The Parliamentary and Scientific Committee

The Journal of the Parliamentary and Scientific Committee

SCIENCE IN PARLIAMENT

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SEPTEMBER 2015

INNOVATION HUBS

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G L Brown Lecture 2015

Extreme Threats

Environmental threats: Origins, consequences and amelioration

Mike Tipton, Professor of Human & Applied Physiology

16.00 on Friday 16 October 2015 followed by a drinks reception
Hodgkin Huxley House, 30 Farringdon Lane, London EC1R 3AW

Contact **events@physoc.org** for more information and to book your place

Sir George Lindor Brown (9 February 1903 – 22 February 1971) was a noted English physiologist.
In 1975 The Physiological Society established the G L Brown Prize Lecture in his memory.
The G L Brown Lecture takes place each year at a variety of locations across the UK.

Founded in 1876, The Physiological Society supports over 3,500 scientists internationally by providing world-class conferences, resources and grants - find out more at www.physoc.org

The Physiological Society

Stephen Metcalfe MP, Chairman, Parliamentary and Scientific Committee

Welcome to my first editorial as the new Chair of the P&SC. I am looking forward to this new role enormously.

I have two thanks to give.

First to my predecessor, Andrew Miller, who did such a superb job in running it for five years. I am sure he is now enjoying the peace and quiet after the hurly burly of Westminster.

Second to our President, Ron Oxburgh, for providing the continuity (and the last Editorial) during the odd inter regnum which occurs between parliaments.

Parliament may have vanished for a few weeks, but the world of science never sleeps.

It was great to see the launch of the MRC Innovation Fund – an initiative of my colleague, George Freeman. We shall be commissioning contributions to SiP from some of the winners in due course.

Some topics which have been covered either in Discussion Meetings or in these pages will not lie down. We have recently witnessed renewed controversy about neonicotinoids and GM insects.

It is excellent that MPs have had a chance to quiz some of the top scientists in these fields.

Our programme for the Autumn commences with "Patient Safety" in October.

I am looking forward to seeing new faces in the audience.

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

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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The covers of this issue are sponsored by NEF: The Innovation Institute, The Physiological Society, The University of Nottingham and The Royal Society of Biology.

INNOVATION HUBS – A STRUCTURED PLATFORM FOR SUSTAINABLE GROWTH

Professor Sa'ad Medhat
CEO, NEF: The Innovation Institute

Achieving growth that generates economic value and social benefit requires a structured approach that binds an organisation's strength and aspiration with that of its stakeholders and partners, thus creating an innovation capability that is scalable and sustainable.

Having such a capability gives the freedom to public or private sector organisations to develop an ethos of entrepreneurship and the ability to experiment with different choices.

Market responsiveness, changing technologies and trends, tighter budgets and shifting economic conditions have all acted as stimuli for organisations to innovate to consider alternative approaches to drive performance. Innovation happens not only in a product or a service but also in the way in which organisations design and conduct their business to maintain competitive positioning.

The drive for innovation requires openness to collaborate and the freedom to be creative. However, organisational rigidity and bureaucracy often inhibit the innovation process. Having a structured approach that contains risk whilst providing a channel to experiment out of the business norms, provides greater opportunity to secure quick wins. One structured approach is the formation of an Innovation Hub.

INNOVATION HUBS

An Innovation Hub presents a compelling platform for harnessing capability, focusing investment and stimulating enterprise. The key to successful innovation hub development is to cluster the organisation's capability around new and emerging economic areas of growth. Clustering delivers constructive alignment between a business strategy and the innovation focus, thus improving speed of response and enhancing the quality of new offerings for the organisation. Innovation hubs can be physical or virtual and their structure and characteristics are determined by strategic goals. They can be implemented at a regional or city level, or as part of a company, a college or a public sector organisation to provide the vital knowledge exchange environment that stimulates creativity and accelerates innovation. Hubs can be formed as an autonomous single unit or as a network of distributed but interconnected thematic entities.

... innovation requires openness to collaborate and the freedom to be creative ...

In education, innovation hubs offer a natural fit with further education colleges in that they build upon the relationship that a college has with local business and industry, and provide a means of collaborative engagement to develop commercial solutions, underpin educational provision and extend outreach and civic activities. Examples of innovation hubs in education include Tyne Metropolitan College who focused on providing solutions in Engineering Systems and Design; Havering College built their Hub on the strength of their healthcare expertise and Plymouth University centred their Innovation Hubs on developing local enterprise capital in eco-environment, health and life sciences and digital and media creative sectors. In business, innovation hubs can be used to leverage broad base IP and identify possible solutions to challenges, thereby enabling faster market response. Pharmaceutical and FMCG businesses often use the notion of open innovation delivered through innovation hubs to access different expert perspectives to support creative problem-solving. An example of an Innovation Hub approach in business has been the collaborative laboratory or 'Collaboratory' in DuPont. Both virtual and physical, the Collaboratory which brings a knowledge base of some nine thousand experts in the fields of science, engineering and technology, is founded on the precepts of collaboration and co-

creation. Through the use of live conferencing, design thinking and ideation, solutions to challenges are being discovered and DuPont's innovation pipeline is flowing.

Three determinants characterise the modus operandi of innovation hubs, they:

- act as a catalyst for driving organisational change
- create the basis for a multiplication factor for growth
- become an instrument for attracting capital investment

In addition, there is a direct correlation between development of a hub and the increase in the level of learning development. Such activities lead to instilling a high performing culture that strengthens the organisation's readiness to innovation and builds its knowledge base.

Organisations which create innovation hubs have the ability to mobilise innovation initiatives quickly and can optimise the time taken to create new value for their end users and themselves.

HUBS LEADERSHIP & GOVERNANCE

Hubs provide an effective vehicle for shaping the dynamics of go-to-market solutions. Their primary focus on innovation make the measurement of their tangible and intangible outcomes more readily identifiable.

... hubs provide a robust mechanism for competitive collaboration ...

However, the key to success for innovation hubs is the ability of organisational leaders embarking upon such development, to take on both a governing and an empowering role. Whilst maintaining a future focus on managing an innovation portfolio, a hub leader should also embrace impact-driven operational accountability that fosters partnership development to drive co-creation and informs the decision-making processes within a hub's ecosystem.

INVESTING IN INNOVATION

Different investment models in innovation hubs could be considered. The simplest is to provide a separate budget for hub development with its own P&L. However, this approach may not necessarily render the best returns. Alternatively, adopting a partnership model for investment with stakeholders (eg supply chain, customers), could potentially extend the opportunities and benefits.

In fact, hubs provide a robust mechanism for competitive collaboration. Again, pharma companies tend to do this well in tackling issues during drug development or a clinical trial stage. Such models can offer a scaffold structure for any sector to consider.

A third option for investment in hubs could be to employ an aggregator concept, where the participation of many stakeholders, particularly small and medium size enterprises, is encouraged. Universities and colleges could adopt such a model as it naturally lends itself to a wider collaborative innovation development.

INCENTIVE PRIZES AND THE ADVANCEMENT OF SCIENCE AND TECHNOLOGY

Paul Ridout
Ocean Scientific International Ltd. (OSIL)

There is a wide range of high-value incentive prizes on offer for the development of technologies to help solve some of today's scientific challenges. The intellectual value of such prizes may be much wider than the original challenge. Details of the recently awarded Wendy Schmidt Ocean Health XPRIZE demonstrates some of these benefits.

During the18th century, the British government offered more than £100,000 in prize money to anyone who could come up with simple and practical methods for measuring longitude to assist maritime navigation. In 1927, there was the $25,000 Orteig Prize, for the first non-stop transatlantic flight. In 2004, the $10 million Ansari XPRIZE was awarded to the first non-governmental organization to launch the equivalent of a three-person crew into space twice within two weeks. More recently the Longitude Prize has been launched which offers a £10m prize to address the problem of global antibiotic resistance. In July 2015, the $2m Wendy Schmidt Ocean Health XPRIZE was awarded to the teams who could improve the accuracy and affordability of ocean pH sensor technology.

Incentive prizes, which offer large cash rewards to motivate the attainment of targets in

scientific research and development, have increased in popularity in the last decade. It is argued that this type of funding could effectively solve a wide range of today's science challenges. Although incentive prizes have long been used and

Electrical Interference Testing and Ozone Testing

may have led to valuable discoveries and inventions, little empirical evidence has been around to understand how prizes work.

In his book, 'Technological Innovation and Prize Incentives', Luciano Kay *(University of California Santa Barbara)* seeks to understand the effect of such prizes on innovation. Some of the key points in his findings are that prizes can induce new R&D activities, re-direct ongoing industry projects and that well designed prizes induce innovation over and above what would have occurred anyway. In addition, prizes may induce technological breakthroughs. However, according to Dr Kay, there are significant funding requirements, by the entrants, in order to carry out the projects and bad economic conditions may slow down (or in some cases, halt) R&D activities to find solutions to the prize challenge.

In this article, I seek to understand more of the processes and effects of incentive prizes by focusing on a recently awarded prize from the USA-based charity, XPRIZE. The XPRIZE philosophy is to incentivise a solution to a problem with challenges that are audacious, but achievable and tied to objective, measurable goals. Groups of experts identify areas of scientific and technological need and then seek to find sponsors for individual projects. One of their 'Grand Challenges' includes Energy and Environment, which has a goal to generate breakthroughs in clean energy, climate change, energy distribution/storage, energy efficiency/use, and water resource management. Previously awarded prizes in this area have included a project to inspire innovative methods to improve cleanup at sea following oil-spill incidents.

The latest award has been the Wendy Schmidt Ocean Health XPRIZE, which was launched in September 2013. This was a 22-month competition to develop accurate and affordable pH sensors to detect ocean acidification. Rising levels of atmospheric carbon are resulting in higher levels of acidity in the oceans, impacting the health of shellfish, fisheries, coral reefs,

... generate breakthroughs in clean energy ...

other ecosystems and our very survival (a topic previously covered by the P&SC). While ocean acidification is well documented in a few temperate ocean waters, little is known in high latitudes, coastal areas and the deep sea. Most pH sensor technologies are too costly, imprecise, or unstable, to allow for sufficient knowledge and coverage on the state of ocean acidification.

Over 70 teams from around the world expressed an interest in competing when registration opened and the final award took place in July 2015. Prize Sponsor, Wendy Schmidt has a keen interest in the marine environment. As President of The Schmidt Family Foundation, she works to advance the development of renewable energy and the wiser use of natural resources. In 2009, Wendy and her husband Eric Schmidt created the Schmidt Ocean Institute (SOI) and in

... higher levels of acidity in the oceans ...

2012 they launched the research vessel, Falkor, as a mobile platform to advance ocean exploration.

Teams participating in the Wendy Schmidt Ocean Health XPRIZE competed for two available prize purses: the $1M

Competition Phase 4 Testing

accuracy purse, based on performance, and the $1M affordability purse, based on cost and usability. In April 2015, 14 semi-finalist teams were narrowed down to the five finalist teams, representing four countries (Table 1). They embarked on a one week deep sea trial to assess ocean pH values throughout the water column at Station Aloha, a 110 square mile region in the Pacific Ocean, located approximately 100 miles off the northern shore of Oahu. During this six-day period, sensors were put through rigorous performance tests focused on accuracy and precision, while battling real-world pressure scenarios in water depths of up to 3,000 meters. To reach this point, teams had to successfully put their sensors through a three-month test in controlled laboratory conditions at the Monterey Bay Aquarium Research Institute (Autumn 2014), followed by a month-long performance test in a coastal environment at the Seattle Aquarium in February 2015.

On July 20th 2015 XPRIZE announced the first-place winner of both prize purses as Sunburst Sensors, a small company of chemists and engineers from Missoula, Montana, led by CEO and co-owner, James Beck, an engineer who graduated at MIT and University of Washington. They won the $750,000 grand prize in both the affordability and accuracy categories, earning them a total of $1.5M. Sunburst Sensors co-owner, Professor Michael DeGrandpre, is a Professor of Chemistry at the University of Montana, where he pioneered the development of an autonomous alkalinity sensor, in collaboration with Dr Reggie Spaulding from Sunburst. However, the competition's requirements were quite different from the sensors they were already producing with

Competition Phase 4 Testing – Hawaii

emphasis on fast sampling rates, deep-water operation, accuracy and affordability. The company concentrated on their previously developed commercial sensors to create the two winning sensors: the i-SAMI ("i" for inexpensive) and the t-SAMI ("t" for titanium). The team collaborated with Woods Hole Oceanographic Institution (WHOI) for development and testing of the t-SAMI deep-water instrument.

The second place prize in affordability was awarded to ANB Sensors from Cambridge, England, and the second place prize in accuracy was awarded to Team DuraFET from Plymouth, Minnesota and Monterey Bay, California. Each team won $250,000. During the course of the competition ANB Sensors formed their own start-up company and have been working on the second generation of their competition entry for market. Team DuraFET has donated their award money to the international ARGO program – a program that is deploying sensors in the global oceans to improve our understanding of the baseline state and any changes.

Professor Ralph Rayner, a British marine scientist who was a scientific advisor for the XPRIZE commented, "It is true that the prizes generally have an initial focus on stimulating technological innovation, but this is just the start of the process. The Ocean Health XPRIZE goal is also to raise awareness of ocean acidification and its potential impacts and there are a large number of post prize activities being planned in this regard".

Team Finalists for the 2015 Wendy Schmidt Ocean Health XPrize

- **ANB Sensors (Cambridge, England)**, a team of scientists and researchers from the Schlumberger Gould Research Center with expertise in lasers, chemistry, fluid mechanics and geophysics.
- **HpHS (Yokosuka, Japan)**, a team of research scientists and engineers from the Kimoto Electric Co., Ltd. and Japan Agency for Marine-Earth Science and Technology (JAMSTEC).
- **Sunburst Sensors (Missoula, Mont, US)**, a team of mechanical engineers from Sunburst Sensors, LLC, a company focused on the development of chemical sensors for marine and freshwater applications.
- **Team Durafet (Plymouth, Minn, US)**, a team comprising representatives from Sea-Bird Scientific, Monterey Bay Aquarium Research Institute (MBARI), Scripps Institution of Oceanography at the University of California, San Diego and Honeywell Aerospace Advanced Technology group.
- **Team XYLEM (Bergen, Norway/Beverly, Mass, US)**, a team representing two Xylem companies, Aanderaa Data Instruments in Norway and YSI in the U.S., with extensive work in commercializing high performance and reliable optical chemical sensors used in oceanography.

... a keen interest in the marine environment ...

The winner of both 1st prize categories, Sunburst Sensors, is a small company mostly working in a different market area and located about as far from the ocean as you can get in the US. In that respect, the prize certainly stimulated transfer of technology from one market to another. Many of the problems they had to overcome revolved around the usual issues that all of us suffer when working on technology to operate in the ocean, including high pressure, corrosion etc.

An example of innovation from 'out-of-the-box' thinkers was the Smartphin project. Environmental film maker, Andrew Stern, and engineer/surfer, Benjamin Thompson, teamed up to produce a sensor system which is embedded in the fin of a normal surfboard. Originally for temperature and salinity they developed the technology to include pH in order to compete for the XPRIZE. They made it to the semi-finals but progress doesn't stop there. Starting in November, 50 researchers from the Scripps Institution of Oceanography (SIO) will be screwing Smartphin prototypes into their boards and taking to the waters outside their workplace to compare data with the fixed sensors located on the SIO pier.

Award Ceremony, New York

The XPRIZE competition aimed to drive industry forward to produce the capability to provide meaningful data needed to take action and produce results. In a wider context the prize hoped to:

- Provide tools for the study and monitoring of ocean acidification's impacts
- Catalyze ocean acidification research
- Increase development of the ocean services industry – data, information and forecasting
- Inspire innovations in ocean sensing technology to monitor the health of the ocean
- Create both tools and support for policymakers and public officials
- Inspire the public to engage in solving ocean acidification

XPRIZE plans to launch three more ocean-based prizes in the next five years as part of the XPRIZE Ocean Initiative. The goal of this initiative is to launch impactful prizes and inspire other actions that put us on an unstoppable path towards healthy, valued and understood oceans.

It remains to be seen how many of these will be achieved but evidence to date is encouraging.

ECOLOGY MATTERS

Ben Connor
Policy Officer,
British Ecological Society

Ecological science is an integral part of finding a way to live well in a world with more people and pressure on our natural resources. Through studying the interactions of living organisms with each other and the environment, we are able to predict the impact of human activity on our natural world and understand how the environment supports our society. Ecology is not environmentalism, but it does have both global and local resonance; it can provide insight into international climate change and localised flooding, endangered species and our garden wildlife.

BRITISH ECOLOGICAL SOCIETY

The British Ecological Society was founded in 1913, and has over 5,000 members. As an independent, authoritative body and the leading voice for ecologists in the UK, the Society is committed to ensuring that policymakers have access to the best available scientific evidence.

Contact us at Policy@britishecologicalsociety.org

Bumblebee – ©Dave Goulson

©David Bird

In the UK, ecologists are able to build on a long history of environmental data collection, which in turn has contributed to the country's pre-eminence in environmental science. The UK hosts centres of world-leading ecological science, but these must be integrated into national policy development, and implemented at the local level in order to maximise the benefits of our natural resource and ensure its long term sustainability. Ecology will be central to the Government's 25 year strategies to restore biodiversity, eradicate bovine TB and improve farming – all commitments made in the Conservative Party manifesto. Ecology also has a role to play in assessing the effectiveness of these policies. This is critical as we face a world which is likely to change significantly through climate change, technological advances, and geopolitical pressures.

THE VALUE OF

Fishing – ©David Bird

ECOLOGY….

… TO THE ECONOMY

Protecting and enhancing our natural capital, from which we derive benefits such as food, timber, and water, is an essential part of sustainable economic growth, yet this has been consistently undervalued. The UK National Ecosystem Assessment placed the value of these goods and services at many billions of pounds[1]. Ecologists working alongside economists in the Natural Capital Committee have set out an innovative framework for

… world-leading ecological science…

corporations to take account of their natural capital, and present a series of potential environmental investments that offer good economic returns. This is an important step in the sustainable management of our natural resource by business and government alike.

The economic value of insect pollinators to the UK economy has been estimated at £690 million a year [2], yet these populations are in decline. Ecologists contribute to the wealth of knowledge needed to safeguard this vital service, providing information on influential factors such as the spill-over of viruses from commercial to wild pollinator species [3], the role of natural habitats on pollination services [4], the impacts of climate change on pollinators such as bumblebees [5] and more.

Application of this knowledge not only provides a lifeline for these species, but brings long term economic prosperity, as well as avoiding costs for both business and the public purse.

… TO SOCIETY

The relationship between mental and physical wellbeing and the natural environment is increasingly well understood, from the role of microbial biodiversity to the importance of local green spaces. Ecologists are working with health professionals to advance this understanding, identify gaps in our knowledge and find out more about the relationship between different types of natural environments and their influence on health and wellbeing.

Good health can also bring economic savings; Natural England have estimated that £2.1billion worth of mental and physical health costs could be averted each year if every household in the country were provided with equitable access to good quality green space [6].

… enhancing our natural capital …

…TO THE ENVIRONMENT

Species and habitats have intrinsic value that should not be underestimated, and are essential for maintaining the benefits we derive from the environment. However the UK is experiencing reductions in all aspects of biodiversity: 60% of species have declined over the last 50 years and 31% have declined strongly [7].

The Making Space for Nature report, led by former British Ecological Society President Professor Sir John Lawton, called for a new approach to nature conservation underpinned by ecological science to meet the target of halting the loss of biodiversity by 2020.

… halting the loss of biodiversity …

Ecological research allows us to understand the underlying causes of biodiversity loss and ensure that our conservation strategies are efficient, cost effective and resilient to external pressures.

The systematic review of ecological evidence provides a basis from which to develop policies; ecologists working in Cambridge and Bangor are leading this approach, analysing evidence to assess the effects of conservation interventions, the impact of invasive species and more.

Ecologists also work to evaluate policies once they are implemented. Recent evidence has emerged that the EU Birds Directive has had a positive impact on target species, including the avocet, marsh harrier and corncrake.

The relationship between people and the environment is at the heart of many of the most important challenges of the 21st century. Investing in ecological research and ensuring that policy is informed by the latest scientific evidence is crucial if we are to tackle these challenges effectively.

Starfish

Hoverfly

Puffin – ©Cheryl Pilbeam

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ONE HUNDRED AND FIFTY YEARS OF THE STATE VETERINARY SERVICE 1865 – 2015

Dr Alison Wilson MCIPR
Senior Press Officer, Animal and Plant Health Agency (APHA)

The State Veterinary Service was created in 1865 when the Government established the Veterinary Department of the Privy Council to tackle a devastating epidemic of cattle plague (Rinderpest), a highly infectious viral disease which caused the loss of around 400,000 animals. For the first time, veterinary medicine was seen as nationally important and attempts to control disease, although effective locally, needed national co-ordination and standardisation.

