by our scientists and others from across the UK and the globe working together to enhance knowledge on the diversity of the natural world.

Our value to society is vested in our research responses to challenges facing the natural world today, in engaging our visitors in the science of nature, in inspiring and training the next generation of scientists and in being a major cultural tourist destination.

The Nutrition Society

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Founded in 1941, The Nutrition Society is the premier scientific body dedicated to advance the scientific study of nutrition and its application to the maintenance of human and animal health.

Highly regarded by the scientific community, the Society is the largest learned society for nutrition in Europe. Membership is worldwide and is open to those with a genuine interest in the science of human or animal nutrition. Principal activities include:

1. Disseminating scientific information through its programme of scientific meetings and publications
2. Publishing internationally renowned scientific learned journals, and textbooks
3. Promoting the education and training of nutritionists
4. Engaging with external organisations and the public to promote good nutritional science

PHARMAQ Ltd

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PHARMAQ is the only global pharmaceutical company with a primary focus on aquaculture. Specialising in the manufacture and supply of veterinary pharmaceuticals for the global aquaculture industry including vaccines, anaesthetics, antibiotics, sea lice treatments and biocide disinfectants.

The Physiological Society

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The Physiological Society brings together over 3000 scientists from over 60 countries. Since its foundation in 1876, our Members have made significant contributions to the understanding of biological systems and the treatment of disease. The Society promotes physiology with the public and Parliament alike, and actively engages with policy makers. It supports physiologists by organising world-class conferences and offering grants for research. It also publishes the latest developments in the field in its two leading scientific journals, The Journal of Physiology and Experimental Physiology.

Prospect

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

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

The Royal Academy of Engineering

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Founded in 1976, The Royal Academy of Engineering promotes the engineering and technological welfare of the country. Our activities – led by the UK's most eminent engineers – develop the links between engineering, technology, and the quality of life. As a national academy, we provide impartial advice to Government; work to secure the next generation of engineers; and provide a voice for Britain's engineering community.

Royal Botanic Gardens, Kew

PLANTS PEOPLE POSSIBILITIES

RBG Kew is a centre of global expertise in plant and fungal diversity, conservation and sustainable use housed in two world-class gardens. Kew receives approximately half of its funding from government through Defra. Kew's Breathing Planet Programme has seven key priorities:

- Accelerating discovery and global access to plant and fungal diversity information
- Mapping and prioritising habitats most at risk
- Conserving what remains
- Sustainable local use
- Banking 25% of plant species in the Millennium Seed Bank Partnership
- Restoration ecology
- Inspiring through botanic gardens

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Inspiring and delivering science-based plant conservation worldwide, enhancing the quality of life

The Royal Institution

The Royal Institution of Great Britain

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The core activities of the Royal Institution centre around four main themes: science education, science communication, research and heritage. It is perhaps best known for the Ri Christmas Lectures, but it also has a public events programme and an online science short-film channel, as well as a UK-wide Young People's Programme of science and mathematics enrichment activities. Internationally recognised research programmes in bio- and nanomagnetism take place in the Davy Faraday Research Laboratory.

The Royal Society

THE ROYAL 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.

RSC | Advancing the Chemical Sciences
The Royal Society of Chemistry

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The Royal Society of Chemistry is a learned, professional and scientific body of over 48,000 members with a duty under its Royal Charter "to serve the public interest". It is active in the areas of education and qualifications, science policy, publishing, Europe, information and internet services, media relations, public understanding of science, advice and assistance to Parliament and Government.

Society for Applied Microbiology

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*Sf*AM is the oldest UK microbiological society and aims 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.

*Sf*AM is the voice of applied microbiology with members across the globe and works in partnership with sister organisations to exert influence on policy-makers world-wide.

Society for General Microbiology

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SGM is the largest microbiological society in Europe. The Society publishes four journals of international standing, and organises regular scientific meetings.

SGM also promotes education and careers in microbiology, and it is committed to represent microbiology to government, the media and the public.

An information service on microbiological issues concerning aspects of medicine, agriculture, food safety, biotechnology and the environment is available on request.

Society of Biology

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The Society of Biology has a duty under its Royal Charter "to serve the public benefit" by advising Parliament and Government is a single unified voice for biology: advising Government and influencing policy; advancing education and professional development; supporting our members, and engaging and encouraging public interest in the life sciences. The Society represents a diverse membership of over 80,000 - including, students, practising scientists and interested non-professionals - as individuals, or through learned societies and other organisations.

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.

Universities Federation for Animal Welfare

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UFAW is an international, independent scientific and educational animal welfare 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 leading journal Animal Welfare and other high-quality publications on animal care and welfare.
- providing expert advice to government departments and other concerned bodies.

The Welding Institute

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The Welding Institute is the leading engineering institution with expertise in solving problems in all aspects of manufacturing, fabrication and whole-life integrity management.

