SCIENCE IN PARLIAMENT
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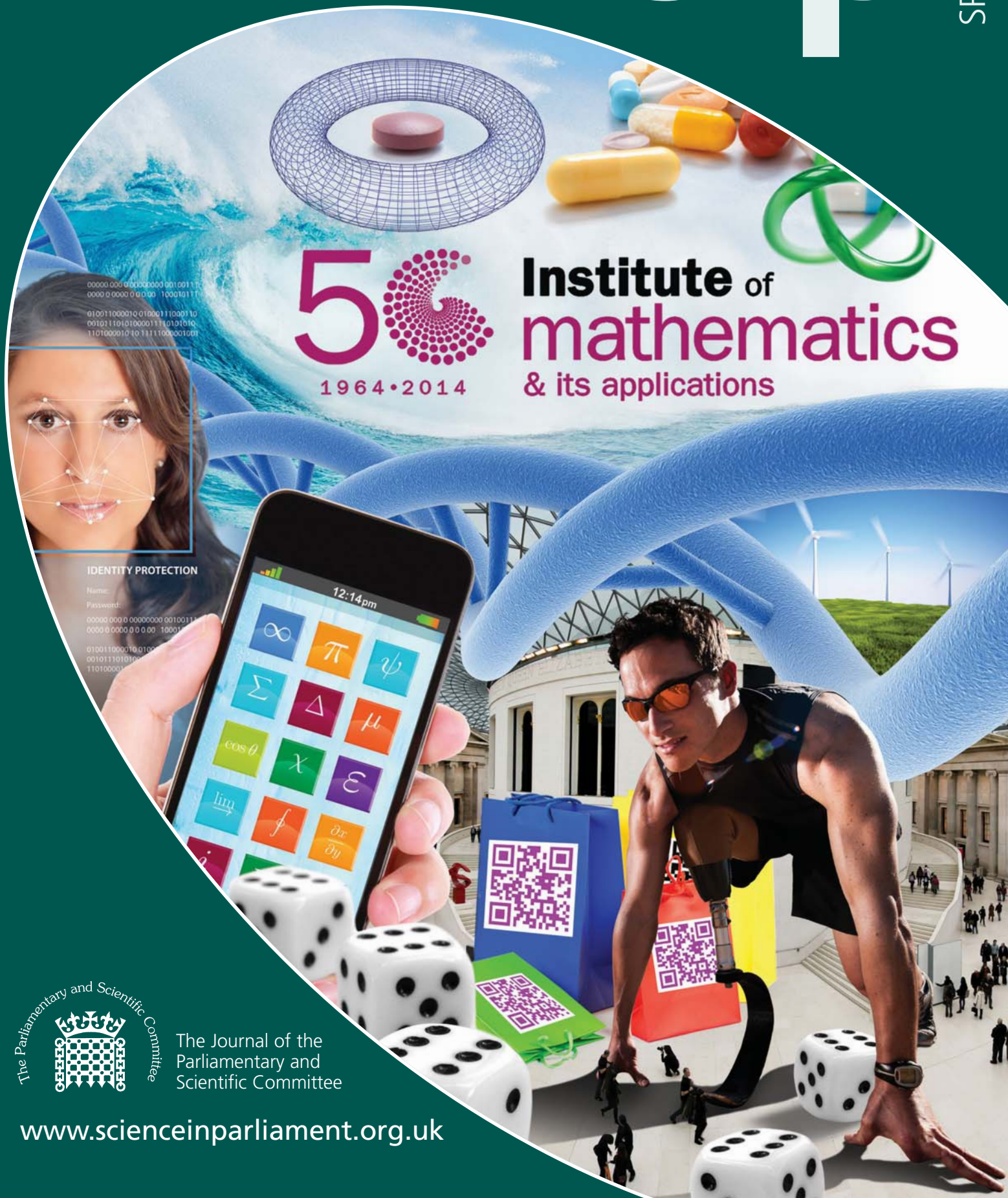
SPRING 2014



The Parliamentary and Scientific Committee
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Inside: Vice-Chancellor Professor David Greenaway on creating a global hub for drug discovery at the University's GlaxoSmithKline Carbon Neutral Laboratory for Sustainable Chemistry

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Andrew Miller MP
Chairman, Parliamentary and Scientific Committee

The latest buzz word is "infrastructure."

Britain used to be great at building canals and railways, but we sometimes seem to lack confidence despite a number of great success stories.

The Channel Tunnel reached completion about 150 years after starting, and HS1 then took a further decade.

Crossrail is now well on the way to completion after 40 years debate, the same delays will be disastrous in respect of HS2 and London's next airport, whichever side of the fence you are on.

Nearer to home, the House of Lords Select Committee has recently (November 2013) reported on "Scientific Infrastructure".