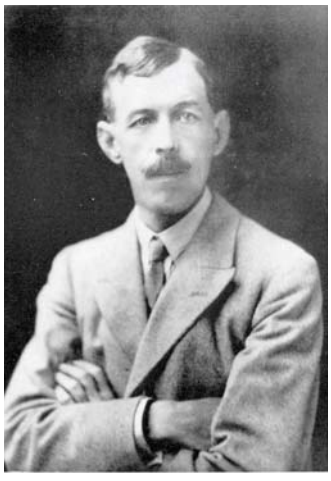
By 1900 the nation had suffered numerous serious outbreaks of infectious livestock diseases including sheep pox, cattle plague, swine fever, foot and mouth disease and bovine pleuro-pneumonia. The policy for eliminating these diseases was to place restrictions on the importation and movement of livestock, and the compulsory slaughter or quarantine of affected animals and their contacts, one of the approaches that continues to this day.

Two widespread endemic diseases, bovine tuberculosis (bTB) and brucellosis remained an issue for both animal and human health. Controlling these was more difficult as signs did not appear until the disease was advanced, so veterinary surgeons looked to develop better diagnostic methods.

This need for better diagnostic support had first been recognised in 1894 during an outbreak of swine fever. At that time dead animals were taken to the Royal Veterinary College at Camden Town for *post mortem* examination. However, the Board of Agriculture decided to set up its own diagnostic service for animal disease eradication schemes. The Veterinary Laboratory Service (VLS) was established in a basement at 4 Whitehall Place and, over the next decade, samples from diseased pigs were transported to the centre of London for examination.

In 1905, under Chief Veterinary Officer Sir Stewart Stockman, the VLS expanded its remit and started to research animal diseases. In 1917 this research was transferred to the newly opened Central Veterinary Laboratory (CVL) at a site near Weybridge[1]. The CVL was one of the first purpose-built state veterinary laboratories in the world and is now an integral part of the Animal and Plant Health Agency (APHA).

Sir Stewart's appointment brought about significant changes in the development of veterinary medicine. His time in post saw the passing of the Tuberculosis Order 1925, which for the first time linked the spread of disease in humans with the consumption of untreated milk and led to bTB testing in cattle herds.



Sir Stewart Stockman

The importance of the veterinary profession in fullfilling a public service was further recognised in 1919 when the newly established Ministry of Agriculture had veterinary expertise at its core in its new Diseases of Animal Division. By unifying the provision of state veterinary medicine and providing leadership to the profession, a significant step had been taken in controlling animal diseases.

During the 1930s demand for veterinary services increased as farmers and the government sought to eliminate bTB and improve the health of the nation's farm animals in order to safeguard agriculture and food production[2]. During that time various Acts and schemes were introduced including:

- the Milk Act 1934, which introduced the notion of an 'attested herd' (ie certified as being free from disease) whereby milk guaranteed as disease-free attracted a premium;
- the Attested Herds Scheme 1935, which enabled farmers to apply for official bTB testing and, in the absence of reactors, to be entered into the Register of Attested Herds;
- the Agriculture Act 1937 saw the Ministry's Animal Health Division take over the Veterinary Investigation Service (VIS), under the control of the

CVL Director at Weybridge. This function, previously carried out by local authorities, was responsible for livestock disease surveillance in the regions, encompassing both animal health and the safety of meat and milk intended for human consumption.

- a system of financial compensation for farmers' losses through compulsory slaughter policies, providing an incentive to them to abide by government regulations and facilitate the work of state veterinary surgeons.

This culminated in the establishment in 1938 of the State Veterinary Service (SVS), as part of the Animal Health Division of the Ministry of Agriculture and Fisheries (MAF), under Sir Daniel Cabot, the Chief Veterinary Officer[3].

World War II further emphasised the important role of the SVS as the Government sought to boost food production in Britain. Following the war, the 1947 and 1957 Agriculture Acts were introduced to increase food production and agricultural systems became more intensive.

During the 1960s, the SVS was heavily involved in eradicating bTB and brucellosis. However, pockets of bTB persisted in the South West; complete eradication has continued to pose a challenge.

Government vets and scientists also played a key role in identifying and investigating emerging diseases in wildlife. In 1971, the regional VIS laboratory in Starcross identified the first case of *Mycobacterium bovis* in badgers and found that badgers were a significant reservoir of the disease.

The wild badger population at Woodchester Park in Gloucestershire has been intensively studied by government scientists since 1975. This is the only long-term study of TB epidemiology in a wild badger population. The capture, examination and sampling of individual animals throughout their lifetimes has yielded a unique database and fundamental insights into badger ecology and TB dynamics. This research has benefited from close collaboration with scientists from Weybridge and led, in 2010, to licensing of the first tuberculosis vaccine for badgers (BadgerBCG) which is in regular use in parts of the country.

Government vets also played a very significant role in enforcing animal welfare legislation, providing an excellent and much appreciated service to the public in relation to safeguarding animal welfare standards.

The VIS continued to work closely with CVL to facilitate investigation into outbreaks of disease. Issues identified by the VIS often led to further research by the laboratory. For example, CVL characterised the first case of bovine spongiform encephalopathy (BSE) in 1986 and, from the epidemiological information provided by the VIS, identified a link between the disease and feed containing a scrapie-like agent in ruminant-derived meat and bone meal.

There followed a period of significant change as Civil Service reforms transformed the delivery of central government services. In 1990, CVL became one of the government's first executive agencies, followed by the merger of CVL and VIS to form the Veterinary Laboratories Agency (VLA) in recognition of the links between them. This brought together a national network of laboratories providing veterinary surveillance, research, laboratory services and specialist advice to MAFF, private veterinarians and the agricultural industry. The VLA was responsible for many significant developments in animal disease recognition, diagnosis, surveillance and monitoring, providing MAFF with scientific evidence to aid policy development. This work extended to zoonotic diseases such as salmonella, working closely with public health bodies to protect human health.

The SVS became an Agency of the Department for Food, Environment and Rural Affairs (Defra) in 2005 and changed its name to Animal Health in 2007 following mergers with the Egg Marketing Inspectorate, Dairy Hygiene Inspectorate and Wildlife Licensing and Registration Service in line with recommendations made by the Hampton Review.

In 2009, Defra created the Animal Health and Veterinary Laboratories Agency (AHVLA) as part of a review of its arms-length bodies. The new Agency brought together a wide range of field services, wildlife and veterinary expertise and scientific capabilities in order to make the delivery of these important services and the ability to respond to disease outbreaks more resilient in the economic climate at that time.

In 2014 the Animal and Plant Health Agency (APHA) was formed by merging the AHVLA with those Defra Inspectorates covering plant, seed and bee health, creating a single organisation responsible for safeguarding animal and plant health.

Over the course of 150 years, the constant theme has been the promotion of better animal health and the detection of threats to the national livestock population. Vets have worked tirelessly to achieve this aim, and will continue to do so for as long as there are animals at risk.

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FOOD AND THE FUTURE

Veronica Vaccari
Consulate General Milan

When it comes to keeping us properly fed, we can't just think about our next meal - we need to keep in mind how we manage food supply in the long-term.

With the planet's population due to hit 9 billion by 2050, the FAO estimate that global food production will have to increase by 70%. At the same time, climate change and resulting weather extremes could mean that current food production systems will not function well by 2050. It is hard to predict what will happen at a local level but climate change has the potential to put millions of people at risk of food shortage, through flood, drought, and other extreme weather events, and through changes in invasive pests and diseases.

Andrew Jackson, Head of the FCO's Science, Innovation and Climate Department, headed up a high-level panel of four speakers looking at weather and climate impact on food supply and security: Kirsty Lewis (Climate Security Team Leader, **Met Office**), Shaun Hobbs (Global Director, Knowledge Bank, the Centre for Biosciences and Agriculture International (**CABI**)), Aaron Davis (Senior Research Leader, Plant Resources, **Royal Botanic Gardens, Kew**), Tania Osejo Carrillo (Climate Change Adaptation Consultant, **The World Food Programme**).

... global food production will have to increase by 70% ...

While debating links between climate and weather, food security and malnutrition, panellists considered how science and industry could work together to support the Agri-Tech sector in the context of long-term climate risks, including:

- considering potential climate impacts on food security, availability and malnutrition, in order to help policy makers build resilience and reduce the threat of future hunger;
- use of weather forecasts, early warning and horizon scanning to prepare better for weather and climate shocks in order to support agriculture and supply chains;
- use of big data to manage crop health and control plant disease and invasive species;
- building resilience of the agricultural economy to the effects of climate change.

The panel members and SIN Italy team in the bee-hive shaped UK Pavilion

As part of the Grown in Britain GREAT week on Agri-Tech, the Science and Innovation Network (SIN) and the Met Office hosted a BIS-funded seminar on 10 July in the UK Pavilion at Milan Expo (part of the series of world Expos that take place every five years).

Participating organisations brought different perspectives and case studies to the discussions. Kew described how they are using climate modelling to find ways to help Ethiopian coffee farmers avoid crop failure; the Met Office presented their 'Human Dynamics of Climate Change' model (including via an exhibition open to the general public); and CABI focused on their work to increase or maintain crop yields in the face of climate change, by using modelling and Big Data to improve management of pests and diseases.

The seminar debate in the UK Pavilion conference room

The panel debate provided insights into how technology and innovation could improve the competitiveness of the Agri-Tech sector whilst also addressing global food security. With agriculture so dependent on weather, the panel concluded that there was more we can do to support resilience in this sector:

"Through science and industry working together to meet the challenges of growing more food in a sustainable way, we can build food security and also help our agricultural industry compete in the global race"

Leading British and Italian research centres and universities attended the event, alongside the European Commission (JRC and EFSA), UKTI, a visiting delegation from Columbia, and the Expo Scientific Committee. Also in attendance were a BIS/UKTI funded UK-Turkey Agri-Tech delegation, visiting the Expo and aiming to forge UK-Turkey Agri-Tech collaborations as part of the UK-Turkey Year of Science and Innovation.

... World-leading UK Agri-Tech research institutions ...

The day was rounded off with Met Office-led sessions on the 'Human Dynamics of Climate Change'. These aimed to illustrate some of the impacts of climate and population change in the context of a globalised world using an interactive map. An exhibition was set up under the bee-hive shaped UK Pavilion and proved very popular: there was strong and sustained public engagement with hundreds of visitors watching the videos explaining the climate change in the "seminar suite" of the Pavilion.

... the UK has pioneered developments in the livestock sector for centuries. ...

The UK is home to world-class agricultural research in areas such as plant and animal breeding, remote sensing, meteorological prediction and data exploitation. From genetics to grazing, the UK has pioneered developments in the livestock sector for centuries. The challenge now is to continue to provide safe, nutritious food that is affordable and accessible to all. The UK's Agri-Tech strengths should help us to ensure better crop productivity and yields, with reduced input and environmental impact. World-leading UK Agri-Tech research institutions, innovative farmers and food manufacturers came to Milan to attend the Agri-Tech GREAT Week and the "Food and the Future" seminar, helping the UK to address the global challenge of feeding the planet.

The "Food and the Future" event was financed by BIS through its Global Partnership Fund and is part of the "Grown in Britain" SIN Programme which aims at maximising the international Science and Innovation opportunities linked to the World Expo Milan 2015.

The Science and Innovation Network (SIN) is funded by the UK Foreign and Commonwealth Office (FCO) and Department for Business, Innovation and Skills (BIS). SIN has nearly 90 officers in 28 countries around the world, working across the entire UK science and innovation landscape to deliver international collaborations in science and innovation. SIN aims to ensure UK researchers have the opportunity to work with the best in the world, to use the best facilities, to leverage research and innovation funding and to ensure science and innovation supports UK growth through international outreach. These collaborations encourage new ideas, inform policy and help drive further innovation.

The exhibition set up in the UK Pavilion

THE UNIVERSITY OF NOTTINGHAM INSTITUTE FOR AEROSPACE TECHNOLOGY: Pioneering UK aerospace innovation & skills

Professor Hervé Morvan, Director of The University of Nottingham Institute for Aerospace Technology and the University Lead for the Aerospace & Transport Research Priority Area

The global aerospace market is buoyant. Over the next 20 years, the original equipment market is forecast to exceed $5trn globally, with services exceeding over $2trn. It is predicted that by 2033, 57,000 new fixed wing aircraft and 40,000 new helicopters will be required.

The UK is at the forefront of these developments and is home to the largest aerospace sector in Europe and the second largest in the world; employing more than 230,000 people across over 3000 companies, including Rolls-Royce, Airbus, Agusta Westland and GKN; and a vast network of small and medium size enterprises. It is a high value-added, research and development intensive sector, where investment has resulted in substantial benefits, anchoring outputs and jobs for decades to come.

Recent UK Government policy has sought to protect and develop the UK aerospace sector. In 2010 the Government, working closely with the UK aerospace industry, established the Aerospace Growth Partnership (AGP) as a way of tackling barriers to growth, boosting exports and increasing the number of high value jobs in the UK. In 2013, building on the success of the AGP, the Aerospace Technology Institute (ATI) was launched to sustain and grow the UK's internationally competitive aerospace sector through investment in technologies consistent with aircraft updates, new aircraft and the sector's strengths. The ATI has secured over £2.1bn in R&D funding to support the sector and, since its establishment, has funded in excess of 140 projects UK wide.

Aware of these opportunities in the UK and related opportunities in Europe, and building on a strong aerospace research heritage, The University of Nottingham established the Institute of Aerospace Technology (IAT) in 2009. The remit of the IAT is to integrate, develop and promote the University's substantial aerospace research portfolio, enabling the University to better support the sector by contributing to knowledge exchange and innovation and driving investment in key national infrastructure and skills development.

Since its establishment, the IAT has been instrumental in the growth of Nottingham's aerospace research portfolio from £35m in 2010 to over £75m in 2015 and has assisted in positioning Nottingham as one of the leading aerospace Universities in Europe, linking research excellence with innovative developments for industry. The IAT works closely with a range of national and international aerospace industry and research partners to address global challenges and drive the development of innovative technological research focused on underpinning technologies based around five key strategic areas:

The Aerospace Technology Centre on The University of Nottingham's Innovation Park.

- **Aero Engines and Propulsion**
  Researchers at Nottingham are carrying out cutting edge research to improve engine performance and efficiency. The University is home to two Rolls-Royce University Technology Centres and one of the UK's Synthetic Biology Research Centres which is carrying out innovative research into biofuels.
- **Aerospace Manufacturing**
  Nottingham has substantial expertise in aerospace manufacturing across a broad range of areas, including additive manufacturing, machining, process control and optimisation. The University is home to the Airbus Centre for Aerospace Manufacturing and two EPSRC Centres for Innovative Manufacturing in Composites and Additive Manufacturing. In addition, the University was also a founding partner of the Manufacturing Technology Centre (MTC).
- **Aerospace Materials and Structures**
  Scientists and engineers at Nottingham work closely with leading aerospace equipment manufacturers to develop and analyse next-generation materials designed to produce lighter, safer, more fuel efficient aircraft. The University is home to the EPSRC Nottingham

Nanotechnology and Nanoscience Centre (NNNC) and also a key member of the UK Research Centre in Non-Destructive Evaluation.

• Aerospace Operations

As the aviation industry grows, there are increased challenges around capacity, sustainability, passenger comfort, safety, supply chains and security. Nottingham is home to a range of high profile centres and institutes with a focus on addressing these challenges. These include: the Nottingham Geospatial Institute, the Nottingham Transportation Engineering Centre, the Centre for Risk and Reliability Engineering and the Automated Scheduling, Optimisation and Planning Research Group.

• More Electric Aircraft

The development of more electric aircraft is a key priority for the future of the aerospace sector. Home to the largest power electronics research group in the world and the George Green Institute for Electromagnetics Research, Nottingham is at the cutting edge of this, with internationally renowned expertise in power management, control and distribution, electrical machines and electromagnetic protection.

A Research Leader in Europe

Across these strategic areas, the University has been successful in securing funding for a suite of research projects. These include a number of projects funded through the EU's Clean Sky Joint Technology Initiative; a major European Aerospace Programme that brings together industry, academia and research centres to deliver next generation technologies for lowering pollution and safeguarding the leading position of the sector. The University of Nottingham was the only University to be awarded Associate Partner status in its own right in Clean Sky and is currently a Core Partner in the €4.2bn Clean Sky 2 programme. Through this funding, researchers from the University are working with a series of UK and European Aerospace companies to develop a range of exciting next generation technologies such as the Helicopter Electro Mechanical Actuation System (HEMAS, see image), Green Taxiing Motor and Electric Starter Generator Motor.

... researchers from the University are working with a series of UK and European Aerospace companies ...

Working with the ATI to Drive Forward Aerospace Research in the UK

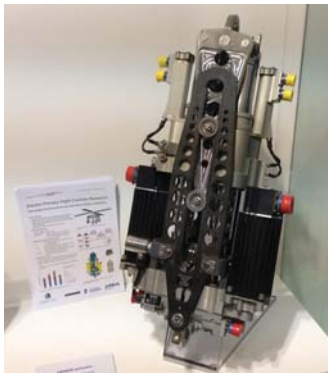
Nottingham's IAT has also secured substantial funding from the ATI. This includes infrastructure funding to establish a national transmissions testing facility to research and develop future aircraft large engine, rotorcraft, industrial and gas turbine transmissions. Through funding from the ATI, the IAT has also developed a series of collaborative projects and strategic partnerships with global aviation leaders such as Rolls-Royce.

Supporting and Working with SMEs

As well as working with leading national and international aerospace companies, the IAT is also committed to supporting Small and Medium-sized Enterprises (SMEs) and is a member of The University of Nottingham's Ingenuity Network. This extensive business support network is part funded by the European Union and aims to transfer knowledge and expertise from the University into local and regional small and medium sized businesses. The IAT has also worked closely with SMEs to facilitate access to UK and European aerospace research funding and was recently a partner in a successful funding proposal to the ATI with local SME Romax.

Leading Innovation

The Institute sits at the interface between university, industrial partners, government and funding bodies: acting as the bridge between academic excellence and industry, accelerating knowledge transfer and the exploitation of research, and supporting technological innovation for the sector. To assist in driving collaboration between academia and industry, the Institute has been successful in securing funding to facilitate the development of infrastructure and facilities. These include a £5.1m Aerospace Technology Centre (ATC), based on The University of Nottingham's Innovation Park. The ATC is a research and knowledge transfer hub, which provides state of the art facilities and support for the development of large scale demonstrations.



Electromechanical actuator for helicopters developed in partnership with Liebherr Group and Airbus Group Innovations on display on the Clean Sky booth at the Paris Airshow in June 2015

Improving Education & Skills

The IAT sees skills development as a key priority for the sector and will be supporting the launch of a new Aerospace Engineering undergraduate programme during 2016-17. The IAT is also home to the University's MSc Aerospace Technologies course and supports the recruitment of world-class students to the University's other undergraduate, postgraduate and CPD courses that have alignment with the aerospace industry. The Institute has also been successful in gaining funding from the European Commission's Marie Skłodowska-Curie actions to launch two multi-disciplinary PhD programmes: INNOVATE and INNOVATIVE, which collectively provide 37 PhD studentships related to aerospace research.

The IAT is also committed to developing and promoting inter-disciplinary aerospace research and is currently working to integrate its exciting research on aerospace with the innovative research taking place across the University on transport. In doing this, the IAT is working closely with groups such as the Impetus Partnership and the Transport Systems Catapult to share knowledge and develop collaborative projects across a newly created University Aerospace and Transport Research Priority Area.

Building on these strategic interventions, The University of Nottingham is advancing its position as one of the leading Aerospace Universities in Europe by continuing to develop its European and UK research portfolio and further expanding its portfolio of fundamental science research to ensure that the UK aerospace sector continues to push the boundaries in terms of research innovation.

For further information on the Institute of Aerospace Technology contact: IAT@nottingham.ac.uk

You can also visit: www.nottingham.ac.uk/aerospace or follow us on Twitter at: @UoNAerospace

FUTURE OF ROAD TRANSPORT

Meeting of the Parliamentary and Scientific Committee on Tuesday 16th June

ELECTRIC CARS

Lord Borwick
House of Lords

Cars represent freedom. You have the right to get into your car for any reason at any time and go where you want, subject only to cost. An electric car with no charge will take away that freedom from you, and many consumers will resent that.

So if we want to see our road network covered with electric cars, then we need further improvements in technology.

But the development of electric vehicles is nothing new. I was the Chief Executive of Manganese Bronze Holdings for 14 years, where we made London black cabs. We made the TX1 London taxi – the new standard London Taxi – diesel powered, with the idea of converting it to electric later.

The key to the success of the TX1 London Taxi was its wheelchair accessibility, but actually this provided space underneath the flat floor, needed for the wheelchair, for siting batteries. However, my first priority was to make the taxi drivers rich by making a great taxi, but what I did not focus on was that rich drivers would move out to the suburbs. The effect of this was that many drivers have a lot of dead mileage before they start earning their living in London, meaning a hybrid is a better solution for their vehicles' needs than a pure electric vehicle.

The Modec van, however, was a pure electric delivery vehicle with a two tonne load and a 100-mile range, which worked on the basis that there is no range anxiety among the delivery companies. FedEx and UPS were two of our biggest customers for the Modec van. They can plan their routes with great accuracy and so they know how many miles their drivers would be doing every day. UPS warned us that in America, driving on the right hand side, they would do ten times as many right hand turns as left hand turns and we should design the steering system accordingly. This of course had

Modec van in London ©Modec

When I sold out of that business in 2003 I started a new electric delivery vehicle business called Modec and I also become chairman of a battery company called Oxis.

an impact on the range of the vehicles.