Personal membership provides professional development for engineers and technicians, and registration as Chartered or Incorporated Engineer, or Engineering Technician.

Industrial membership provides access to one of the world's foremost independent research and technology organisations.

TWI creates value and enhances quality of life for Members and stakeholders through engineering, materials and joining technologies.

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 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, longer lives 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 leading research and training agency addressing economic and social concerns. We pursue excellence in social science research; work to increase the impact of our research on policy and practice; and provide trained social scientists who meet the needs of users and beneficiaries, thereby contributing to the economic competitiveness of the United Kingdom, the effectiveness of public services and policy, and quality of life. The ESRC is independent, established by Royal Charter in 1965, and funded mainly by government.

EPSRC

Engineering and Physical Sciences Research Council

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EPSRC is the UK's main agency for funding research 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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For almost 100 years, the MRC has been improving the health of people in the UK and around the world by supporting the highest quality science on behalf of UK taxpayers. We 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. MRC-funded scientists have made some of the most significant discoveries in medical science – from the link between smoking and cancer to the invention of therapeutic antibodies – benefiting millions of people.

Natural Environment Research Council

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The UK's Natural Environment Research Council funds and carries out impartial scientific research in the sciences of the environment. NERC trains the next generation of independent environmental scientists.

NERC funds research in universities and in a network of its own centres, which include:

British Antarctic Survey, British Geological Survey, Centre for Ecology and Hydrology, and National Oceanography Centre.

Science & Technology Facilities Council

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The Science and Technology Facilities Council is one of Europe's largest multidisciplinary research organisations supporting scientists and engineers world-wide. The Research Council operates world-class, large-scale research facilities and provides strategic advice to the UK Government on their development. The STFC partners in two of the UK's Science and Innovation Campuses. It also manages 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. The Council directs, co-ordinates and funds research, education and training.

SCIENCE DIARY

THE PARLIAMENTARY AND SCIENTIFIC COMMITTEE

Tel: 020 7222 7085
annabel.lloyd@parliament.uk
www.scienceinparliament.org.uk

Tuesday 16 October 17.30
Energy - The Next Generation
Speakers: Dr Gordon Edge
Director of Policy, RenewableUK
Frans van den Heuvel
Chief Executive Officer, Solarcentury
Francis Egan
Chief Executive Officer, Cuadrilla Resources

Wednesday 31st October
Annual Lunch
Guest of Honour: Professor John Womersley
Chief Executive Officer, Science and Technology Facilities Council
Please contact Secretariat for tickets

Tuesday 6th November 17.30
Energy - How to use less
Speakers to be confirmed.

Tuesday 11th December 17.30
Climate Change and the Polar Regions
Speakers to be confirmed.

Discussion meeting dates 2013
Tuesday 22 January 17.30
Tuesday 26 February 17.30

THE ROYAL SOCIETY

Website: royalsociety.org

The Royal Society hosts a series of free events, including evening lectures and conferences, covering the whole breadth of science, engineering and technology for public, policy and scientific audiences. Events are held at the Royal Society's offices in London, at the Royal Society at Chicheley Hall, home of the Kavli Royal Society International Centre in Buckinghamshire and other venues.
Many past events are available to watch or listen to online at royalsociety.org/events. The collection includes events with speakers such as David Attenborough, Margaret Atwood and Lord Rees FRS.
Highlights in the next few months include the following. Details of how to attend all these, plus information on many more events can be found on our website at royalsociety.org/events:

Monday 22 and Tuesday 23 October
Regulation from a distance: long-range control of gene expression in development and disease
Scientific discussion meeting organised by Professor Wendy Bickmore and Professor Veronica van Heyningen FRS

Monday 22 October 18:30
How does your body know what time it is?
Cafe scientifique with Professor Debra Skene

Wednesday 24 and Thursday 25 October
Regulation of gene expression from a distance: exploring mechanisms
Satellite meeting organised by Professor Wendy Bickmore and Professor Veronica van Heyningen FRS

Friday 26 October 13:00
Spooks and spoofs: psychologists and psychical research in the inter-war years
Professor Elizabeth Valentine

Friday 2 November 17:30
Standing on the shoulders of giants: cumulative culture and social learning strategies
Dr Rachel Kendal at the Manchester Museum, part of the of the Manchester Science Festival

Friday 2 November 13:00
Wellcome's collectors
Ross MacFarlane

Sunday 4 November 14:30
Massive: the particle that sparked the greatest hunt in science
Ian Sample at the John Rylands Library, part of the of the Manchester Science Festival

Friday 9 November 13:00
Teaching language to the deaf in the 17th century: the dispute between John Wallis and William Holder
Dr David Cram

Monday 12 November 18:30
Sustainable materials: with both eyes open
Dr Julian Allwood

Monday 12 and Tuesday 13 November
Energy transduction and genome function – an evolutionary synthesis
Scientific discussion meeting organised by Dr Nick Lane, Professor John Allen, Professor William Martin and Professor John Raven FRS

Wednesday 14 and Thursday 15 November
Bioenergetics and the major evolutionary transitions
Satellite meeting organised by Dr Nick Lane, Professor John Allen, Professor William Martin and Professor John Raven FRS

Friday 16 November 13:00
Iron from the sky: the potential influence of meteorites on ancient Egyptian culture
Dr Diane Johnson

Monday 19 November 18:30
What's going on inside volcanoes?
Cafe scientifique with Dr Alison Rust

Wednesday 21 November 18:30
Finding patterns in genes and proteins: decoding the logic of molecular interactions
Dr Sarah Teichmann

Friday 23 November 13:00
Science in the news: regional independent television in the British Midlands during the 1950s and 1960s
Dr Sally Horrocks

Monday 26 November 18:30
Royal Society Winton Prize for Science Books 2012 Award Ceremony

Monday 3 and Tuesday 4 December
Achieving food and environmental security – new approaches to close the gap
Scientific discussion meeting organised by Professor Guy Poppy, Professor Paul Jepson, Professor John Pickett CBE FRS and Dr Michael Birkett

Wednesday 5 and Thursday 6 December
Can science help us get back to the countryside?
Satellite meeting organised by Professor Guy Poppy, Professor Paul Jepson, Professor John Pickett CBE FRS and Dr Michael Birkett

Monday 10 December 18:30
Nature's glass: half-full or half-empty?
Professor Andrew Balmford FRS

Tuesday 22 January 18:30
Royal Society GlaxoSmithKline Prize Lecture
Professor Adrian Bird CBE FMedSci FRS

Monday 28 and Tuesday 29 January
UK-China workshop on the chemistry and physics of functional materials
Theo Murphy international scientific meeting organised by Professor Henning Sirringhaus, Professor Anthony Cheetham FRS, Professor Wenping Hu and Professor Deqing Zhang

Thursday 7 and Friday 8 February
Storage and indexing of massive data
Theo Murphy international scientific meeting organised by Professor Costas Iliopoulos, Dr Simon Puglisi and Professor Maxime Crochmore

Monday 11 and Tuesday 12 February
Taking X-ray Phase Contrast imaging into mainstream applications
Scientific discussion meeting organised by Dr Alessandro Olivo and Professor Ian Robinson

Wednesday 13 and Thursday 14 February
Real and reciprocal space X-ray imaging
Satellite meeting organised by Dr Alessandro Olivo and Professor Ian Robinson

Wednesday 13 February 18:30
Milner Award Lecture
Professor Gordon Plotkin

Tuesday 19 February
Michael Faraday Prize Lecture
Professor Brian Cox OBE

THE ROYAL INSTITUTION

21 Albemarle Street
London W1S 4BS.

All events take place at the Royal Institution. Details of future events can be found at www.rigb.org
For more information and to book visit www.rigb.org

Tuesday 6 November 19.00-20.30
The science of fear

Thursday 8 November 19.00-20.30
Gravity's engines: The other side of black holes

Tuesday 13 November 19.00-20.30
The fear of science

Tuesday 20 November 19.00-20.30
You're going to die!

Wednesday 21 November 19.00-20.30
How the Internet works

INSTITUTION OF MECHANICAL ENGINEERS

1 Birdcage Walk
Westminster
London SW1H 9JJ
http://www.imeche.org

Wednesday 24 October
How to solve friction, wear and lubrication problems
Belfast
Details: www.imeche.org/events/s1690

Wednesday 7 November
Significant seven: hot topics in airworthiness
Bristol
Details: www.imeche.org/events/s1683

Thursday 22 November
Tribology at sea
Southampton
Details: www.imeche.org/events/s1691

Wednesday 28 November
Impact, damage, protection, simulations and evaluation
Bristol
Details: www.imeche.org/events/s1734

Wednesday 5 December
Donald Julius Groen prize lecture
Details: www.imeche.org/events/s1736

Wednesday 12 December
MX Club Visit Carl Zeiss Microscopy
Cambridge
Details: www.mxawards.org/mx-club

Thursday 31 January
Residual stresses: when do they matter?
Manchester
Details: www.imeche.org/events/s1693

SCIENCE IN PARLIAMENT sip
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Andrew Miller MP, Stephen Metcalfe MP
and Dr Julian Huppert MP invite you to attend

The Society of Biology and the Biotechnology and Biological Sciences Research Council launch of the inaugural

Biology Week

Biology Week 2012 aims to inspire people of all ages and backgrounds with the fascinating science of biology and give everyone the chance to get involved with life science events

Wednesday 17 October 2012

7.00pm—9.00pm

The Churchill Room at the House of Commons

SOCIETY OF Biology

In partnership with: BBSRC bioscience for the future

biology week 2012

NPL
National Physical Laboratory

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www.npl.co.uk/2020vision