This question of range anxiety for vehicles has a long history. Indeed, electric vehicles were far more common than petrol ones at the end of the 19th century. In 1905 if you compared the very common electric vehicles with the awkward and dirty petrol ones, the driver with the range anxiety would have been the man wanting to buy petrol.

At the start of the 20th century most people would have predicted that electric vehicles would be far more common than the internal combustion engine vehicles by the start of the 21st century. Petrol and diesel cars clearly took over for many decades but as politicians – and consumers – become more conscious of the environmental impact of the combustion engine, a lot of resources were ploughed into the development of a new wave of electric cars, including various types of hybrids.

The first effective one of these was the Toyota Prius, and the company made two brilliant moves when introducing this car which are lessons to remember. The first was to ensure that the vehicle had a different body shape so that it was distinctive; it enabled the driver to boast visually that he was doing something better – and possibly more virtuous – than other drivers. (Honda, on the other hand, made their first hybrid in the same body shell as their small saloon and consequently sold very few of them.) The lesson is that it is useless to be good unless everybody knows it – ask any two year old.

The second brilliant move by Toyota was ensuring that the Prius was allowed to travel in the car pool lanes on Californian freeways. A second hand Prius with one of these stickers on the window was worth about $2,000 more at five years old. Perhaps the lesson here in the UK is to allow electric cars into bus lanes.

To achieve success in the longer term, the electric car really has to beat normal petrol or diesel engine vehicles, so studying the competition is important. For instance, a feature of all internal combustion engines is their exhaust pipe, which are made as attractive as possible with chromium plating and placed low down at the back of the vehicle. This is the one point where the driver cannot see them, but that is the place where they feed their fumes into the faces of bicyclists and children on the pavement. Exhaust is, of course, poisonous, and this poison comes in many forms; no longer filled with lead, but it is the diesel particulates that we should worry about most.

... the electric car really has to beat normal petrol or diesel engine vehicles ...

Over the last ten years there has been constant and justified attention to carbon dioxide, but a single minded pressure on reducing CO_2 meant new cars used diesel. This then led to more particulates in the air.

... the future of electric vehicles depends on the future of batteries ...

As the efficiency of diesel engines improved, PM2.5s increased (particulate matter less than 2.5 microns in size) and only later did we discover that these particulates bypass the throat and go right down into the lungs where they can cause most damage. If somebody wants to clean up the air we could do worse than put the exhaust pipe at the front of the car, where the driver would see it and feel pressurised to do something about it.

The bottom line of the internal combustion engine is that it is very, very complex and has had millions of engineers working many hours to improve it. Each one may have many thousands of components. The electric motor would probably only have three components and not require any maintenance. So why has it not conquered the world? The answer is because petrol and diesel are very hard to beat. When you pour petrol into your car at the petrol pump you are transferring energy at a rate of about 30 megawatts. That means that a 20-pump petrol station beside the road has the power output of a modern nuclear power station. Electricity at 30 megawatts would need a 300 mm wide cable and be far more dangerous.

In the long term, the future of electric vehicles depends on the future of batteries. Right now, they come in two major types – the stationary and the moveable. The stationary batteries include pumped storage, the marvellous system we have in Dinorwig in North Wales. The obvious moveable battery is in your mobile phone. It is lithium ion, the major type of batteries developed in the UK in the late 1980s and early 1990s.

In the lithium ion battery, power density and energy density improved rapidly. But new technologies develop most quickly at the start of their lives, and the law of diminishing returns is now starting to apply. So we have to look at other chemistries to make our future electric vehicles. The two chemistries that immediately come to mind are lithium sulphide and lithium titanate.

There are five features of a battery that must be optimised. The first is the speed of discharge, essentially the power output of the battery. The second is the speed of the charge. The third feature is the number of charge cycles I can do. All the pure electric car companies have agreed that they need a minimum of 1,000 charge discharge cycles. The fourth feature is the temperature stability and how its performance varies in tropical or arctic conditions. The final feature to look at is how close to the capacity edges you can get without ruining the longevity of the battery.

Of course, all of this makes it harder to produce and test a new battery. If I were to invent brilliant new battery chemistry tomorrow, I cannot start selling it for at least three years. With pave testing, where you rattle the suspension of a car on a single mile of cobbles, this is equivalent to 100 miles of use. But nobody has yet developed a robust and accepted "accelerated cycling" test algorithm for batteries.

Having said all that, some great work has been done on lithium titanate and there are apparently several manufacturers prototyping vehicles with a 300 mile range, quite enough to abolish range anxiety and enable electric vehicles to take their place in the market.

But the rewards for whoever cracks it will be huge. Low speeds make an electric car the perfect car for a teenager or elderly driver. And for a teenager, the electric car is cool. It is new technology that can be marketed at an environmentally aware young audience – another piece of the latest kit to go with their smart phones and tablets. Electric cars will, in time, be the new vehicles of freedom.

AUTOMATED VEHICLES

Rob Wallis
Chief Executive, Transport Research Laboratory (TRL)

Professor Nick Reed
TRL Academy Director

INTRODUCTION

TRL, the UK's Transport Research Laboratory, was created in 1933, originally as part of UK Government, and privatised in 1996.

A world-leader in creating the future of transport, our heritage includes major contributions to the UK's transport infrastructure and international projects supporting established and emerging markets in developing transport solutions. Our in-depth sector experience provides the insight to recognise an approaching revolution in transport and mobility, driven by acceleration in the development of connected and automated vehicles and triggering safer, more efficient journeys but also dramatic, broader changes in the movement of people, goods and services with far-reaching implications.

REALISING THE VISION OF AUTOMATED VEHICLES

In 2010, Google announced that they had been testing self-driving cars on the road, gaining substantial media attention. TRL has been evaluating automated driving for many decades, starting in the 1950s with a 'self-steering' Standard Vanguard. TRL's system used two coils mounted symmetrically across the front bumper to detect offset of the vehicle from an electric cable buried in the centre of the lane under the road surface. This technology was adapted to a Citroën DS, Ford Cortina Mk II and even a Daimler single-decker bus. Coupled with a rudimentary cruise control system, these vehicles were able to drive themselves; initially around TRL's test track. Plans for on-road testing were ultimately still-born. Technology has progressed significantly. The implications for legislation, economic impact and driver behaviour have been researched by TRL in many dimensions.

In 2014, Innovate UK launched the 'Introducing Driverless Cars to UK Roads' competition. This was not in order to fund the development of new technologies, but to consider the wider implications of automated vehicle deployment. TRL's reputation for independent, trusted and technology-agnostic research allowed us to develop and lead the successfully funded GATEway (Greenwich Automated Transport Environment) project. GATEway includes eleven organisations, each bringing specialist knowledge and capability to the project. It is supported by an advisory group, chaired by Lord Borwick, and includes more than twenty organisations, each feeding diverse insights into study design and the interpretation of results.

GATEway has six primary aims:

1. Demonstrate automated vehicles safely and effectively in public environments.

2. Understand legal, societal and technical barriers to implementation.

3. Inspire industry, government and the wider public to engage with automated vehicles.

4. Generate valuable, exploitable knowledge of the systems required for effective management of automated transport.

5. Create a long-term test bed for future automated transport system evaluation.

6. Position UK plc at the forefront of global industry, encouraging inward investment and job creation.

In achieving these, the project must demonstrate and evaluate automated vehicles. This will be achieved in three public trials. Firstly, testing electric, driverless shuttles each capable of carrying up to 10 passengers and operating as a service on the Greenwich peninsula; secondly, automated valet parking to improve parking space and time efficiency and thirdly, the use of automated, low noise and zero emission vehicles for urban collection/delivery. Further, we will address cybersecurity issues and conduct off-street simulations and trials, gaining deeper knowledge about public perceptions, driver behaviour and attitudes towards automated vehicles.

CREATING FUTURE MOBILITY

Beyond the GATEway project, TRL worked with Ricardo on a feasibility study for the Department for Transport looking into platooning of trucks on highways, potentially leading to on-road trials. We are also researching the deployment of ultra-low-emission vehicles (ULEVs) where battery range remains a challenge. TRL is leading another consortium on behalf of Highways England to conduct a feasibility study into dynamic wireless power transfer. This concept would enable a vehicle to charge its batteries inductively while the vehicle is driving at motorway speeds, dramatically increasing vehicle range and the viability of large, commercial ULEVs.

Working with the European Commission, vehicle manufacturers and the automotive supply chain, we systematically reviewed more than fifty vehicle safety systems such as autonomous emergency braking, lane departure warning systems and alcohol ignition interlocks, providing evidence to support possible changes in legislation. We are also engaged in the push for harmonisation of safer urban cycling behaviours to help TfL drive the Mayor's vision to double cycling in London by 2020.

AN APPROACHING REVOLUTION

There are divergent expert opinions on how road transport will change in the next ten years, with new business models challenging the established mobility sector.

TRL Autonomous driving 1962

global crashworthiness standards, linked to our heritage in developing these standards over many decades and founding the EuroNCAP protocol in 1996.

Air quality has an increasingly high priority. TRL has pledged support to the United Nations-sponsored Urban Electric Mobility Initiative, which aims to achieve 30% of urban vehicles as ULEVs by 2030, with an anticipated multi-trillion dollar benefit to the global economy through reduced fuel costs and improved public health. A tangible example of where TRL is seeking to make an environmental difference in the UK is the integration of real-time air quality satellite data into our world-leading SCOOT traffic management and signal optimisation software, working with the University of Leicester, the European Space Agency, and relevant Local Authorities.

In the push for improved public health, we should not forget that walking and cycling have health benefits – automated vehicles should not discourage these activities. We have undertaken research into

Considering vehicle automation, will we see:

a) driver assistance systems evolve leading to a proliferation of partially automated vehicles, with a driver still present and no prospect of full automation for many years? Established vehicle manufacturers are pursuing this model.

b) or mass adoption of fully automated and driverless vehicles, especially in urban areas, bringing major market disruption by non-traditional players such as Google, Uber or Tesla? Mass changes in vehicle ownership models may influence public transport, deliveries and manufacturing with significant re-shaping of the employment market.

Considering ULEVs, will we see:

a) a revolution in propulsion – a breakthrough in battery technology or the development of practical fuel cell EVs enabling vehicle range that matches or exceeds that of vehicles with combustion engines.

b) improvements in battery technology while traditional combustion-engine vehicles remain dominant – driving the necessity for smart infrastructure, including fixed/dynamic wireless charging? Will businesses adopt automated ULEV vehicles, optimised for smooth and safe freight journeys through urban centres, using wireless power technologies?

These new emerging technologies create opportunities for the UK and for industry, but acceleration is required to remain relevant and competitive. The US provides examples:

... reduced fuel costs and improved public health ...

a) Uber emerged in five years to have millions of clients, operating in 300 cities globally. While their business model is causing friction in established markets, Uber is now investing in automated vehicles to enhance their service radically.

b) Google has been trialling its driverless cars for some time, with over 1.7 million miles covered on Californian public roads. This in itself is revolutionary but is just one dimension of profound advances in artificially intelligent system development.

c) Tesla is pushing electric car capabilities, investing heavily in battery technologies, including its planned 'Gigafactory' in Nevada. They will apply an over-the-air update to existing Tesla vehicles to enable automated driving on highways.

What are some inspiring implications of this revolution? A few observations:

1. The UK Driving Test is 80 years old; TRL plays a major role in its ongoing development. How will this evolve as vehicles become automated? Will it become obsolete?

2. Can roadside infrastructure be removed – supplanted by in-vehicle information displays and automated driving? Does the windscreen become a viewing gallery rather than giving the driver a critical view of the road ahead?

3. How will automated vehicles operate amongst manually driven vehicles? Will they act aggressively to optimise journey-time (for a fee?) or passively to maximise comfort and network efficiency? Will they exacerbate road rage?

4. Road vehicles are developed to withstand crashes (caused mostly by driver error). Reduced crash risk and differences in crash types might prompt a re-think into the design, materials, weight and cost of such vehicles.

5. How will technology developers make decisions about codifying driving style and ethics into software? How will automated vehicles make instant, safety critical decisions?

TRL actively supports the UK and industry to participate and shape this revolution in the global transport and mobility marketplace. It is pleasing to see further UK Government investment and related activity in vehicle automation and connectivity to support advances in journey safety and efficiency and stimulating a hugely significant market opportunity.

THE FUTURE OF ROADS AND CITIES

Steve Yianni
Chief Executive
Transport Systems Catapult

INTELLIGENT MOBILITY: AN ECONOMIC OPPORTUNITY

Britain has a long history of transport innovation: from the shipbuilders who paved the way for globalisation, to the railways that underpinned the industrial revolution. We pioneered the era of modern aviation, the airline industry, air traffic control and even the development of radar. Britain is still a world leader in transport innovation, and the Transport Systems Catapult is positioning the UK at the forefront of the next revolution in how we move people and goods around the world.

Encompassing everything from autonomous vehicles to seamless journey systems and multi-modal modelling software, Intelligent Mobility uses emerging technologies to enable the smarter, greener and more efficient movement of people and goods around the world. Intelligent Mobility is a fast growing sector with the global market estimated to be worth £900 billion a year by 2025.

The Transport Systems Catapult is helping the UK secure as much of this market as possible by supporting business, creating jobs and driving economic growth. With a clear emphasis on collaboration we are bringing together diverse organisations across different modes of transport, breaking down barriers and providing a unique platform for meeting the world's most pressing transport challenges.

The common goal is to develop future transport systems that will make;

- Travelling an end to end, user centric experience
- A positive impact on our carbon footprint
- Travel safer and quicker making assets more productive
- The UK generate a larger share of the economic opportunities available
- Our transport systems more resilient
- Improvements to mobility for all areas of society

Intelligent Mobility is about taking a different approach to the challenges that have traditionally beset the transport sector, whether it be congestion, pollution or the lack of "joined up" thinking between the different modes of transport. It goes further than that, however, by also helping the transport industry to address wider societal trends including a growing and ageing global population, climate change, the rapid depletion of our traditional energy resources, the shift away from personal cars to mobility as a service and increasing urbanisation.

In order to meet these challenges, Intelligent Mobility has to cut across and go beyond the traditional transport sector. Intelligent Mobility therefore focuses on new and emerging technologies that make it possible to achieve more for less.

SMART AS STANDARD

The business demand for co-location of like-minded organisations and people presents significant challenges for those in charge of city planning and infrastructure. Technological advances in areas such as augmented-reality and 3D printing could soon render some of our journeys and deliveries as unnecessary but the smooth movement of the growing numbers of people around the world's already congested cities won't be solved by technology alone. It is how we deploy technology that will determine which cities prevail. Transport should be regarded as a key enabler to cities becoming smart and by overcoming barriers such as business models and attitudes to change, we can start to unlock the potential of such technologies.

... shift away from personal cars ...

One example of this is how the Transport Systems Catapult is working collaboratively with Milton Keynes on these challenges. Whilst the city has experienced great economic success, the challenge of supporting sustainable growth without exceeding the capacity of the infrastructure, and ensuring achievement of key carbon reduction targets, is a major one.

To help address these challenges, the collaborative initiative MK:Smart (partly funded by HEFCE) is developing innovative solutions to support economic growth in Milton Keynes. Central to the project is the creation of a state-of-the-art 'MK Data Hub' which will support the acquisition and management of vast amounts of data relevant to city systems from a variety of data sources. These include data about energy and water consumption, transport usage, data acquired through satellite technology, social and economic datasets, and crowd-sourced data. Building on the capability provided by the MK Data Hub, the project will innovate in the areas of transport, energy and water management, tackling key demand issues. Similar projects are under way across the UK which collectively will start to unlock new business models and enable innovative technologies to emerge.

Many projects are informed by and feed into the Transport Systems Catapult's data visualisation programme, which by deploying and visualising data holds huge potential for Intelligent Mobility. This enhanced use of data is only possible because of the explosion in digital connectivity and as this paves the way for transport connectivity. The Transport Systems Catapult is unique in its approach, identifying the barriers that hold back modelling and visualisation true potential. High on its hit list is the 'silo approach', where key individuals, departments and organisations fail to share valuable information with each other, thus mitigating the potential of data modelling. By 2020, the market for data, modelling and analytical tools and techniques is set to grow to £60 billion from £15 billion in 2014. The market size, comprising modelling, simulation and augmented reality, is some £125 billion. The UK is an international leader and has a strong professional services industry. The Transport Systems Catapult's work is about equipping the industry to maintain this world leading status.

REALISING THE BENEFITS

As champions of Intelligent Mobility, the Transport Systems Catapult and its partners are taking advantage of developments in web connectivity, integrated systems, state of the art modelling and visualisation, and the emerging Internet of Things to change how we think about the movement of people and goods.

The LUTZ Pathfinder programme, managed by the Transport Systems Catapult on behalf of the UK Automotive Council, will trial three self-driving pods on the pavements of Milton Keynes, with a focus on 'last mile' journeys. The advent of autonomous vehicles is expected to change how we perceive car ownership. Instead of seeing the car as a status symbol, people are likely to regard it as an on-demand service which must accommodate our schedules in an efficient, safe and eco-friendly manner. If vehicles can be made to run entirely without human drivers, automation could also offer a new lease of mobility to those who cannot currently drive, whether on account of age, disability or simply because they do not own a car.

... Introducing Driverless Cars ...

Proof of the UK's willingness to invest in this area can be seen in the three projects exploring these technologies as part of the Government's 'Introducing Driverless Cars to UK Roads' competition announced in December 2014. These three programmes already represent a public private partnership investment of £40m. In March 2015, the Government announced the creation of a £200m investment (half financed by the State and half by industry) to enhance the development of driverless car technology and the systems required to improve and adopt the technology.

Connected cars also take away the element of human fallibility, which is estimated to be at least partly responsible for more than 90 per cent of road traffic accidents. A study from KPMG, commissioned by The Society of Motor Manufacturers and Traders predicted that connected and autonomous vehicles would save over 2,500 lives annually and prevent more than 25,000 serious accidents in the UK alone.

... save over 2,500 lives annually ...

Studies undertaken by the Department of Transport highlight a significant reduction in the number of 17 to 20 year olds obtaining a driving licence with data showing a peak at 48% in 1993 and a steady fall to 31% by 2011. The data for 21 to 29 year olds is a similar proportion from 75% to 63% over the same period. The growing popularity of usage rather than ownership will see new business models begin to emerge, with the diversification of the traditional car manufacturer potentially moving towards the operation of models such as fleet management of autonomous vehicles and car sharing clubs.

Recent improvements in route planning software that consider multiple transport modes is an example of the first steps being taken towards overcoming some of the challenges to mobility becoming a service, but there is still a long way to go. Part of our remit at the Transport Systems Catapult is to overcome the silo thinking that has typically dogged the transport sector and encourage collaboration among all transport providers and modes.

As we progress closer to Intelligent Mobility, the benefits will become increasingly clear. Reduced congestion, fewer car related deaths, an easing pressure on our natural resources and more flexible journeys to name a few. A myriad of opportunities are there to overcome some of the barriers and challenges that stand in the way and the Transport Systems Catapult looks forward to helping technology and society to catch up.

THE BIG DATA OPPORTUNITY

Hetan Shah
Executive Director, the Royal Statistical Society
@HetanShah

What steam was to the 19th century, and oil has been to the 20th, data are to the 21st. They are the driver of prosperity, the revolutionary resource that is transforming the nature of social and economic activity, the capability that differentiates successful from unsuccessful societies.

There is considerable interest in data and how they can improve policy, prosperity and even our democracy. There is particular talk of 'big data'. It is a term that is not well defined – perhaps better seen as 'mood word' which indicates the ubiquity of data and our growing interest in them. Big data hints at the rise of digital data which come from our phones, our supermarket purchases, and soon (with the emergence of the internet of things) our fridges and other household devices. We know we are in an era of big data through the explosion of data visualisation; the increased linking of datasets, interest in new types of data such as digital or administrative data; the rise of new ways of analysing data such as machine learning; and technological change which means we can gather and store more data than we ever dreamt possible.

... the driver of prosperity ...

The opportunities from greater usage of data for better policy are limitless. In health we will see the rise of personalised medicines, as well as improved methodologies for clinical trials. Better local data could lead to 'smarter cities' which can monitor transport needs or improve energy usage through real time data. The Foreign Office is already experimenting with analysis of social media data to find key influencers who can act as bridges between communities in troubled hotspots. The Office for National Statistics is trialling how to use administrative data (the data we give to government for other non statistical purposes – eg applying for a driving licence) to supplement and perhaps even supplant the traditional decennial census in order to provide more real time information about the society we live in.

TAKING DATA SERIOUSLY IN POLICY

To make the most of the big data opportunity, evidence must be taken more seriously in policy formulation and evaluation. Making policy when resources are tight is difficult but decision makers should take into account the probable quantified consequences of alternatives.

The Government has made welcome investment into the 'What Works' centres, which link academics with policymakers to cast evidential light on key issues. The Behavioural Insights Team or 'nudge unit' has focused on the small changes that can make a big difference, such as what letter wording from the tax man leads to more people paying their taxes. To build on this, Government should publish the data and evidence that underpin any new policies it announces, and should also commit to regular and long term evaluation of policies. Where we lack the data to inform choices between options in important policy areas, we should invest in getting it.

DATA SHARING

Greater data sharing between government departments for statistics and research purposes would provide opportunities for a range of public services and policy areas ranging from 'smart cities' to better healthcare. One option would be to follow the Canadian model and allow the Office for National Statistics access for statistical purposes to all major public and private sector datasets – which are already regulated and controlled – to focus not on us as individuals, but on how society is changing as a whole. Increasingly important data are held by the private sector – eg think of what aggregating everyone's mobile phone data or supermarket loyalty card data could help tell us about our society's lifestyle, movements, dietary habits etc. These new data sources can provide more real time evidence than was previously possible. Our research[1] with Ipsos MORI suggests that the public supports data sharing if it is done for the public good by organisations

... Government should publish the data and evidence that underpin any new policies ...

trusted to safeguard privacy and confidentiality. Safeguards should be built into any sharing of personal data at the outset including anonymisation of the data (as far as is possible), legal penalties for misuse, access only to accredited researchers where appropriate, and gate-keeping access to big linked data sets so that personal identities are protected, as in the UK's Administrative Data Research Centres. There needs to be more detailed reporting of cases where personal data is shared with companies, as this is the area on which the public most want reassurance.

OPEN DATA

We can also make considerable gains through the 'open data' agenda which seeks to make data more open, accessible and reusable. The best known examples come from transport data – for example, Transport for London has made its transport data open, and as a result companies have made apps which tell you when your next bus is due. As well as making society more convenient, this is economically productive as it reduces time that might otherwise be wasted. Open data can be a rich source of innovation at relatively little cost – particularly if it is effectively marked with standard codes for geography, time and other attributes. Geospatial data such as postcode address files are the core reference data upon which society depends, and also act as a catalyst to release economic value from other open datasets. Government has made some progress in this area but can do more to open these up. And in future if public entities are privatised, their underlying data should not be lost to the public good which is sadly what happened to the Royal Mail's Postcode Address File.

PRIVATE SECTOR DATA

The private sector has an important role to play in sharing and opening their data. Companies should be encouraged to share data with researchers for research purposes, to share the data they hold about individuals with those individuals, and to publish open data for everyone, for the public good. More and more important data is being held by private companies and much of them are not commercially sensitive. If they were released as open data we would know more about the country we live in – eg the location of supermarkets, ATMs, post boxes and water company boundaries. I would also like to see the rigour shown around official statistics in the public sector, and financial statements in the private sector, extended to other crucial information sources, such as the clinical trials reported by pharmaceutical companies. And as we move to a wider range of public service providers, schools and hospitals and other public services provided by private providers should adhere to the same data standards and transparency as those in the public sector, so that we are able to monitor services across the board.

... important data are held by the private sector ...

... Open data can be a rich source of innovation at relatively little cost ...

SKILLS FOR THE DATA ECONOMY

To prepare for the increasing 'data economy' that we inhabit we need to skill up the nation. More and more people – eg teachers, nurses, will have to handle data to do their jobs. But as a nation we don't have the skills. Our research[2] in association with Nesta and Creative Skillset supports that skills shortages are a pressing issue for the UK's data industries. In part this will need to be addressed in our education system. We should ensure that all young people learn to handle and interpret real data using technology, and should train teachers from primary school through to university lecturers to encourage data literacy from an early age. Basic data handling and quantitative skills should be an integral part of the taught curriculum across most A level subjects. The Nuffield Foundation found in 2010 that across 24 countries, England, Wales and Northern Ireland had the lowest level of participation in the study of any kind of mathematics post-16. This has a severe impact on higher education and employment. Recent rises in A Level Mathematics participation are welcome, but wider improvements are needed. We should also put resources into making sure that new A levels and AS levels, as well as new Core Maths qualifications for those who do not wish to take A level mathematics, deliver appropriate statistical skills.

As well as improving everyone's skills to a basic level, we need to ensure we have the higher level skills for data analysis that will give our top companies and universities the edge that they need. As a recent report[3] by Nesta and Universities UK indicated, to achieve this Research Councils UK probably needs to take a cross-cutting interest in data analytics so that action on this issue is properly co-ordinated. We also have to ensure an appropriate balance between capital and revenue spending on science – big data is not just about high powered computers, but highly skilled analysts who can understand the data. And we have to ensure that all universities retain their data analytics capabilities. It is good to see the new Alan Turing Institute as a home for data science, but for good science all universities need to retain a strong data analytics and statistical unit, both for the strength of UK innovation in this field, and as a service to support other scientific disciplines. Otherwise we will continue to hear about the 'reproducibility crisis' where advances in our science and research base are too limited due to a lack of collaboration on the underlying data.

... skills shortages are a pressing issue for the UK's data industries ...

There is also a wide range of public service professions for which data skills are increasingly important, including in government. Politicians, policymakers and other professionals in the public sector should be given basic training in data handling and statistics. To address these needs and following our pre-election 'Parliament Counts' campaign, the Royal Statistical Society is glad to offer workshops for MPs and their staff on basic statistical concepts.

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2 http://www.statslife.org.uk/files/model-workers-report.pdf

3 http://www.nesta.org.uk/publications/analytic-britain-securing-right-skills-data-driven-economy

BIG DATA IN NEUROSCIENCE:

Improving efficiency, efficacy, and transparency in clinical and basic research

Professor Mark Stokes
Head of Attention Group, Oxford Centre for Human Brain Activity, Department of Psychiatry, University of Oxford

Nicholas Myers
Research Associate, St John's College, Oxford University

We have entered the Age of Big Data. Every day, the world generates over two exabytes of information (that's two million 1-TB hard drives, or a video in DVD quality that runs for 100,000 years[1]). From online marketing to particle physics, scientific as well as economic progress critically depends on aggregating, and understanding, *Big Data*. The same is true for the burgeoning field of neuroscience. Understanding how the brain works is without doubt one of the most complex challenges facing science today. Thousands of laboratories around the world are pushing the boundaries of this exciting frontier, generating vast amounts of valuable information each year. While the 20th century was marked by ever-improving techniques for measuring the brain, the next big leap in neuroscience will be driven by improved methods for aggregating, sharing, and understanding Big Data. Such a collective endeavour will depend on the support of science funders, who will need to encourage and reward researchers who share their data openly. Success in this new era of neuroscience will have implications for understanding and treating brain-related disorders, from autism to Alzheimer's disease.

... Understanding how the brain works...

What does big data in neuroscience look like? Frequently, it consists of vast archives of brain images from healthy volunteers and/or patients with neurological or psychiatric disorders. Data banks also exist for maps of brain activity patterns, collected across dozens of facilities and hundreds of individual brains using non-invasive functional imaging (eg functional magnetic resonance imaging: *fMRI*). However, arguably the most valuable data to neuroscience come from individual brain cells that can only be recorded during rare neurosurgical procedures, or in research animals. Individual labs lack the resources to generate enough of this kind of data for rigorous scientific analysis. The full potential of such information can only be realised by sharing research output across labs and between institutes. A recent example is a project that provides anonymized brain scans from over 500 volunteers with autism[2]. Compared to individual studies (which would typically test only 20 to 30 individuals), this database allows fine-grained research at an unprecedented scale that could never be reached without data sharing. Aggregating data therefore promises benefits beyond its constituent parts.

... reward researchers who share their data ...

A major advantage is that large sample sizes make discovery easier. The evidence is simply clearer for generating robust conclusions. For instance, studies scanning the human genome for variations that increase the risk of Alzheimer's disease already involve thousands of individuals. Similarly, the compilation of brain scans from patients with Alzheimer's disease into an openly accessible database has spurred a wealth of discovery (over 400 research articles have made use of the database[3]). However, data sharing is equally important for basic research, where small sample sizes still pose a fundamental problem[4]. More refined theories of brain function will require validation on larger amounts of data. As with the self-correcting nature of websites like Wikipedia, openness inherent to the collective process will also help eliminate errors that inevitably creep into the scientific literature, and will help prevent outright fraud. By increasing the reliability of published research, data sharing can increase trust and reduce wasteful follow-up studies that are based on false leads.

Furthermore, by making data available online, funders of research can save money that would otherwise be spent collecting redundant data. One neuroscience sharing platform alone is estimated to have saved funders 35 million $US (over 166 studies that used their shared data[5]). In addition to saving money, data sharing also democratizes the business

of doing science: valuable resources are no longer under lock and key, but can be accessed by researchers, laboratories, or countries that could otherwise not afford to test their theories. The diversity of a broader collective of scientific minds could help us find new directions and ways of thinking.

... Animal models make a unique and irreplaceable contribution ...

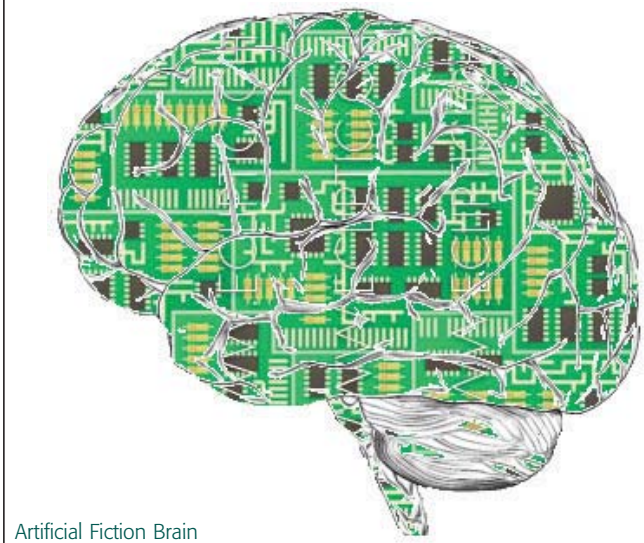
There is also an additional ethical dimension when considering data acquired from experimental animals. Animal models make a unique and irreplaceable contribution to neuroscience, but we have a greater responsibility to share these data, because their maximal re-use will increase the value of each animal life that is lost in the name of science[6]. Secure storage and accessibility of animal data will ensure that they not fall victim to the otherwise inevitable loss of data over time.

Given these benefits, it may be surprising that the majority of data in biology, and in neuroscience in particular, are not shared publicly. Data sharing

... Who owns the data ...

platforms are still the exception to the rule, and only cover particular areas (such as Alzheimer's disease). There is a number of hurdles holding back data sharing in the mainstream.

Privacy is an issue for human studies. Often there is no explicit consent from participants to share data, and obtaining consent retroactively is not feasible. Moreover, while databases typically strip scans of any information that links them with an individual, there is no guarantee that they could not be identified in the future by comparison with other publicly available data. Furthermore, group identification is possible even with anonymized data, and could lead to group discrimination based on shared neurological properties[7]. Future studies must consider ethical solutions that are pragmatic but respect individual privacy rights. One solution is to appoint a *data steward*. This custodian would be entrusted with the shared data, and grant access to it on a case-by-case basis, ensuring that data are not mined excessively or for nefarious reasons, and that they remain as anonymous as possible.



Artificial Fiction Brain

A bigger challenge may be changing the mind-set of researchers to adopt a culture of open data. At the moment, many researchers mistrust others' use of their data, and suspect that a researcher who was not involved in the initial measurements might not know how to analyse their data correctly[8]. This issue cannot be resolved over night, but once again, trained stewards could help build trust in appropriate use. For instance, they could track who accesses the shared data, and for what purpose, but also act as a consultant on correct and incorrect uses of particular data sets.

There is a related issue of intellectual property. Who owns the data, and the discoveries that arise from them? Data generators currently lack an incentive to share: as long as their valuable data are kept private, they keep exclusive access without fear of another lab publishing similar results first. In a system that rewards novel discoveries, not data sharing, it is not surprising that some researchers feel reluctant to change their ways. This problem has been recognized by funders[9], and incentives for data sharing have appeared (such as specialized data publications that can be cited by users). However,

... group discrimination based on shared neurological properties ...

these incentives are so new that they lack an agreed-upon value (and don't ensure tenure or further grants). Moreover, universities can also raise issues of intellectual property, especially when financial rewards from the translation of basic research findings into drugs or therapies are at stake[10]. How future benefits from shared data are awarded to all data generators is in urgent need of discussion.

Funding in neuroscience needs to start taking a Big Data perspective. Breaking up funds into too many small projects, without a strategy to aggregate those data sets properly and make them accessible, is wasteful and will slow down scientific discovery. By appointing stewards to coordinate and encourage data sharing, and by explicitly rewarding individual researchers and departments for sharing, funders and public policy can help effect a cultural shift in neuroscience, creating an open research community that is more than the sum of its parts.

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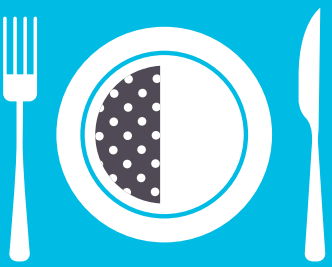
UNIVERSITY OF BIRMINGHAM

THE COLD TIME BOMB

UP TO 50% OF GLOBAL FOOD IS WASTED BECAUSE FOOD PERISHES WHILE 1 IN 8 GO HUNGRY



GLOBAL URBAN POPULATION WILL GROW TO 6 BILLION BY 2050

AIR POLLUTION CURRENTLY CAUSES 1.2 MILLION PREMATURE DEATHS IN CHINA EACH YEAR AND 600,000 IN INDIA

DEMAND FOR COOLING IN ALL ITS FORMS IS ACCELERATING. THESE ARE THE PROBLEMS, WE HAVE THE SUSTAINABLE SOLUTIONS... WWW.BIRMINGHAM.AC.UK/DOINGCOLDSMARTER

TIME TO RETHINK COLD ENERGY

BIRMINGHAM ENERGY INSTITUTE

BIRMINGHAM POLICY COMMISSIONS

THE COLD TIME BOMB

Professor Martin Freer
Director, Birmingham Energy Institute

Professor Toby Peters
Visiting Professor of Power and Cold Economy at the University of Birmingham and CEO of the Dearman Engine Company

800 million people in the world are under nourished and the UN Food and Agriculture Organization estimates that by 2050 feeding the global population will require a 70% increase in food production.

The supply chain is under pressure. Currently up to 50% of food perishes or is thrown away, when it could be used to feed the one in eight going to bed hungry every night. In emerging and developing economies, this is largely because produce cannot be kept at sufficient temperature en route to market.

From field to fork, the cold chain – the movement of fruit, vegetables and meat via a 'chain' of refrigerated transport and storage – is extensive and complex. The journey is problematic and fleets are challenged, particularly in developing countries where reaching rural communities without adequate infrastructure is complicated.

Closer to home, the increase in 'doorstep delivery' services has extended the chain and seen a surge in smaller refrigerated transport vehicles and cold storage facilities.

The provision of cold energy, or cooling, is integral to modern society; without it, the supply of medicine and data, as well as food, would simply break down. It is also essential to domestic and retail comfort through air conditioning solutions and modern server space for rapid and widespread internet provision.

A rapid growth in new middle classes across the world, including an anticipated increase to 3 billion in Asia in the next five years, means the demand for cold energy to provide the luxury comforts of air conditioning, modern technology and healthcare is soaring, from Starbucks to the latest Apple i-product.

If this ever-increasing need is met using existing fossil fuelled technologies then that would add to the pressure upon the environment, both adding to dangerous air pollution and contributing to climate change.

HEATING THE PLANET

The rapid growth in urban populations is having a dramatically worsening impact on the environment. As urban populations grow and people become more affluent, so their patterns of consumption change and their demand for cold in particular will increase.

This has the potential to have a very significant impact upon the local environment and upon climate change. The energy required to deliver cooling is significant and highly polluting. If refrigerant usage trends continue, for example, Hydrofluorocarbons (HFCs) will be responsible for nearly half of all global greenhouse gas emissions by 2050.

Furthermore, an estimated 200 million tonnes of perishable food is wasted in developing countries each year, the production for which contributes around 3.3 billion tonnes of carbon emissions. The delivery vehicles and storage facilities are also significant polluters with refrigeration units consuming up to 20% of a refrigerated vehicle's diesel but emitting up to six times as much Nitrogen oxides (NO and NO_2) as a modern truck engine.

While ambitious targets to reduce carbon emissions by 80% in the UK and the new US Climate Change plan announced by President Obama earlier this year show that developed countries are taking sustainability seriously, statistics around cold show this area cannot be ignored.

OUT OF CONTROL

The need for cooling provision in many forms will rise with the growth of global populations and the escalating demands of the new middle classes.

70% of food consumed in the UK is chilled or frozen to store and the demand for commodities is expected to rise by around 30% over the coming decade. Food security is a problem in the developing world now but if cold is not addressed properly the food crisis will come to Britain's door too. This puts huge pressure on energy provision and could have ruinous effects on the environment.

AIR POLLUTION CURRENTLY CAUSES 1.2 MILLION PREMATURE DEATHS IN CHINA EACH YEAR AND 600,000 IN INDIA

While current technologies are capable of improving the cold chain and overcoming some of the challenges, the environmental impact would be severe. Air pollution currently causes nearly 1.2 million premature deaths in China and 600,000 in India. The impacts of climate change are familiar but the role of cold and cooling is, as yet, still ignored.

A COLD ECONOMY

Experts at the University of Birmingham say addressing cold demand and energy consumption is essential to delivering on carbon reduction targets and planning energy systems for the future.

Furthermore they have recognised that the process of 'doing cold smarter', including providing new clean cold technologies and providing the expertise required to integrate them could lead to the foundation of a 'cold economy'. The UK has a unique opportunity to lead this emerging global sector.

The Cold Economy has the potential to include far more than just a collection of energy efficient technologies. Importantly, it could involve a systems analysis and cover many aspects of efficiency, including the recycling of waste cold and utilisation of 'wrong time' energy – such as excess wind power generated at night when demand is low – to provide, through novel forms of energy storage and low-carbon, zero-emission cooling and power.

Professor Martin Freer, Director of the Birmingham Energy Institute, said: *'A systems approach to energy that looks at integrating the different aspects of generation, storage and use is vital to future-proofing our lifestyles – from food to data and modern technology.'*

New technologies for sustainable cooling, including alternatives to refrigerators, delivery vehicles and storage options are gaining traction with a number of SMEs developing innovative new products and prototypes. For example, creative entrepreneurs are pioneering new technology for utilising the most simple power of water for cooling with extensive medical, food and domestic applications as well as the properties of liquid air to pave the way for zero-emission transport refrigeration and other liquid coolants which could revolutionise data cooling.

Professor Freer said: *'The UK has enormous talent and expertise in energy solutions manufacturing and technology innovation but it is being stifled. We can achieve the country's ambitious carbon reduction targets but only if we invest in these sustainable innovations – the government must take cold seriously instead of focusing solely on heating.*

'There is significant opportunity for the UK to grow new business and generate jobs but time is ticking and if we don't act now, economic giants such as China and India will get there before us.'

SOLUTIONS

A policy commission titled 'Doing Cold Smarter' led by the Birmingham Energy Institute at the University of Birmingham and independently chaired by Lord Teverson, Liberal Democrat Spokesperson for Transport and former Member of the European Parliament, was launched earlier this year to produce a roadmap for the UK to navigate the complexity of cold energy provision and provide direction for investment in sustainable solutions. The commission, which is made up of academic researchers and industry experts, is researching new ways of providing cold in a sustainable way, specifically through a system level approach, as well as exploring the economic opportunities this new clean cold industry could present.

This commission will also demonstrate ways the UK could become a global leader in the development of new cold energy systems and the technical, economic, research and skills issues around 'cold'.

Lord Teverson said: *'Cold is a vital part of energy policy for the future, but has been little explored. The demand for cooling is rising globally, and if we fill this urgent need with existing technologies it would have a detrimental effect, not only on the environment, but also for our energy supply.*

'There's significant opportunity in the UK to develop a new economic hub of innovative manufacturing and technology, as well as positioning ourselves as leaders in this field on the world stage. This will generate jobs and important economic benefits for our country as well as essential carbon reductions.'

The global energy storage market is set to grow by 8% per annum, rising to be worth £35 billion by 2020. For cooling and refrigeration this means £14.6 billion. Anticipated growth of the global energy demand over the next 25 years presents significant opportunity for innovation in the field and export of technology and knowledge.

Around 14% (almost £5.2billion each year) of Britain's electricity goes to cooling, yet compared with transport and heat, cold and cooling has received little attention in the international energy debate.

Toby Peters, Visiting Professor of Power and Cold Economy at the University of Birmingham and CEO of the Dearman Engine Company said: *'The next 10 years of development in the reconfiguration of the UK's energy landscape and the rapid building out of the energy infrastructure in emerging markets requires an accelerated adoption of a variety of novel energy technologies. These technologies will be a radical departure from the traditional methodologies and could provide sustainable solutions to cooling. There is an exciting opportunity for the UK to embrace these new business and export opportunities spurring innovation and generating tens of thousands of jobs.'*

With urban populations growing at pace and the increased demands of new middle classes for energy intensive luxuries, this is a critical time for transformation of the global energy system. Time is running out for changing the course of food security and environmental crises, as well as the UK opportunity to boost economic growth in this area.

28 OCTOBER 2015

The commission will report on its findings at a launch event on 28 October 2015 and present a roadmap for policy. For further information about the commission and to get involved, visit www.birmingham.ac.uk/doingcoldsmarter

PARLIAMENTARY LINKS DAY 2015
SCIENCE AND THE NEW PARLIAMENT

The Attlee Suite was once again filled to capacity with MPs, Peers, scientists and engineers – it was standing room only from the very start – for this year's Parliamentary Links Day at the House of Commons on the theme of *Science and the New Parliament*.

There was a stellar array of speakers and for connoisseurs of *Twitter* this year's #LinksDay2015 was *trending* by 10.30am and reached #5 – a new record!

The Speaker of the House Rt Hon John Bercow MP – a steadfast supporter of science during his Speakership – launched the event as he had done throughout the last Parliament.

Links Day remains the largest annual science event of its kind on the Parliamentary calendar and this year was sponsored on a bipartisan basis by the newly-elected Chair of the Parliamentary and Scientific Committee Stephen Metcalfe MP and Shadow Minister Chi Onwurah MP (whom the Speaker later allowed to put

"I would like to congratulate the (Royal) Society of Biology for its vision in organising this event which I know has long been an established fixture in the annual Parliamentary calendar."

Rt Hon David Cameron MP
Prime Minister

"The Society is to be congratulated for its initiative and leadership in organising today's event on behalf of the wider science and engineering community"

Rt Hon John Bercow MP, Speaker of the House of Commons

Links Day into the *Hansard* record on the floor of the House).

Organised by the Royal Society of Biology on behalf of the science and engineering community Links Day promotes links and understanding between the worlds of Science, Parliament and Government.

This year's format included a mixture of keynote speeches and panel discussions. The speakers explored the importance of effectively engaging Parliament and Government and concentrated on the value of Science in both a national and international context.

The political contributions to Links Day were made by Jo Johnson MP, the newly-appointed Minister for Universities and Science, Nicola Blackwood MP, the newly-elected Chair of the House of Commons Science & Technology Select Committee, and by the Earl of Selborne, Chair of the House of Lords Select Committee on Science and Technology.

In his Keynote address the Minister of State for Universities and Science, Jo Johnson MP, said that developing collaboration between academia and business will be among his main priorities during this Parliament.

The Minister addressed over 200 MPs and representatives from the science community and, in one of his first appearances since being appointed to the role in May, Johnson admitted that he was 'no science buff at school' but had been 'putting in the hard yards' to visit the UK's wealth of

"Many of the key global issues that we face – whether they involve Health, Global Climate Change, Food Security, the Environment or Access to Water – have a scientific aspect to them. None can be addressed or solved without scientific advice."

Rt Hon Harriet Harman MP
Leader of the Opposition

A SELECTION OF TWEETS CAPTURED ON THE STORIFY ABOUT LINKS DAY

BSI Resources Parliamentary Links - British Society for Immunology

The Society of Biology demonstrated its heft in bringing together a heavyweight set of panellists and speakers for this latest Parliamentary Links Day

Joanna Barstow @DrJoVian
Innovate or regress - Speaker of the House supporting development of science facilities in schools #LinksDay2015

BES Policy Team @BESPolicy
A new Parliament offers new opportunities...exciting time for the scientific community says Stephen Metcalfe MP #LinksDay2015

Jenna Stevens-Smith @J_DoubleS
Great to hear @ChiOnwurah address #linksday2015 a female engineer on #NWED #womeninengineering

CaSE @sciencecampaign
"I welcome the strong cross-party commitment to science" says @JoJohnsonMP #linksday2015

RSB @RoyalSocBio
.@JoJohnsonMP 'We want to make Britain the best place in the world to do science' #LinksDay2015

Jane MacArthur @Jane_MacArthur
"Chinese science spending is overtaking European science spending, likely to overtake US spending in 2019." @LiamByrneMP #LinksDay2015

science and engineering centres and get to grips with his brief.

He welcomed the fact that there was strong cross party consensus for investment in science and said that science ran through the Conservative party's manifesto – which he helped to write – 'like through a stick of rock'.

The Minister reiterated the Government's commitment to investing £6.9bn in science infrastructure capital by 2020/21, and set out three 'themes' that he said will be priorities for his Department. These include the acceleration of collaboration between universities and businesses, 'making the most' of the UK's scientific expertise and output, and ensuring the UK nurtures the best scientific talent in the world and continues to inspire others into science and engineering careers.

> **"Arriving at the Links Day, I was immediately struck by how well attended the event was by both scientists and parliamentarians… Parliamentary Links Day was filled with inspirational speeches that instilled hope in the future of science in the UK.""**
>
> Arikana Massiah, Society Champion and pre-registration Clinical Microbiologist at Barts Health NHS Trust

> **"This House congratulates the (Royal) Society of Biology…. and welcomes the continuing contribution that Parliamentary Links Day makes to strengthening the dialogue between Parliament and the science and engineering community."**
>
> Early Day Motion 141
> Tabled 17 June 2015

The Panels were both chaired by Stephen Metcalfe MP and they discussed the national and international value of science to the UK. These debates (and across Twitter) were lively question and answer sessions.

The contributors on the first Panel were Rt Hon Liam Byrne MP (Shadow Science Minister), Naomi Weir (Acting Director of the Campaign for Science & Engineering), Clare Viney from the Royal Society of Chemistry, Sarah Hartwell-Naguib (Head of the Science and Environment Section, House of Commons Library) and Dr Luke Alphey of the Pirbright Institute.

The contributors on Stephen Metcalfe's second Panel were Dame Jocelyn Bell Burnell (President of the Royal Society of Edinburgh), Dr James Larkin (Royal Marsden Hospital), Dr Hetan Shah (CEO of the Royal Statistical Society), Dr Chris Tyler (Director of the Parliamentary Office of Science and Technology) and Chris Whitty (Chief Scientific Adviser at the Department for International Development).

Sir Venki Ramakrishnan FRS, Nobel Laureate and incoming President of the Royal Society, gave the closing speech at the event. He addressed several issues that hinder growth in science and engineering but at the same time acknowledged the achievements that UK research has made and called for improved immigration and

education policies that would encourage an influx of scientists into the country. Sir Venki highlighted how science is crucial to maintain the advanced society status that Great Britain has, enabling us to help not just ourselves, but other citizens of the world too. This advancement is, however, limited by the salary element of the UK immigration system, and the turmoil in the EU that may discriminate against overseas research scientists.

This year's Links Day made another welcome and unique contribution to the debate about the role of science and well and truly launched Science in the New Parliament.

Further details about Parliamentary Links Day are available at: http://blog.rsb.org.uk/links-day-2015-keynote-speakers/

LIGHT

British Science Week Seminar on Thursday 19th March

Professor Sir Colin Humphreys
Department of Materials Science and Metallurgy
University of Cambridge

Gallium nitride for saving lives, energy, carbon emissions and money!

SUMMARY

Gallium nitride and its alloys make up an amazing family of new materials which could save 25% of all the electricity we use and 25% of carbon emissions from power stations. This is not scientific hype: it is already starting to happen. Gallium nitride also has the potential to provide clean water, saving millions of lives in the developing world, and to enable totally secure communications. In addition, optimized gallium nitride Light Emitting Diodes (LEDs) will increase productivity at work and performance in schools, and improve the health of us all. Finally, our gallium nitride research is already being exploited in the UK where Plessey is manufacturing LEDs and creating jobs in Plymouth, an unemployment black spot. The UK is at the forefront of this outstanding developing technology.

WHAT IS GALLIUM NITRIDE?

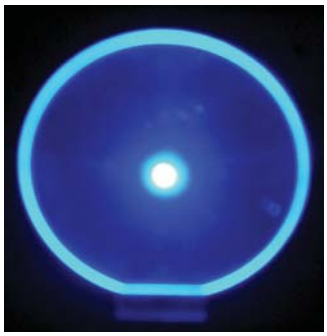
Gallium nitride and its alloys can emit light over a wide range of colours – from the infra-red (IR) to the ultra-violet (UV), including all the colours of visible light. Already these materials are widely used in LEDs that are part of our everyday lives: from blu-ray DVD players through to bicycle lights, from replacement LED light bulbs to back-lighting of our computer and TV screens. Cambridge and Manchester have been collaborating on gallium nitride research for over ten years. Our research has led to lower-cost LEDs that are now being manufactured in the UK. Plessey sold 2 million LEDs based on our research in 2014 and plans to sell many more in 2015.

ENERGY SAVINGS FROM GALLIUM NITRIDE LEDS

The Department of Energy (DoE) in the US has stated that by 2025 gallium nitride LEDs could reduce the global amount of electricity used for lighting by 50%. In the UK, lighting uses about one-fifth of all electricity. LEDs are poised to reduce this figure by 50%. Lighting will then

use 10% of all electricity, thus saving 10% of electricity. This amounts to an annual saving of over £2 billion per year in electricity costs. If this electricity comes from fossil-fueled power stations, as most does, LED lighting will save 10% of carbon emissions from these.

Commercially available replacement LED light bulbs are already six times more efficient than incandescent light bulbs and 50% more efficient than so-called low-energy compact fluorescent lamps (CFLs). In the laboratory there are LEDs which are even more efficient, and these will become commercially



available in the next few years. If we replaced all our lighting in the UK with LEDs we could close (or not build) eight large (1 GW) power stations.

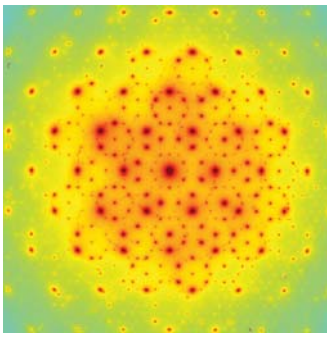
WHAT IS PREVENTING THE WIDESPREAD USE OF LED LIGHTING IN OUR HOMES AND OFFICES?

The main problem is cost. Low-power LEDs, for example used in toys, are very cheap; but high-power LEDs for lighting a room are expensive. I recently paid £15 for a replacement 60W equivalent LED light bulb. Not many people will pay this, even though the LED bulb rapidly repays for its cost in lower electricity bills. All commercial gallium nitride LEDs are grown on sapphire or silicon carbide wafers, both very expensive. My research group

has pioneered the growth of gallium nitride LEDs on silicon wafers, which are much cheaper. We patented our technology and set up two companies in 2010 and 2011 to exploit it. The UK company Plessey acquired both companies in 2012, hired post-docs from my research group to transfer the technology and are now manufacturing low-cost gallium nitride LEDs on silicon at their factory in Plymouth, Devon. This is the first manufacture of LEDs in the UK and the first commercially available LEDs on silicon in the world. Plessey are selling the LED chips to other companies to put into lightbulbs and other products. So this will enable cost reductions in LED lighting and accelerate its widespread adoption, thus saving the UK over £2 billion per year in electricity costs.

THE IMPORTANCE OF PEAK ELECTRICITY

Peak UK electricity demand in 2014 was on 3 January at 6pm. In general, electricity demand is highest on winter evenings. The



... close eight large (1 GW) power stations ...

electricity supply must match this peak demand or else the lights go out (and governments risk not being re-elected!).

There is often high pressure weather in winter, which results in weak winds, and so wind turbines often make a tiny supply to peak demand. By definition, solar power makes zero contribution to peak energy demand, because the sun is not shining on a winter's evening. So wind and solar energy cannot be relied upon to contribute to our peak electricity demands. On the other hand, LED lighting makes a major contribution to reducing peak electricity demand on winter evenings, when lights are switched on, so it is a much more effective way of making this peak demand than wind and solar power.

A COMPARISON OF LEDS, WIND AND SOLAR

The US Department of Energy has recently made an interesting forecast comparing electricity savings from LEDs, wind and solar. The DoE predicts that if LED costs continue to come down and the efficiency continues to increase, LEDs will have 90% of the US lighting market by 2030. LEDs will then save twice the electricity generated by wind and twenty times the electricity generated by solar. The annual US electricity savings due to LEDs in 2030 is estimated to be $40 billion. And there are no subsidies for LEDs.

TUNABLE WHITE LEDS

Nearly all the LED replacement light bulbs sold today are gallium nitride blue LEDs coated with phosphor materials, the combination producing white light. If we could eliminate the phosphors and produce white light by mixing blue, green and red LEDs within a single light bulb we would save another 5% of electricity, so that LEDs would save a total of 15% of all electricity, equivalent to saving the UK over £3 billion per year. We would also have colour tunable white lighting, so that you could choose to have reddish white light for a romantic dinner, for example. More of this later!

ENERGY SAVINGS FROM GALLIUM NITRIDE POWER ELECTRONICS

Gallium nitride not only has a low electricity consumption for lighting, it also has for electronics. Power electronic devices are very widely used, for example in chargers for mobile phones and laptops, in electric cars and in IT server farms. All these power electronic devices are made from silicon. However, gallium nitride power electronic devices are 40% more efficient than those made from silicon. If we replaced the silicon devices by gallium nitride ones we would save 10% of all the electricity we use.

... save up to 25% of carbon emissions from power stations ...

ENERGY SAVINGS FROM GALLIUM NITRIDE

Gallium nitride devices can save us 10% of electricity using existing LEDs. If we eliminate

the phosphors we can save a further 5% of electricity. If we replace silicon power electronic devices with gallium nitride ones we could save another 10%. So an astonishing 25% of the total electricity we consume can potentially be saved using gallium nitride devices. In addition, we could save up to 25% of carbon emissions from power stations. Unlike solar and wind power, these savings will be made at times of peak electricity demand.

LIGHT AND OUR HEALTH

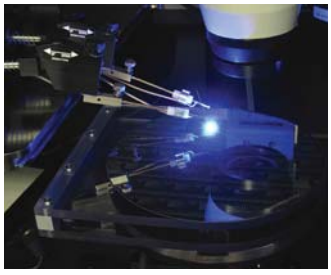
Life has developed over millions of years in natural lighting: sunlight. There is increasing evidence that sunlight is good for our health (if over-exposure is avoided). For example 90% of the vitamin D in our bodies comes from sunlight on our skin and only 10% comes from food. Two-thirds of the UK are "severely lacking" in vitamin D, leading to a weak immune system (enabling colds, coughs and worse), fatigue, broken bones, headaches, etc. Vitamin D is also believed to protect against certain cancers (eg breast, prostate) by preventing the overproduction of cells. With tunable LED lighting we will be able to mimic sunlight indoors and hence produce vitamin D indoors. We will also be able to minimize or eliminate Seasonal Affective Disorder (SAD), which affects over 3 million people in the UK.

IMPROVING PRODUCTIVITY AT WORK AND IN SCHOOLS

There is clear evidence that good quality lighting reduces absences due to illness from schools and improves exam performance. It also increases productivity at work. Optimised LED lighting in schools and workplaces should be a government priority to improve productivity and performance.

WATER PURIFICATION

The earth's atmosphere prevents deep ultra-violet radiation from reaching us, so life on earth has developed in the absence of deep-UV light, and it has no defence against it. Deep-UV light damages the nucleic acid in both DNA and



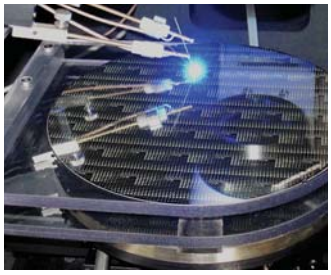
RNA and stops all bacteria and viruses from reproducing: effectively killing them. By adding aluminium to gallium nitride we can produce LEDs emitting deep-UV light. At present the intensity of the light is not sufficient to purify flowing water, so more research is needed. However, there is the clear potential to save literally millions of lives in the developing world by using this gallium nitride technology, which

... Optimised LED lighting in schools ...

could be powered by solar cells. It would also be more efficient than chlorination in the developed world.

SECURE COMMUNICATIONS AND LIFI

We are researching gallium nitride single photon sources to create pairs of entangled photons for totally secure communications. For example, mobile phone conversations could then be totally secure. In addition, in about five years time WiFi radio frequency bands will become saturated. We are



researching transmitting the same information using light from LEDs, thus overcoming the potential WiFi crisis.

CONCLUSIONS

Gallium nitride is a key material for saving 25% of electricity and carbon emissions. It can also save millions of lives, provide secure communications and augment WiFi. It can improve productivity at work and in schools. It can help UK

... stops all bacteria and viruses from reproducing ...

manufacturing and job creation. Optimised LED lighting can improve the health of us all. The UK is at the forefront of this amazing new material.

NANOTECHNOLOGY

Meeting of the Parliamentary and Scientific Committee on Tuesday 14th July

NANOTECHNOLOGY – what is it and what is it for?

Professor Andrew Fisher
University College London

Professor Milo Shaffer
Imperial College London

Co-Directors, London Centre for Nanotechnology

Nanotechnology is driven by a collision of science and techniques drawn from different disciplines, which has uncovered new fundamental behaviours of matter and new opportunities for practical applications. Modern semiconductor integrated circuits are carved, "top-down", at increasingly short length scales, underpinning the continuous improvement in electronics over recent decades ('Moore's law'). At the same time, chemists have learnt how to build increasingly large, well-defined structures from "the bottom up". These worlds intersect at the nanoscale, where dimensions are measured in nanometres (billionths of a metre); it is the same lengthscale on which much of the complex machinery of living systems operates. Within this range, the physical laws governing the behaviour of matter begin to switch from classical to quantum mechanical, and become subtly dependent on size. The concepts, knowledge, and tools from different disciplines, including electronic engineering, materials science, chemistry, physics, biochemistry, and medicine are being exchanged and developed, creating new opportunities in which science and technology are synergistic: new science leads to new technologies, which in turn enable further scientific developments.

THE LONDON CENTRE FOR NANOTECHNOLOGY

Almost ten years ago UCL and Imperial College London decided to create a joint London Centre for Nanotechnology (LCN) using funding from the HEFCE Science Research Infrastructure Fund, recognizing the very widespread importance that now attaches to the ability to control matter in the nanometre range. The LCN concept involves making available to the widest possible range of researchers a full set of tools for making and characterizing nanostructures, enabling them to carry out leading fundamental research and to target applications in

information technology, healthcare and the environment.

By combining two of the UK's strongest research universities the LCN provides a large, high-quality and exceptionally diverse research community that can take full advantage of these nanoscale tools, which have become pervasive in current science and technology. The institutions have great strengths across the physical and biological sciences, as well as in engineering, and in biomedicine – the location in central London, close to Europe's largest concentration of specialist medical care, gives it unmatched opportunities for research with the healthcare sector and for technology transfer. This large research community makes it possible to invest in a broader range of equipment than would be possible for for a single university.

LOCAL VERSUS NATIONAL FACILITIES

An important part of the LCN philosophy is that nanoscale fabrication tools should be available as locally as possible, so that they can become part of the everyday research programme for the participating groups. Even in London traffic, UCL and Imperial are close enough that it is easy to travel from one to the other!

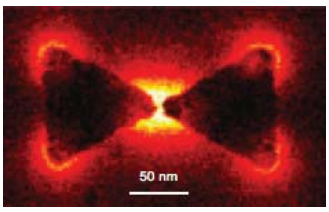
Other facilities involve major infrastructure that cannot be provided even in a multi-institution collaboration such as the LCN. Particularly important are neutron and X-ray scattering, which involve wavelengths which match the separation between atoms. This infrastructure is best provided as a national facility, and LCN researchers are large users of the UK's ISIS neutron facility and Diamond X-ray synchrotron.

The LCN team also works closely with a range of other interdisciplinary initiatives in London, including the Thomas Young Centre for the Theory and Simulation of Materials, a leading platform for advancing the performance of materials, and the Centre for Plastic Electronics, focused on the development of cheap, large area devices such as solar cells and displays.

NANOSCALE TOOLS

Core fabrication facilities in nanotechnology rely on both the high performance clean room environments needed for detailed photo- and electron lithography, scribing nanoscale patterns on the surface of a material, and the wet labs required for (bio)chemical synthesis and analysis. Some of the most interesting opportunities arise from the integration of these approaches, requiring adjacent coordinated facilities. Characterization of the resulting structures has often been a limiting step. The LCN, with support from the Engineering and Physical Sciences Research Council (EPSRC), installed the UK's first Titan monochromated, aberration-corrected electron microscope, giving access to an order of magnitude improvement in resolution. Over the last decade, revolutionary developments in electron microscopy have allowed imaging even of individual atoms. In addition, electron spectroscopy can reveal the chemical identity of the atoms or resolve functional properties of nanostructures.

Similarly, again supported by EPSRC, the LCN installed the UK's first neon ion microscope, providing unprecedented combined ability to mill nanostructures and to image the results.



Direct imaging of the plasmon resonance associated with a metal "nano-bow tie", using the Titan electron microscope; such structures are useful for manipulating light on scales shorter than its own wavelength, for sensing, high resolution imaging, and photonics, courtesy of Prof Stefan Maier

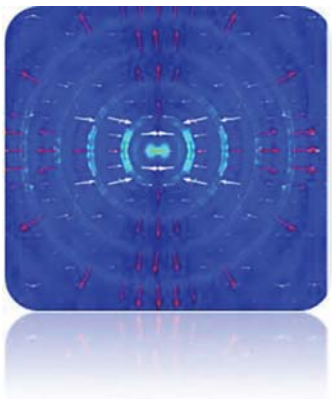


Image of a 20 nm nanopore ion-milled into a membrane, designed to assist the sequencing of individual strands of DNA. The concentric 'bull-eye' pattern concentrates light to control the temperature at the pore. Courtesy Dr Josh Edel.

Future infrastructure developments may target emerging themes in automated/instrumented robotic experimentation, three (or more) dimensional imaging/visualisation at different lengthscales, and environmental characterisation under "realistic" conditions. It is essential to continue to invest in state of the art equipment, to remain internationally competitive, and to exploit the latest technological opportunities.

EXAMPLES

Nanoscience and nanotechnology now play an integral role in many fields, and in many potential applications. These range from improved high performance electronics, aiming to beat the limitations of Moore's law, to the development of more environmentally-friendly chemical processes and energy sources, and the advancement of new therapies based on nanomedicine. A few examples follow.

Catalysts

Catalysts are now playing an increasingly important role in the removal of pollutants from vehicle exhausts in catalytic convertors. The active components of many catalysts are nanoparticles, and it is becoming clear that their effectiveness depends critically on how much the atoms are 'strained' or distorted from their ideal geometries. It has been difficult or impossible to determine this strain until recently but now Prof Ian Robinson, in a joint project with Johnson Matthey, has shown how the information from scattered X-rays can be cleverly combined to produce a strain image of a single particle. An alternative strategy includes nanoparticles catalysts within the fuel itself to improve fuel efficiency and reduce soot formation; the effect of such particles on the vehicle exhaust and their potential impact on human health is being studied using advanced imaging tools, such as Titan, in a collaborative project with the US Environmental Protection Agency, led by Prof Terry Tetley.

Scanning probes

One of the most powerful tools in probing the nanoscale world has been the scanning

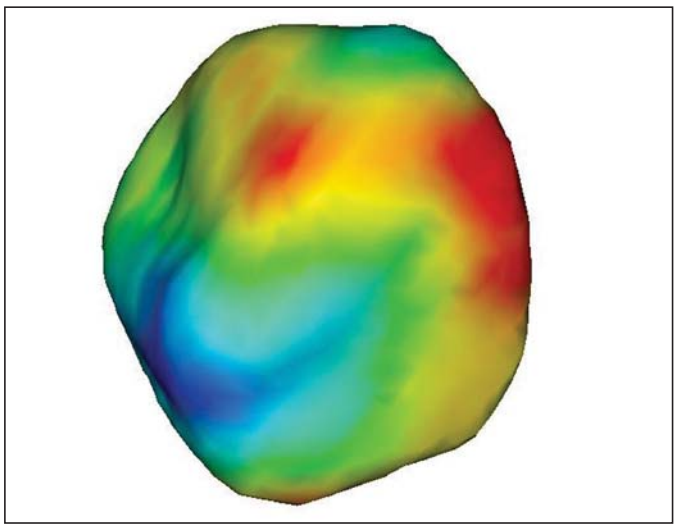
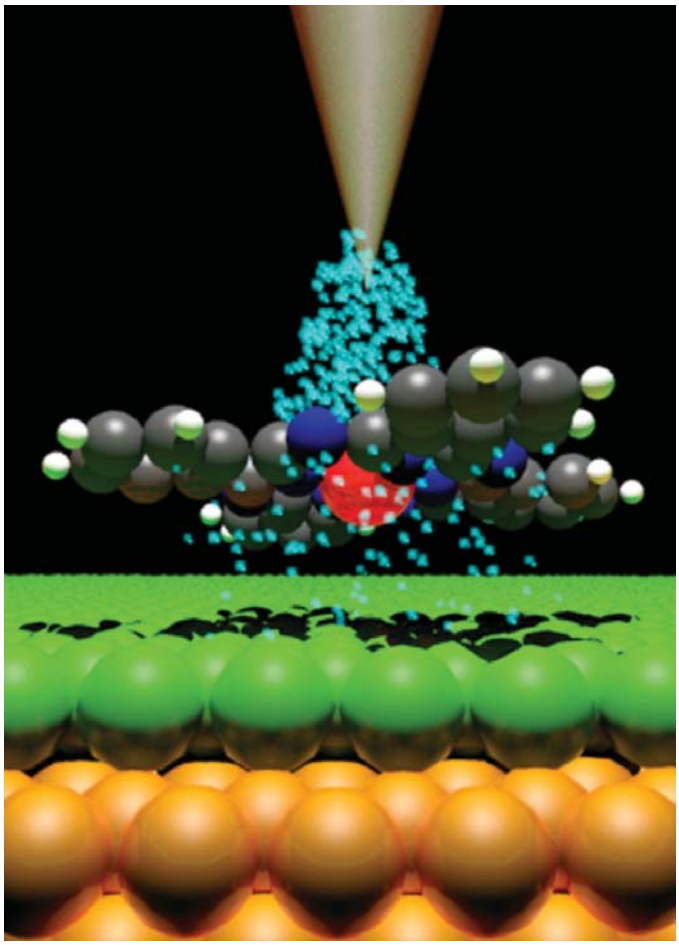


Image of an individual nanoparticle, the colour coding the strain of the atoms. Courtesy Professor Ian Robinson and Rachel O'Malley (Johnson Matthey).

probe microscope, in which a microscopic tip 'feels' the structure under investigation as it scans across it. LCN researchers have been particularly prominent in developing this technique; in one notable example Dr Bart Hoogenboom and his colleagues were able to image "nanodrills" at work, built by individual proteins that bacteria produce to kill living cells That advance relied on pushing the technique to detect the weak forces that operate in soft biological environment. Another variant involves detecting the electrical current through an atom or molecule, rather than the force. Using this approach, Dr Cyrus Hirjibehedin and his colleagues have been able to demonstrate a single-molecule magnetic sensor in which the electrical current is up to 60 times more sensitive to a magnetic field than had previously been expected.

Nanoscale devices for quantum technologies

Ultimately, we would like to be able to create devices that function entirely according to the microscopic laws of quantum mechanics. It has been known for many years that these laws determine the behaviour of individual atoms and molecules, but whole devices operating on quantum principles have new properties – they can process information in new ways, and can perform some important tasks (for example, breaking large whole numbers into their factors – a critical task in attacking the security of present-day cryptography) much more efficiently than any 'normal' computer. The UK National Quantum Technology programme has recently started some important projects to bring quantum technologies to short-term application, but in the long term many researchers believe that the scalability possessed by nanoscale solid-state systems will win out over competing approaches. In this context, an especially important recent demonstration came from the LCN's Prof John Morton and colleagues, who showed that fragile quantum information can be preserved in silicon (the same material used in conventional electronics) for unprecedentedly long times from seconds to several hours



Schematic of a magnetic molecule (centre) on a surface. The magnetization of the molecule interacts with local magnetic fields and also with electrons emitted by the scanning probe microscope tip, thereby affecting the current and forming a sensitive magnetic field sensor. Courtesy Dr Cyrus Hirjibehedin, image by Tobias Gill

i-sense: Early detection of infectious disease

Globally, infectious diseases such as influenza, Ebola, MRSA and HIV rank among the gravest threats to human health, alongside global warming and terrorism. Nanotechnology offers the possibility of sensitive and specific, cheap, disposable diagnostics that will widen access to testing in the community and the developing world. At the LCN, Professor Rachel McKendry directs i-sense, the EPSRC Interdisciplinary Research Collaboration in Early Warning Sensing Systems for Infectious Diseases. This multi-partner centre aims to detect disease much earlier than before by linking web data, such as social media posts, with nano-enabled, mobile phone-connected diagnostic tests. Patients will benefit by gaining faster access to treatment, the NHS and global healthcare providers will benefit from targeted care and antibiotic stewardship, and populations will benefit from the reduced spread of infection.

THE NANOTECHNOLOGY WORKFORCE

What kinds of people are driving this work forward? A quick survey of the current LCN workforce reveals representatives from France, Italy, Germany, Sweden, The Netherlands, Israel, Russia, India, Japan, China and Kenya as well as the United States, Canada, Australia and of course the UK. This mix is not atypical of fast-moving areas of science and technology, but underlines how important it is for UK universities to be able to appoint people with the very best skills internationally, in order to compete in the global

Image illustrating the concept of the i-sense project. Low-cost diagnostic tests, relying on nanotechnology and integrated with mobile phones, form part of a multi-scale approach including monitoring of web posts and social media. Courtesy of Prof Rachel McKendry and Kailey Nolan.

marketplace for ideas. It is essential to be able to access the best talent at every level from students, through researchers, to experienced academics and industrialists. Policies that encourage, for example, PhD students to stay in the UK and start new businesses here exploiting their knowledge, rather than insisting that they leave the country immediately, would be beneficial.

For such an international field it is also especially important to ensure that the UK is able to take part in international collaborative research projects. In particular, the UK benefits disproportionately from EU funding; any withdrawal from the EU science framework would have a devastating impact on UK science, both in loss of revenue and loss of opportunities for international collaborations, most of which also involve companies or end-users. Many of the schemes (such as the European Research Council Fellowships) bring significant international prestige as well as opportunity, which helps the UK to attract the best talent.

SAFETY

As nanotechnology moves forward into commercialization, it is critical to ensure that potential impacts on human health and the environment are taken into account. The field in the UK benefited from a landmark Royal Society and Royal Academy of Engineering report in 2004 entitled *Nanoscience and nanotechnologies: opportunities and uncertainties*, which provided an early and widely respected analysis. It served both to promote an awareness of safety and ethical issues within the field, and to reassure those outside it that early and somewhat sensational warnings of the risks from 'grey goo' nanotechnologies were overstated. The report concluded that many nanotechnologies do not raise any particular concerns beyond conventional industrial manufacturing, for example, when small structures are buried within larger electronic devices. The safety of the manufacturing process and the life cycle fate of the product must be considered, but conventional approaches are generally appropriate. In certain cases, however, there is a chance that discrete, engineered nanoparticles might be released, either accidentally or deliberately, leading to human or environmental exposure. In these cases, the fate of the nanoparticles must be considered carefully. Atmospheric pollution, for example by diesel soot, is one very prominent example of nanoparticle release; other nanoparticles occur in very much smaller quantities. However, the fate and influence of these particles need to be considered on a case by case basis. Considerable research to date has shown that the behaviour is very dependent on the composition, size, and use of the nanoparticles. In some cases, there is no immediate concern, while in others suitable precautions relating to exposure should be employed. Particular care will be needed in nanomedical applications, where nanomaterials are directly administered to humans, although rigorous testing can be anticipated.

THE FUTURE AND COMMERCIALIZATION

Nanostructured components will increasingly appear as crucial enabling elements integrated in complete functional systems for a wide range of applications. Improvements in cost-effective nanomanufacturing will accelerate implementation. The combination of nanostructures with other components will increasingly create "hierarchical systems" operating over a range of lengthscales. It is worth highlighting that biology is especially adept at building functional materials specified at every possible lengthscale. We, on the other hand, are good at atomic scale manipulation through chemistry, and micron-scale manipulation through engineering, but very unskilled in the intervening nanoscale. Famously, Richard Feynman announced that there was "plenty of room at the bottom", but we may now consider that there is still "plenty of room in the middle" to integrate top-down and bottom-up approaches, to deliver new technologies with economic and societal benefits.

New materials and manufacturing technologies typically have long development cycles. Initial enthusiasm sometimes wanes too quickly for the development of real technologies, and many opportunities are lost in "the valley of death" between initial promise and ultimate delivery. Unfortunately, the UK generally has a poor record in making the most of its own intellectual achievements. It is critical that government, industrial, and venture-driven R&D investment takes a sufficiently long term view that the new opportunities are manifested within the UK.

Transforming our lives with Nanotechnology in safe and responsible way

Professor Alex Orlov
Assistant Professor of Material Science and Engineering, State University of New York, Stony Brook

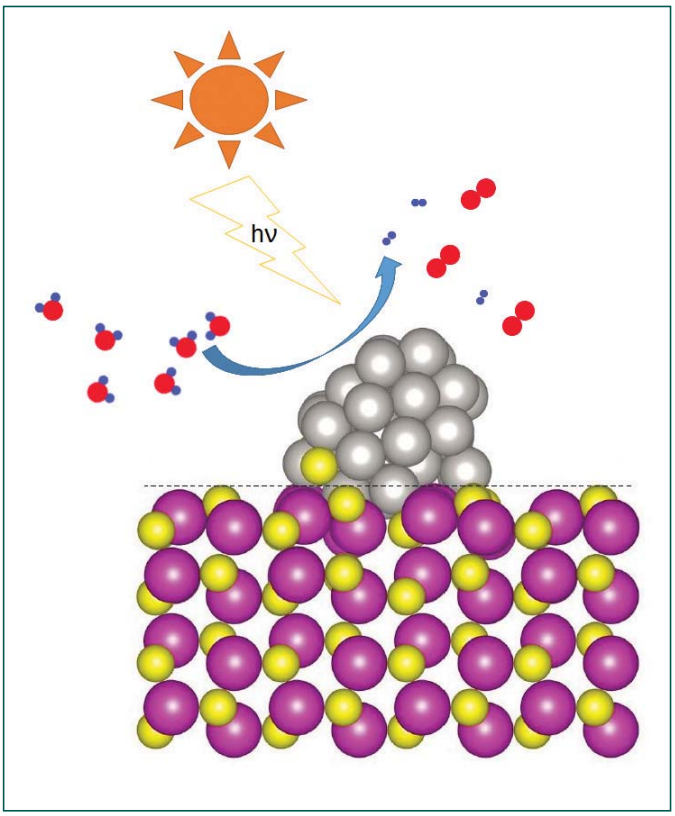
Nanotechnology is very exciting field. From revolutionizing medical applications to producing the most efficient electronic devices, it is already transforming our daily lives.

In the US there has been very little controversy related to funding of this emerging field. The US National Nanotechnology Initiative (NNI), a coordinating organization for 20 Federal departments and independent Agencies, was given over $21 billion since its inception in 2001. The budget request for the coming year was $1.5 billion, in line with the previous budget proposals. This initiative has gained strong support from three Presidential administrations, resulting in technological advances in solar energy conversion, nanomanufacturing and sensors. It is not a coincidence that the technological competitiveness of the US economy is strongly linked to research and commercialization of nanotechnology.

... NNI has recognized the importance of blue sky research ...

The late John Marburger, Chief Science Adviser to President Bush, stated that NNI was one of the least controversial sciences and technology programs for budget appropriations. This is not surprising, given that this initiative facilitates investment into research infrastructure, education and applied/ fundamental research. It has enabled many disciplines, ranging from medicine to electronics, to develop new science and commercial applications. The NNI has recognized the importance of blue sky research, with almost 35% of the budget dedicated to such fundamental research. The Policy makers in the US have recognized that skewing research funding too much towards applied research can potentially undermine all the future breakthroughs enabling commercial applications of nanotechnology.

Despite the enormous potential for nanotechnology to improve our wellbeing, there are still questions about safety of nanoparticles to humans and the environment. In relation to safety there are two aspects to consider. Firstly, contrary to popular beliefs, nanotechnology can solve many environmental problems. For example, nanoparticles can reduce environmental contamination, produce energy in a cleaner way



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and make conventional materials less harmful. In 2009 the OECD organized one of the first meetings on the topic, to offer an alternative view to toxicology driven perception of nanomaterials. This meeting offered a glimpse of the emerging field, called environmental nanotechnology, aimed at improving human health and the environment. Nanoparticles can also enhance ecological health indirectly by facilitating clean energy production. We have created a new generation of nanoparticles, which can produce clean source of energy from water using sunlight. The product of this reaction, hydrogen gas, can then be used to power fuel cells to produce electricity. We have also demonstrated how to use nanoparticles to clean water and air pollution, both on a small scale and on urban scale. This approach is currently being utilized in a recent commercial development by the US company called PURETi, which coats urban surfaces with self-cleaning and air purifying nano-coatings. In addition to nanoparticles, nanotechnology can also create such nanostructures as nanopores in membranes. These membranes are already saving millions of lives by delivering clean drinking water.

The second aspect of safety of nanoparticles is as following. Despite the promise of nanotechnology it is foolish to dismiss toxicity aspects. There are credible scientific reports on toxicity of nanoparticles. In fact the UK Government has a long standing Hazardous Substances Advisory Committee (HSAC) advising DEFRA on toxicity aspects of nanotechnology.

Being a member of this committee for almost seven years gave me a number of unique insights into the interdisciplinary aspects of the safety nanoparticles. One of the most important nuggets, which came out of numerous discussions at this committee, was that scientists working on applications of nanotechnology should collaborate with toxicologists, economists, environmental and social scientists. All these disciplines are incredibly important for conducting risk assessment of nanotechnology and for communicating these assessments to general public and policy makers. Whereas scientists and engineers always try to quantify risk factors, given the incomplete information available for most of new nanomaterials, it is often a challenging task. Finding pathways to incorporate qualitative information and accounting for such externalities as public perception and regulation is a daunting task for traditionally trained scientists and engineers working in academic environment. Transcending interdisciplinary boundaries is the only way to advance nanotechnology without harming public and environment.

... the safe development of nanotechnology will bring multiple benefits for all. ...

It can be argued that the toxicity of some nanomaterials does not necessarily mean that they have to be removed from the market. Environmental health professionals know that even the most hazardous materials present zero risks if we are not exposed to them. This concept can be used to guide new product development, whereby exposure to potentially hazardous materials can be eliminated during production, use and disposal of nanomaterials containing products. However, if existing manufacturing practices do not provide adequate protection, they have to be changed or the product has to be redesigned. If nano-enabled products are designed responsibly, it is possible to reduce risks associated with exposure to nanoparticles to negligible levels while taking advantage of their extraordinary properties. We have demonstrated a new approach to evaluation of safety of products containing carbon nanotubes. It is often assumed that nanoparticles encapsulated in polymers are safe. We demonstrated that under certain conditions this assumption might not be true. In fact there are some scenarios of these materials' exposure to sunlight, moisture and abrasion where carbon nanotubes might become detached from the polymers holding them inside. Given numerous reports of toxicity of carbon nanotubes the question then becomes whether to remove these from the market or to reformulate them to improve their safety. Recent work offered several pathways of making nanomaterials more stable and thereby safer to use. The first pathway is to substitute more harmful nanomaterials with the less harmful one. The second pathway is to redesign the entire nanomaterials containing product to make it more resilient towards environmental degradation. In case of polymers this can be achieved by adding various UV stabilizers and by making carbon nanotubes more compatible with polymer matrices.

We can be certain that the ingenuity of researchers in this area will ensure that the safe development of nanotechnology will bring multiple benefits for all.

COMBATING ANTIMICROBIAL RESISTANCE:

A Coordinated Global Response by the UK Science and Innovation Network

Dr Lindsay R Chura

Elizabeth Hogben

Stefania Di Mauro-Nava

Antimicrobial resistance (AMR) is a global threat that has been referred to in the same terms as terrorism and climate change. The ability for doctors to prescribe antibiotics to combat infection has been part of modern medicine since Scottish biologist Sir Alexander Fleming discovered penicillin in 1928. However, widespread and sometimes unregulated use of antibiotics in both humans and livestock has led to the growing problem of antimicrobial resistance. "Superbugs" know no borders; therefore coordinated international action is vital.

Lord Jim O'Neill, Chairman of the Review on AMR, commissioned by the Prime Minister in 2014, suggests that without action, AMR could cost some 2-3.5% of global GDP and cause 10 million more deaths by 2050. The UK is leading on global efforts to prevent, detect, and control illnesses and deaths caused by antibiotic-resistant bacteria. The UK's international engagement to tackle AMR is a comprehensive cross-government effort, with the Department of Health, Foreign and Commonwealth Office, Department for International Development, Department for Environment, Food and Rural Affairs, Department for Business, Innovation and Skills and others working in partnership to develop and deliver coordinated action. An international cross-Whitehall steering group on AMR has been established and plays a key role in guiding activities across government departments.

... coordinated international action is vital ...

The Chief Medical Officer, Dame Sally Davies, has led a UK government push to raise global awareness and galvanise action. Significant progress has been made in 2015 with the World Health Organisation (WHO) adopting an AMR Global Action Plan in May followed by the UN Food and Agriculture Organisation and World Organisation for Animal Health adopting resolutions expanding action into agriculture and animal health spheres. The Global Health Security Agenda (GHSA) is an important mechanism for delivering international engagement on AMR with the UK as a leading partner on the AMR action package. GHSA was launched by the United States in February 2014 to advance a world safe and secure from infectious disease threats and to bring together nations to make new, concrete commitments, and to elevate global health security to a national leaders-level priority. The G7 endorsed the GHSA in June 2014.

... raise global awareness ...

New international partnerships: The UK Science and Innovation Network (SIN), based in 28 countries, is playing a key, supporting role in the UK Government's international campaign for global action on AMR. SIN India co-organised a workshop on Open Innovation in Drug Discovery and AMR in September 2014. SIN Japan co-organised a workshop in November 2014 to discuss research collaboration on diagnostics and drug discovery, and a network for research collaboration is being established on animal health. SIN US worked with Chatham House to organise a "One Health" Colloquium in December 2014 to examine direct and indirect benefits and risks to human health posed by livestock. In February 2015, the team organised a symposium at the American Association for the Advancement of Science conference in California involving the CMO and other UK experts. SIN US also supported a recent visit by Lord O'Neill in June 2015, where highlights included engagement with the United Nations, a keynote presentation at the Biotechnology Industry Organization convention (the world's largest gathering of the biotechnology industry) as well

as a range of high-level meetings in Washington.

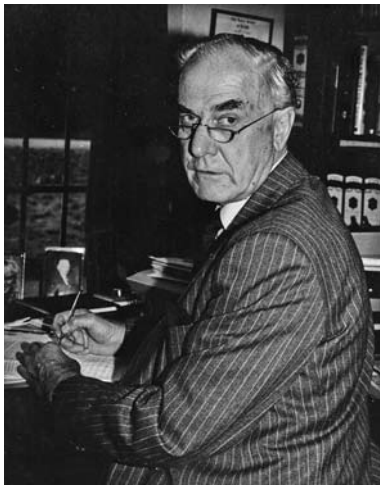
Promoting innovation: The network works closely with UKTI to ensure that opportunities are maximized to showcase innovative technologies from the UK. SIN has been working with Nesta to promote the Longitude Prize, a £10 million UK-led challenge to find a cost-effective, accurate, rapid and easy-to-use point of care **test kit for bacterial Infections.**

Building capacity: SIN is well placed to support efforts to boost capacity. SIN helped support development of the first Commonwealth laboratory AMR regional twinning workshop in Trinidad and Tobago. SIN China ran a series of collaborative research workshops on quantitative microbial risk which resulted in the UK Institute for Food Research conducting risk assessment training for the Chinese Centre for Disease Control and Prevention. SIN will continue to place a big emphasis on wider engagement in BRIC countries, particularly as China prepares to host the G20.

... network for research collaboration ...

Galvanising global action: The WHO Global Action Plan was ratified in May 2015 on AMR and represented a landmark moment in global health. SIN is working in a number of areas to further progress and will continue to support the UK's international engagement on AMR, including through advancing work towards a high-level 2016 meeting on AMR at the United Nations.

AMR is a global health and economic issue which cannot be solved by any one country acting alone. Action is needed to drive forward the development of more refined diagnostics, surveillance and infection control methods. Governments around the world must act collectively to address the growing threat posed by AMR, taking into account both the human and animal dimensions of this complex challenge.



PROFESSOR JOHN BLEBY 1932-2015

The Parliamentary and Scientific Committee is sorry to record the recent death of Professor John Bleby.

He had been a loyal and supportive member of the P&SC for more than 30 years. He was a member of the Steering Committee, and later was elected to the Council.

He joined Sir Gerard Vaughan in Westminster Publishing which published Science in Parliament between 1989 and 1998.

He represented the Research Defence Society (now Understanding Animal Research) on the Parliamentary and Scientific Committee for many years.

He was also one of the small team of Parliamentary and Scientific Committee members who went to Washington to learn about the Office of Technology Assessment. This fact finding mission then led to the establishment of the Parliamentary Office of Science and Technology (POST).

During the foot and mouth outbreak in 2001 he volunteered as a Ministry vet and spent six months in Cumbria.

He also went on one of the Parliamentary and Scientific Committee delegations to China.

HOUSE OF COMMONS SELECT COMMITTEES 2015

The Chairs of all the House of Commons Select Committees were elected by a secret ballot of the House of Commons on Thursday 18th June.

BUSINESS INNOVATION AND SKILLS COMMITTEE

The Business, Innovation and Skills Committee is appointed by the House of Commons to examine the administration, expenditure and policy of the Department for Business, Innovation and Skills (BIS) and its associated public bodies, including the Office of Fair Trading (OFT).

Mr Iain Wright (Labour, Hartlepool) was elected Chair. Other members of the Committee, formally appointed on Wednesday 8 July, are: Paul Blomfield (Labour, Sheffield Central); Richard Fuller (Conservative, Bedford); Peter Kyle (Labour, Hove); Amanda Milling (Conservative, Cannock Chase); Amanda Solloway (Conservative, Derby North); Jo Stevens (Labour, Cardiff Central); Michelle Thomson (Scottish National Party, Edinburgh West); Kelly Tolhurst (Conservative, Rochester and Strood); Craig Tracey (Conservative, North Warwickshire); Chris White (Conservative, Warwick and Leamington).

INQUIRY

On 20 July the Committee announced an Inquiry into the Government's Productivity Plan, exploring whether the Productivity Plan addresses the main causes of low productivity in the UK and whether it is likely to achieve its desired results. The Productivity Plan covers a wide range of areas, including the tax regime for businesses, skills, science and innovation, digital infrastructure, investment and trade. Written evidence was sought, to be submitted by 10 September.

Contact: Business, Innovation and Skills Committee, House of Commons, London SW1A 0AA. Telephone: 020 7219 5777; Email: biscom@parliament.uk

EDUCATION COMMITTEE

The Education Committee monitors the policy, administration and spending of the Department for Education and its associated arms' length bodies, including Ofsted.

Mr Neil Carmichael (Conservative, Stroud) was elected Chair. Other members of the Committee, formally appointed on Thursday 6 July, are: Lucy Allan (Conservative, Telford); Ian Austin (Labour, Dudley N); Michelle Donelan (Conservative, Chippenham); Marion Fellows (Scottish National Party, Motherwell and Wishaw); Suella Fernandes (Conservative, Fareham); Lucy Frazer (Conservative, SE Cambridgeshire); Kate Hollern (Labour, Blackburn); Ian Mearns (Labour, Gateshead); Caroline Nokes (Conservative, Romsey and Southampton N); Kate Osamor (Labour Co-op, Edmonton).

INQUIRIES

The work of Ofsted

On 16 July the Committee announced an inquiry into the work of Ofsted and called for written evidence (to be submitted by Tuesday 1 September) ahead of a one-off evidence session with Sir Michael Wilshaw, Her Majesty's Chief Inspector, to be held on Wednesday 16 September.

Regional Schools Commissioners

On 20 July the Committee announced an inquiry into The role of Regional Schools Commissioners. The Regional Schools Commissioners (RSCs) were appointed in 2014 to work with school leaders to promote and monitor academies and free schools. This inquiry explores the expanding role of RSCs, their resources, impact and accountability.

Contact: Education Committee, House of Commons, London SW1A 0AA.

Telephone: 020 7219 1376;
Email: educom@parliament.uk

ENERGY AND CLIMATE CHANGE COMMITTEE

The Committee is appointed by the House of Commons to examine the expenditure, administration and policy of the Department of Energy and Climate Change (DECC) and its associated public bodies.

Angus Brendan MacNeil (Scottish National Party, Na h-Eileanan an Iar) was elected Chair. Other members, appointed 8 July, are: Rt Hon Alistair Carmichael (Liberal Democrats, Orkney and Shetland); Glyn Davies (Conservative, Montgomeryshire); James Heappey

(Conservative, Wells); Ian Lavery (Labour, Wansbeck); Melanie Onn (Labour, Great Grimsby); Matthew Pennycook (Labour, Greenwich and Woolwich); Dr Poulter (Conservative, Central Suffolk and North Ipswich): Antoinette Sandbach (Conservative, Eddisbury); Julian Sturdy (Conservative, York Outer); Dr Alan Whitehead (Labour, Southampton Test).

INQUIRIES

DECC priorities 2015

On 15 July the Committee announced an inquiry into DECC priorities 2015 and on Tuesday 21 July held a one-off evidence session with the Secretary of State looking at the Department's priorities and objectives for 2015 and for this Parliament. The evidence is published on the website.

ECC priorities for holding Government to account

On 16 July the Committee announced an enquiry looking to gather views on which areas of DECC's policies will require particular scrutiny over the years to come to inform the Committee's future work programme and its priorities for holding Government to account.

Contact: Energy and Climate Change Committee, House of Commons, London SW1A 0AA

Telephone: 020 7219 2158; Email: ecc@parliament.uk

ENVIRONMENT FOOD AND RURAL AFFAIRS COMMITTEE

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

Mr Neil Parish (Conservative, Tiverton and Honiton) was elected Chair. Other members (appointed on 8 July) are: Sarah Champion (Labour, Rotherham); Chris Davies (Conservative, Brecon and Radnorshire); Jim Fitzpatrick (Labour, Poplar and Limehouse); Harry Harpham (Labour, Sheffield, Brightside and Hillsborough); Simon Hart (Conservative, Carmarthen West and South Pembrokeshire); Dr Paul Monaghan (Scottish National Party, Caithness, Sutherland and Easter Ross); Rebecca Pow (Conservative, Taunton Deane); Margaret Ritchie (Social Democratic & Labour Party, South Down); David Simpson (Democratic Unionist Party, Upper Bann); Rishi Sunak (Conservative, Richmond).

INQUIRIES

The 2015 EFRA Committee is appealing to the public to tell it what key issues should be addressed this Parliament.

Tweet them @CommonsEFRA using #EFRAtopics – or send 100 words via email to efracom@parliament.uk with the subject line: EFRA Topics.

Contact: Environment, Food and Rural Affairs Select Committee, House of Commons, London SW1A 0AA. Telephone: 020 7219 5774/3262; Email: efracom@parliament.uk

ENVIRONMENTAL AUDIT COMMITTEE

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

Huw Irranca-Davies (Labour, Ogmore) was elected Chair. The remaining members of the Committee were appointed on Monday 20 July 2015: Peter Aldous (Conservative, Waveney); Caroline Ansell (Conservative, Eastbourne); Jo Churchill (Conservative, Bury St Edmunds) Zac Goldsmith (Conservative, Richmond Park); Margaret Greenwood (Labour, Wirral West); Luke Hall (Conservative, Thornbury and Yate); Carolyn Harris (Labour, Swansea East); Peter Heaton-Jones (Conservative, North Devon); Mr Peter Lilley (Conservative, Hitchin and Harpenden); Caroline Lucas (Green Party, Brighton Pavilion): Holly Lynch (Labour, Halifax): John Mc Nally (Scottish National Party, Falkirk); Rebecca Pow (Conservative, Taunton Deane); Jeff Smith (Labour, Manchester Withington); Rory Stewart (Conservative, Penrith and The Border).

INQUIRIES

The Government's approach to sustainable development

On 21 July the Committee announced an inquiry into the Government's approach to sustainable development. The Committee will be exploring what impact the new Government's fiscal and legislative agenda will have on sustainable development. It will be looking to establish themes for its work during the Parliament and measures against which the Government's success can be judged.

The Airports Commission report: Carbon emissions, air quality and noise

On 23 July the Committee announced an inquiry into the Airports Commission report and the implications for Government commitments on carbon emissions, air quality and noise should the Airport Commission's recommendation of a third runway at Heathrow Airport be adopted.

Contact: Environmental Audit Committee, House of Commons, London SW1A 0AA.

Telephone: 020 7219 6150; Email: eacom@parliament.uk

HEALTH COMMITTEE

The Health Committee is appointed by the House of Commons to examine the policy, administration and expenditure of theDepartment of Health and its associated bodies

Dr Sarah Wollaston was elected Chair. The remaining members of the Committee, who were elected by the House on Wednesday 8 July, are: Dr James Davies (Conservative, Vale of Clwyd); Andrea Jenkyns (Conservative, Morley and Outwood); Liz McInnes (Labour, Heywood and Middleton); Rachael Maskell (Labour Co-op, York Central); Andrew Percy (Conservative, Brigg and Goole); Paula Sherriff (Labour, Dewsbury); Emily Thornberry (Labour, Islington South and Finsbury); Maggie Throup (Conservative, Erewash); Helen Whately (Conservative, Faversham and Mid Kent); Dr Philippa Whitford (Scottish National Party, Central Ayrshire).

INQUIRIES

Current issues in NHS England

On 14 July the Committee announced an inquiry into Current issues in NHS England. It will review the current performance of the NHS and examine how NHS England is planning to implement the vision outlined in the Five Year Forward view.

On 21 July the Committee took evidence from NHS England's Chief Executive Simon Stevens, Sir Bruce Keogh, Medical Director and Jane Cummings, the Chief Nursing Officer for England. The evidence is published on the Committee's website.

Primary care

On 30 July the Committee announced an inquiry into challenges affecting primary care services in England. It will consider whether the Department of Health and its arms' length bodies have the plans and policies in place now to ensure that high quality care is consistently available to patients at the point of need.

Contact: Health Committee, House of Commons, London SW1A 0AA

Telephone: 020 7219 6182; Email: healthcom@parliament.uk

SCIENCE AND TECHNOLOGY

The Science and Technology Committee exists to ensure that Government policy and decision-making are based on good scientific and engineering advice and evidence. The Science and Technology Committee is unusual amongst departmental select committees in that it scrutinises the Government Office for Science (GO-Science), which is a "semi-autonomous organisation" based within the Department for Business, Innovation and Skills (BIS). GO-Science "supports the Government Chief Scientific Adviser and works to ensure that Government policy and decision-making is underpinned by robust scientific evidence". The committee therefore has a similarly broad remit and can examine the activities of departments where they have implications for, or made use of, science, engineering, technology and research.

Nicola Blackwood (Conservative, Oxford West and Abingdon) was elected as Chair. The other members, appointed on 13 July, are: Victoria Borwick (Conservative, Kensington); Jim Dowd (Labour, Lewisham West and Penge); Chris Green (Conservative, Bolton West); Dr Tania Mathias (Conservative, Twickenham); Liz McInnes (Labour, Heywood and Middleton); Carol Monaghan (Scottish National Party, Glasgow North West); Graham Stringer (Labour, Blackley and Broughton); Derek Thomas (Conservative, St Ives); Matt Warman (Conservative, Boston and Skegness); Daniel Zeichner (Labour, Cambridge).

INQUIRIES

The Science Budget

On 10 July the Committee announced an inquiry into the Science Budget, ahead of the Spending Review. The deadline for written submission was Wednesday 26 August 2015.

On 15 July the Committee took evidence from Jo Johnson MP, Minister of State for Universities and Science, Gareth Davies, Director General, Knowledge and Innovation, and Philippa Lloyd, Director General, People and Strategy, Department for Business, Innovation and Skills; Sir Paul Nurse, President, The Royal Society, Professor Richard Parker, Chair, Research and Secondments Committee, Royal Academy of Engineering, Lord Stern of Brentford, President, British Academy, and Professor Sir John Tooke, President, Academy of Medical Sciences. The oral evidence is published on the Committee's website.

Science in emergencies

On 20 July the Science and Technology Committee announced an inquiry into science in emergencies after the Ebola outbreak, examining what lessons have been drawn concerning the use of scientific advice in the UK for similar disease outbreak emergencies in future.

The Big Data Dilemma

On 24 July the Committee announced an inquiry into opportunities and risks of big data. The committee will look at whether the Government is doing enough to ensure that UK entrepreneurs can benefit from the data revolution, and at data protection and privacy issues.

Contact: Science and Technology Committee, House of Commons, London SW1A 0AA

Telephone: 020 7219 2793; Fax: 020 7219 0896; Email: scitechcom@parliament.uk

TRANSPORT COMMITTEE

The Transport Committee examines the expenditure, administration and policy of the Department of Transport and its associated public bodies.

Mrs Louise Ellman (Labour, Liverpool, Riverside) was elected Chair. The remaining members of the Committee, appointed on 8 July, are: Robert Flello (Labour, Stoke-on-Trent South); Mary Glindon (Labour, North Tyneside); Karl McCartney (Conservative, Lincoln); Stewart Malcolm McDonald (Scottish National Party, Glasgow South); Mark Menzies (Conservative, Fylde); Huw Merriman (Conservative, Bexhill and Battle); Will Quince (Conservative, Colchester); Iain Stewart (Conservative, Milton Keynes South); Graham Stringer (Labour, Blackley and Broughton); Martin Vickers (Conservative, Cleethorpes).

INQUIRY

The Department for Transport and rail policy

On 14 July the Committee announced an inquiry into the Department of Transport and rail policy, and took evidence from the Secretary of State on Monday 20 July. The evidence is on the Committee's website.

Contact: Transport Committee, House of Commons, London SW1A 0AA

Telephone: 020 7219 3266; Email: transcom@parliament.uk; Twitter: @CommonsTrans

HOUSE OF LORDS SCIENCE AND TECHNOLOGY SELECT COMMITTEE

The members of the Committee (appointed 8 June 2015) are: the Earl of Selborne (Chairman), Lord Cameron of Dillington, Lord Fox, Lord Hennessy of Nympsfield, Lord Hunt of Chesterton, Lord Kakkar, Baroness Manningham-Buller, Lord Maxton, the Duke of Montrose, Baroness Morgan of Huyton, Baroness Neville-Jones, Lord Peston, Viscount Ridley and Lord Vallance of Tummel.

GM Insects

In July 2015, the Committee launched an inquiry into GM Insects. Written submissions were sought by 18 September and oral evidence will be taken in the autumn. The Committee intends to report before the end of the year.

The Relationship between EU Membership and the effectiveness of Science, Research and Innovation in the UK

In July 2015, the Committee agreed to conduct an inquiry into the relationship between EU Membership and the effectiveness of science, research and innovation in the UK. A Call for Evidence will be issued in September and oral evidence will proceed later this year.

The Dowling Review

On 7 July 2015, the Committee held an oral evidence session on the Dowling Review, hearing from Professor Dame Ann Dowling DBE, FRS, FREng, President of the Royal Academy of Engineering and Dr Hayaatun Sillem, Director of Programmes and Fellowship, the Royal Academy of Engineering. The transcript is available on the Committee's website.

Nuclear Fusion

On 21 July 2015, the Committee held an oral evidence session on the topic of nuclear fusion. The Committee heard from: Professor Steven Cowley FRS, FREng, Chief Executive Officer, UK Atomic Energy Authority, Professor of Physics at Imperial College London and Head of the EURATOM/Culham Centre for Fusion Energy (CCFE) Fusion Association; Dr David Kingham, Chief Executive Officer, Tokamak Energy; and Dr Sharon Ellis, Deputy Director, Research Councils Unit, Department for Business, Innovation and Skills. The transcript is available on the Committee's website.

The Resilience of the Electricity System

In July 2014, the Committee launched an inquiry into the resilience of electricity infrastructure. Responses to the Call for Evidence were invited by late September 2014. The inquiry focused on the resilience of the UK's electricity infrastructure to peaks in demand and sudden shocks. It was interested in the resilience of the system both in the short term (to 2020) and in the medium term (to 2030) as electricity generation is decarbonised. Oral evidence was taken across the autumn and concluded in late January 2015. The Committee reported on 12 March 2015. A Government response was published in June 2015. A debate in the Chamber on the report and the Government response is being sought.

FURTHER INFORMATION

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

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (POST)

RECENT POST PUBLICATIONS

Sugar and Health

May 2015 POSTnote 493

Sugars can be added to food and drinks or occur naturally in fruit, vegetables and milk. A high sugar diet increases the risk of tooth decay and weight gain, and high consumption of sugar-sweetened drinks is associated with type 2 diabetes. This paper describes trends in sugar consumption in the UK, the public health implications and outlines policy options.

UK Broadband Infrastructure

May 2015 POSTnote 494

The growing use of smart phones and data intensive services (such as video streaming), has increased demand for both fixed and mobile internet. This POSTnote looks at patterns in broadband access and use, and the technical and policy challenges of enhancing UK broadband infrastructure to meet future needs.

Obesity Treatments

June 2015 POSTnote 495

A quarter of adults in the UK are clinically obese and therefore at an increased risk of developing chronic diseases. NHS advice is to eat fewer calories and take more exercise to lose weight. Increasingly, drug treatments and surgery are being considered as a means to lose weight for extremely obese people who have had difficulty in adhering to lifestyle changes. This briefing discusses the current methods used to manage and treat obesity.

Trends in Transport

June 2015 POSTnote 496

Transport is a key driver of economic growth. It links people to their workplaces and connects businesses. It also affects health, the environment and societal wellbeing. This POSTnote looks at why transport is changing, outlines current trends across and within transport sectors and considers the planning of transport networks.

Regulation of Synthetic Biology

June 2015 POSTnote 497

Synthetic biology can be defined as the design and engineering of novel biologically-based parts, devices and systems or the redesign of existing biological systems. It may deliver potential benefits across a wide range of applications. However, some future applications may raise social and ethical issues and challenge current regulatory systems. This POSTnote examines the potential benefits and challenges.

Trends in Political Participation

June 2015 POSTnote 498

Over the last fifty years in the UK, some aspects of participation in formal politics have decreased, such as political party membership. But new forms of participation, such as online activism, have emerged, which may become increasingly important, especially for younger people. This POSTnote discusses trends in political participation, with a focus on new forms, drivers of these trends and how UK democratic institutions are responding.

Novel Food Production

June 2015 POSTnote 499

Food production systems worldwide may have to adapt radically to meet the rising global demand for food. Emerging approaches in the food sector include controlled-environment farming, alternative animal feeds, edible insects, and lab-cultured meat. This POSTnote considers these new technologies and summarises their respective advantages and limitations.

Towards 2020 and Beyond

June 2015 POSTnote 500

This note focuses on policy drivers leading towards 2020 and beyond. It looks at the relationship between UK policy and the following drivers: people (demographics), technological change, climate change, resource security and sustainability, inequality, and governance issues.

CURRENT WORK

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

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

Physical sciences and IT – Commercial Space Activities, Trends in ICT, Automation in Military Operations

Social Sciences – Preventing extremism, Trends in Education

CONFERENCES AND SEMINARS

What Went Wrong With the Polls?

On June 10th, POST hosted a working breakfast for MPs, Peers and their staff on what may have gone wrong with pre-election polls, why the exit polls succeeded where other polls failed, and where election polling goes from here. We also asked whether polling data affected the way the campaigns were run, or even the result itself. The speakers included: Lord Finkelstein, Times journalist and peer; Professor John Curtice, Professor of Politics at the University of Strathclyde and President of the British Polling Council; Professor David Spiegelhalter, Winton Professor of the Public Understanding of Risk, University of Cambridge; Penny Young, Librarian and Director General of Information Services at the House of Commons; Professor David Firth, Professor at the University of Warwick's Department of Statistics and exit pollster; and Ben Page, Chief Executive of Ipsos MORI.

Waking Up to UK Futures

On 23rd June, POST hosted a working breakfast for MPs, Peers and their staff to discuss five areas that are the focus of the UK Government's futures work, Robotics and Autonomous Systems, Internet of Things, Financial Technologies, Cities and the Future of Ageing. It was chaired by Lord Peter Hennessy. The speakers included: Professor David Lane, Professor of Autonomous Systems Engineering at the Ocean Systems Laboratory Heriot-Watt University; Mr Stephen Pattison, Head of Government Relations, ARM Holdings; Dr Louise Beaumont, Head of Public Affairs and Marketing for GLI Finance; Professor Sir Alan Wilson, Professor of Urban and Regional Systems in the Centre for Advanced Spatial Analysis at University College London; Professor Sarah Harper, Professor of Gerontology at the University of Oxford, Director of the Oxford Institute of Population Ageing and Senior Research Fellow at Nuffield College, University of Oxford; Jessica Bland, Principal Researcher in the Policy and Research team, NESTA; and Josef Hargrave, Head of coordination and delivery of global and regional foresight activities, ARUP.

Valuing our Life Support Systems Report Launch

On 25th June, POST hosted a seminar to launch the Natural Capital Initiative's 'Valuing our Life Support Systems' summit report summarising the findings of the 2014 meeting and its recommendations for future activity. It was chaired by Barry Gardiner MP. The speakers included: Professor Rosie Hails, Chair of the Natural Capital Initiative, Science Director for Biodiversity and Ecosystem Science at the Centre for Ecology and Hydrology (CEH); Professor Mike Acreman, Science Area Lead on Natural Capital at the Centre for Ecology and Hydrology and visiting Professor at University College London; Will Evison, Assistant Director and Environmental Economist, PwC; Professor Bill Sutherland, President of the British Ecological Society and Miriam Rothschild Professor of Conservation Biology at the University of Cambridge; and, Dr Ruth Waters, Head of Profession for the Ecosystem Approach in Natural England.

Vegetative and Minimally Conscious States

On 30th June, POST, in collaboration with the Wellcome Trust, hosted a seminar exploring the medical, legal and ethical challenges associated with the care of patients in vegetative and minimally conscious states. Medical advances mean that increasing numbers of people survive trauma, stroke, periods of low oxygenation and severe brain infections. Some, however, are left with substantially reduced consciousness in either a vegetative or minimally conscious state. It was chaired by Dr Sarah Bunn and the speakers were: Paul Woodgate, Humanities & Social Science Research Funding at the Wellcome Trust; Judy Taylor, Co-Founder and Trustee of Brain Injury is BIG; Professor Lynne Turner-Stokes, Professor of Rehabilitation at King's College London and Chair of the Royal College of Physicians' Guidelines development Group for prolonged Disorders of Consciousness; Professor David Menon, Head of Division of Anaesthesia, University of Cambridge and Honorary Consultant, Neurosciences Critical Care Unit, Addenbrooke's Hospital; and the Honourable Mr Justice Baker, Family Division Liaison Judge for the Western Circuit, Royal Courts of Justice.

Future of Natural Gas

On 16th July POST hosted a working breakfast for MPs, Peers and their staff to discuss the future of UK natural gas production, gas use in the electricity, heat and transport sectors and the gas distribution network. It was chaired by Lord Oxburgh. The speakers included: Peter Mather, Vice President Europe and Head of UK, BP; Francis Egan, CEO, Cuadrilla; Ben Caldecott, Director of Stranded Assets Programme, Oxford University; Prof Jim Watson, Research Director, UK Energy Research Centre; Amy Clemitshaw, Head of Fossil Fuel and CCS Policy, Department of Energy and Climate Change; Jo Coleman, Strategy Development Director, Energy Technologies Institute; Mark Lewis, Low Carbon Economy Manager, Tees Valley Unlimited and Dr Paul Dodds, Lecturer, University College London.

STAFF, FELLOWS AND INTERNS AT POST

Fellows

Klara Wanelik, University of Oxford, Natural Environment Research Council

Helen Snell, University of Aberdeen, Natural Environment Research Council

Jonathan Carruthers, Rothamsted Research, Biotechnology and Biological Sciences Research Council

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

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

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

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

Claire Louise Carter, Science Policy Research Unit, University of Sussex, Economic and Social Research Council

David Neale, Faculty of Education, University of Cambridge, Economic and Social Research Council

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

Leila Jameel, Department of Experimental Biology, University College London, Economic and Social Research Council

Sarah Foxen, Department of Modern Languages, University of Exeter, Arts and Humanities Research Council

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Joshua Rogers, University of Durham, Nuffield Foundation

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HOUSE OF COMMONS LIBRARY SCIENCE AND ENVIRONMENT SECTION

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

Summaries of new and recently updated briefings are opposite.

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RECENT PUBLICATIONS

Reforming the Electronic Communications Code

26.5.15 | CBP-7203

The Electronic Communications Code, which facilitates the installation and maintenance of electronic communications networks, has long been considered in need of reform.

In early 2015 the Coalition Government tabled an amendment to the Infrastructure Bill (now the Infrastructure Act 2015) which would have substantially reformed the Code along the lines of the Law Commission's recommendations. The amendment was later dropped amid criticism from stakeholders. A nine-week consultation on reforms to the Code then followed, and closed on 30 April 2015.

In the Productivity Plan published after the summer 2015 Budget, the Conservative Government announced that it planned to introduce legislation in the first session of the (2015-20) Parliament to reform the Electronic Communications Code. This briefing paper looks at attempts to reform the Electronic Communications Code, including the Coalition Government's withdrawn amendment to the Infrastructure Bill in early 2015, and the subsequent consultation on Code reforms.

New Psychoactive Substances

4.6.15 | CBP-7215

New Psychoactive substances (commonly referred to as 'legal highs') are a relatively new challenge in drugs policy. This briefing covers the background to these substances, policies to target them, the current legislative framework and the New Psychoactive Substances Bill, recently announced in the Queen's Speech.

New psychoactive substances (NPS) are designed to mimic the effects of a range of traditional controlled drugs and, in contrast to traditional illicit drug use, their use is increasing. They can be a challenge to control under existing drugs legislation and new versions of substances develop at a swift rate to attempt to avoid the current controls. As a result of this, new policies to target them have been introduced. These include Temporary class drug orders and the use of alternative legislation.

This Briefing paper provides a background to NPS, including problems of definition, speed of development and prevalence of use and their associated harms. It provides an overview of current legislation in this area, the considerations of a Government appointed expert panel review and the new Bill.

Food Waste

10.6.15 | SN07045

Food poverty, and a rise in food bank use, has recently brought the issue of food waste to Parliament's attention.

The House of Commons Environment, Food and Rural Affairs Committee's report, Food security: demand, consumption and waste (January 2015) called for Defra to appoint a Food Security Co-ordinator to spur a step change in the redistribution of surplus food to those in need.

The All-Party Parliamentary Group on Hunger and Food Poverty suggested in its December 2014 Feeding Britain report that re-distributing and using surplus food would be the 'next big breakthrough' in eliminating hunger in the UK. It also called for the creation of a new, national network of the food industry, food banks and government working to match food needs to resources at local level.

The House of Lords EU Committee report on EU food waste, Counting the Cost of Food Waste (April 2014) highlighted a need to maintain momentum on EU food waste reduction and obtain more accurate data.

It is estimated that the UK produces 15 million tonnes of food waste annually – UK households produce almost half of this. Avoidable household food waste has reduced by 21% since 2007 but the average UK household still throws away the equivalent of six meals per week.

This note describes further the scale and implications of food waste, and sets out industry and other responses to tackle it.

Support for Science

19.6.15 | CBP-7237

Public funding for research comes from a mix of devolved (eg Higher Education Funding Council for England) and UK (eg Research Councils) institutions. Bodies like Innovate UK have a specific focus on industrial research. Within these broad frameworks, grants are awarded on a competitive basis.

Successive governments have sought to protect the science budget – both in terms of recurring and capital costs. The latter are increasingly being linked to earmarked projects, a recent one being the Alan Turing Institute based at the British Library. The non-capital science budget, held by the Department for Business, Innovation and Skills, currently stands at £4.6 billion per annum. The Conservative Party Manifesto 2015 provides an outline of the new Government's general policy commitments in this area.

Planning for Onshore wind

22.6.15 | SN04370

In England the planning process for onshore wind developments varies according to size. The former Government temporarily expanded the planning appeals recovery criteria to allow the Secretary of State to take the final decision on onshore wind appeals. This expired in April 2015. The new Government has not yet said whether it plans to renew this power.

This note sets out planning policy for onshore wind development, controls in place, rules on separation distances, possible community benefits and new Government proposals for change. It applies to England only.

Shale Gas and Fracking

25.6.15 | SN06073

Shale gas is extracted from solid rock using a process called hydraulic fracturing, or 'fracking'. The Royal Society and Royal Academy of Engineering have reviewed the risks associated with fracking. They concluded that the health, safety and environmental risks can be managed effectively in the UK by implementing and enforcing best operational practice. However, they made several recommendations including calling for more research on the carbon footprint of shale gas extraction. In the UK, drilling for shale gas is at only the exploratory phase. But the rapid development of shale gas resources in North America has transformed the world gas-market outlook.

The regulatory regime for fracking in the UK is covered in this note along with comment on environmental concerns. It also covers the new access provisions and debate on fracking during the Infrastructure Bill's passage through Parliament.

The UK 4G spectrum auction and mobile coverage

20.7.15 | SN06383

Ofcom auctioned radio spectrum needed for 4G mobile devices in 2013, raising £2.34 billion (less than Treasury forecasts). This briefing summarises the details of the auction, potential interference with digital television and future plans for the 700 MHz lot of spectrum.

ACTIVITIES

In addition to providing bespoke briefings for MPs, and publishing briefing papers such as those highlighted above, the section has prepared debate packs, containing briefing and supporting press and parliamentary material, for debates on: Air pollution in London; Effect of Gypsies and Travellers on local communities; Opposition Day debate on Climate Change; Food Waste; Access to drugs for ultra-rare diseases; Superfast Broadband Rollout; Science and research in the UK and regional economies; Shale gas; Coastal flood risk; and Sentencing for cruelty to domestic pets.

The Section bid farewell to Michael Everett who competed a six month secondment to the section, and welcomed a new member of the team, Sara Priestley, formerly a specialist working for the Environment, Food and Rural Affairs Committee.

During the election dissolution the whole SES team visited the RSPB reserve in Sandy, Bedfordshire, and had a series of briefings with policy advisers there. Some of the team took up the chance to visit businesses as part of a placement scheme run by the Industry and Parliament Trust. David Hough, Sara Priestley and Ed White visited the University of Lancaster and heard about the latest developments in research into energy, environment and climate change policies and issues being undertaken by the University.

A number of the team have participated in stakeholder engagements arranged by committee staff with Imperial College, University of London, the Environment Agency and the National Farmers Union. David Hough and Grahame Danby took part in outreach events designed to help academic institutions to understand the workings of Parliament and how to communicate research findings to MPs through engagement with the Library and Select Committees.

Research Councils UK

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

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

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

Biotechnology and Biological Sciences Research Council (BBSRC)

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

Economic and Social Research Council

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

EPSRC

Pioneering research and skills

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

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

Medical Research Council

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

Natural Environment Research Council

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NERC is the UK's leading public funder of environmental science. We invest £330 million each year in cutting-edge research, postgraduate training and innovation in universities and research centres.
Our scientists study the physical, chemical and biological processes on which our planet and life itself depends – from pole to pole, from the deep Earth and oceans to the atmosphere and space.
We partner with business, government, the public and the wider research community to shape the environmental research and innovation agenda. Our science provides knowledge, skills and technology that deliver sustainable economic growth and public wellbeing.

Science & Technology Facilities Council

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

Alzheimer's Research UK

The Power to Defeat Dementia

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

Association of the British Pharmaceutical Industry

abpi
Bringing medicines to life

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

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

AIRTO

airto
making innovation happen

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

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

AMPS

AMPS
The Association of Management and Professional Staffs.

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

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

BIOCHEMICAL SOCIETY

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The Biochemical Society works to support the advancement of the molecular biosciences; facilitating the circulation of knowledge and supporting innovation, raising awareness of the importance of our discipline in addressing societal grand challenges.

We achieve our mission by:

- Supporting the next generation of biochemists
- Bringing together molecular bioscientists; fostering connections and providing a platform for collaboration and networking
- Promoting and sharing knowledge through meetings, publications and public engagement
- Highlighting the role of molecular biosciences in interdisciplinary and translational research, while supporting the fundamental science that underpins applied studies

The British Ecological Society

British Ecological Society

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

British In Vitro Diagnostics Association (BIVDA)

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

British Nutrition Foundation

BRITISH Nutrition FOUNDATION

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

BRITISH PHARMACOLOGICAL SOCIETY

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

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

The British Psychological Society

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

The British Society for Antimicrobial Chemotherapy

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www.e-opat.com | www.nas-pps.com
|www.appg-on-antibiotics.com
www.bsacsurv.org

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

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

British Society for immunology

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

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

British Society of Soil Science

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

Brunel University London

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

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

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

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

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

Cavendish Laboratory

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

The research programme covers the breadth of contemporary physics

Extreme Universe: Astrophysics, cosmology and high energy physics

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

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

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

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

The Cosmetic Toiletry & Perfumery Association | ctpa

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www.thefactsabout.co.uk

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

Clifton Scientific Trust

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

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

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

Clifton Scientific Trust Ltd is registered charity 1086933

The Council for the Mathematical Sciences

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

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

Eli Lilly and Company Ltd

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

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

Energy Institute

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The Energy Institute (EI) is the chartered professional body for the energy sector, supporting over 20,000 individuals and 250 companies worldwide. The EI provides learning and networking opportunities, professional recognition and technical and scientific knowledge resources on energy in all its forms and applications.

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

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

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.

Fera

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

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

First Group

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

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

GAMBICA Association Ltd

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

The Geological Society

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The Geological Society is the national learned and professional body for Earth sciences, with 11,500 Fellows (members) worldwide. The Fellowship encompasses those working in industry, academia and government, with a wide range of perspectives and views on policy-relevant science, and the Society is a leading communicator of this science to government bodies and other non-technical audiences.

Glass and Glazing Federation

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

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

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.

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. We are a charitable organisation with a worldwide membership of more than 50,000, working together to advance physics education, research and application.

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

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

Visit us at www.iop.org, follow us @physicsnews

Institute of Physics and Engineering in Medicine

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IPEM is a registered, incorporated charity for the advancement, in the public interest, of physics and engineering applied to medicine and biology. Its members are medical physicists, clinical and bio-engineers, and clinical technologists. It organises training and CPD for them, and provides opportunities for the dissemination of knowledge through publications and scientific meetings. IPEM is licensed by the Science Council to award CSci, RSci and RSciTech, and by the Engineering Council to award CEng, IEng and EngTech.

IChemE

ADVANCING CHEMICAL ENGINEERING WORLDWIDE

The Institution of Chemical Engineers

With over 42,000 members in 120 countries, IChemE is the global membership organisation for chemical engineers. A not for profit organisation, we serve the public interest by building and sustaining an active professional community and promoting the development, understanding and application of chemical engineering worldwide.

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

Institution of Civil Engineers

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

Institution of Engineering Designers

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

IET The Institution of Engineering and Technology

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

Institution of Mechanical Engineers

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

LGC

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

Under the Government Chemist function, LGC fulfils specific statutory duties as the referee analyst and provides advice for Government and the wider analytical community on the implications of analytical chemistry for matters of policy, standards and regulation. LGC is also the UK's designated National Measurement Institute for chemical and biochemical analysis.

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

The Linnean Society of London

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

A Forum for Natural History

L'ORÉAL UK AND IRELAND

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L'Oréal employs more than 3,800 researchers world-wide and dedicates over €850 million each year to research and innovation in the field of healthy skin and hair. The company supports women in science research through the L'Oréal UNESCO For Women In Science Programme and engages young people with science through the L'Oréal Young Scientist Centre at the Royal Institution. L'Oréal also collaborates with a vast number of institutions in the UK and globally.

Marine Biological Association

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

Met Office

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

National Physical Laboratory

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

Natural History Museum

Advancing the science of nature

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

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

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

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

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

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

NEF: The Innovation Institute

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

- Businesses
- Education providers
- Government bodies

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

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

The University of Northampton

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The University of Northampton is a Top 50 UK University*. We are committed to science education through initial teacher training, a STEM Ambassador network which works within the community and teaching and research to doctoral level. We are an Ashoka U 'Changemaker Campus' status university recognising our commitment to social innovation and entrepreneurship.

(*Guardian University Guide 2015)

The University of Nottingham

UNITED KINGDOM · CHINA · MALAYSIA

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

PHARMAQ Ltd

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

The Physiological Society

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Physiology is the science of how molecules, cells and organs work in the body. Representing over 3000 life scientists, The Physiological Society supports scientific research through its grants schemes, conferences and its three open access journals.

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

Prospect

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Prospect is an independent, thriving and forward-looking trade union with 117,000 members across the private and public sectors and a diverse range of occupations. We represent scientists, technologists and other professions in the civil service, research councils and private sector.

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

Rainbow Seed Fund

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

risksolutions

leave nothing to chance

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

Using traditional qualitative and quantitative methods, combined with cutting-edge participative approaches, we work with clients from across the public and private sectors, their stakeholders and customers, to bring a depth of understanding of the issues and to develop consensus about how to tackle them.

Our small, highly motivated and client focused team delivers:

- policy design, appraisal and decision support
- risk assessment and risk based strategies and plans
- evaluation, assurance and organisational review, and
- training, coaching and guidance.

ROYAL ACADEMY OF ENGINEERING

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

Royal Botanic Gardens, Kew

Kew ROYAL BOTANIC GARDENS

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

Kew's strategic priorities for science are:

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

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

Ri The Royal Institution Science Lives Here

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

The Royal Society

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The Royal Society is the 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.

Royal Society of Biology

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

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

Society for Applied Microbiology

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

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

Society for Underwater Technology

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

SCI

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

Society of Cosmetic Scientists

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

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

Society of Maritime Industries

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

STEMNET

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

- STEM Ambassadors - We run the UK network of STEM Ambassadors: over 30,000 inspiring volunteers
- STEM Clubs Programme - We provide free, expert advice and support to all schools which have set up or plan to develop a STEM Club
- Schools' STEM Advisory Network (SSAN) - We deliver free impartial advice to teachers and use our business links and partnerships to enhance the STEM curriculum in secondary schools in the UK

Universities Federation for Animal Welfare

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Registered in England Charity No: 207996

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

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

The Welding Institute

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

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

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

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

SCIENCE DIARY

THE PARLIAMENTARY AND SCIENTIFIC COMMITTEE

Tel: 020 7222 7085
office@scienceinparliament.org.uk
www.scienceinparliament.org.uk

Tuesday 13 October 17.30
Patient Safety
Discussion meeting

Tuesday 3 November 17.30
Soil
Discussion meeting

Tuesday 17 November
Annual Lunch (invitation only)
Guest of Honour: Sir Paul Nurse PRS
President, Royal Society

Wednesday 18 November
Breakfast meeting (invitation only)

Tuesday 8 December
Drones
Breakfast meeting (Invitation only)

Royal Society of Biology Biology Week 2015
Parliamentary Launch
Wednesday 14 October 2015
7pm Churchill Room
House of Commons

THE ROYAL SOCIETY

Details of all events can be found at www.royalsociety.org/events

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY

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

THE ROYAL INSTITUTION

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

THE INSTITUTION OF MECHANICAL ENGINEERS

For details of events visit: www.imeche.org/events

THE LINNEAN SOCIETY OF LONDON

For details visit: www.linnean.org

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

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IAT Institute for Aerospace Technology

The University of Nottingham

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Aerospace research with industrial impact

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Stephen Metcalfe MP and Chi Onwurah MP

invite you to attend the Parliamentary Reception to celebrate

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