Their conclusion is that while the UK is reasonably well supplied with major equipment, there is almost always inadequate provision for maintenance, repair and depreciation, to say nothing of decommissioning. This means that equipment is not always used as intensively as desirable.

The problem is that such costs are boring compared with the excitement of launching a new piece of kit.

It is also a reflection of the paucity of expertise in the Treasury in running major projects.

On a totally different scale, the oceans are a major natural asset, and some recent chemical data are giving rise to concern.

The inexorable rise of CO_2 in the atmosphere is having two consequences for the seas. The first may be benign – an increase in algal photosynthesis. This increase in biomass *may* provide extra nourishment for sea creatures.

The second – increasing acidity through absorbing the gas – is more worrying. Although the pH has only moved from 8.11 to 8.06 during the past twenty-five years (data have not been collected for long), because the scale is logarithmic, this means a 12% rise in hydrogen ion concentration. Many shells and exoskeletons are made of calcium carbonate which is susceptible to dissolution in acid.

Better book your trip to the Great Barrier Reef while it is still there.

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

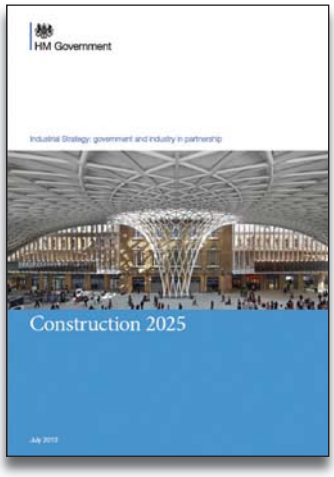
The Parliamentary and Scientific Committee

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

CONTENTS

The Industrial Strategy For Construction: CONSTRUCTION 2025

Peter Hansford
Government Chief Construction Adviser



Construction 2025[1] was launched on 2 July 2013. It sets out a vision for how industry and Government will work together over the next decade to change the UK construction industry.

It starts with a vision of a world different from the past – and from today – where buildings and infrastructure are conceived and built much faster, with greater whole-life value and better carbon and energy performance. A vision where construction drives growth across the whole economy, and with UK companies working in partnership in markets overseas. The vision is that by 2025 construction has been radically transformed.

... world different from the past ...

The strategy sets out ambitions for 2025:

- a 33% reduction in the initial cost of construction and the whole life cost of assets;
- a 50% reduction in the time from inception to completion for new build and refurbished assets;
- a 50% reduction in greenhouse gas emissions in the built environment; and
- a 50% reduction in the trade gap between exports and imports for construction products and materials – with more built in Britain.

We will not achieve these ambitions by small changes; the task requires industry to do things differently. In tackling this, *Construction 2025* has five broad themes.

PEOPLE

People are at the heart of construction. To transform construction in the UK we must attract and retain the right people – multi-skilled, diverse, creative and hard working – and become an industry of choice. To achieve this we need to fundamentally change how the construction industry is perceived by the public.

We need to inspire the next generation – both girls and boys – to embark on careers in our industry. This must start before school curriculum choices have to be made. In addition we need to inspire teachers and parents, as they are very influential when it comes to career choices.

... inspire the next generation ...

We must also remember the public's main point of contact with the construction industry is through the domestic improvements sector. We therefore need to drive up standards in the domestic market.

In tackling the image of the industry we must address working conditions. The UK construction industry has made enormous progress over the last decade to improve site safety; but we still have a long way to go. We must now bring the same focus on safety to occupational health.

Lack of diversity in construction has a huge impact on the image of the industry. Less than 14% of people in construction are women and only 2% are from ethnic minority groups, far from being representative of UK society. Our goal must be to create a working environment that is comparable to those in other sectors of today's economy, making this industry a great place in which to pursue a career.

We must do all this while increasing the capability in the workforce. As the economy emerges from the recession, construction firms must recruit and retain competent people in sufficient numbers to meet the increasing demand for construction. The industry will need people with new skills who can deliver change over the next decade.

SMART

Technology is moving fast, even in construction. We are moving towards a digital economy, which has profound implications for our built environment. We must ensure

UK construction remains at the vanguard of smart construction and digital design.

We have made a good start through the Building Information Modelling programme (BIM). These digital approaches to how we design, manufacture, assemble and manage facilities are starting to transform the way construction is carried out. Impressive efficiencies are being realised, with around 20% savings on some projects now being delivered. Only through the implementation of digital techniques will we be able to deliver more sustainable

SUSTAINABLE

The transition to a low carbon economy presents the industry and Government with opportunities for growth. Environmental considerations will transform what we build, what materials we build with and how we build it, reaching into every part of the supply chain. One of the biggest areas of opportunity is our existing housing stock, which accounts for over half of the greenhouse gas emissions from the built environment.

The construction industry has perhaps the most influence over

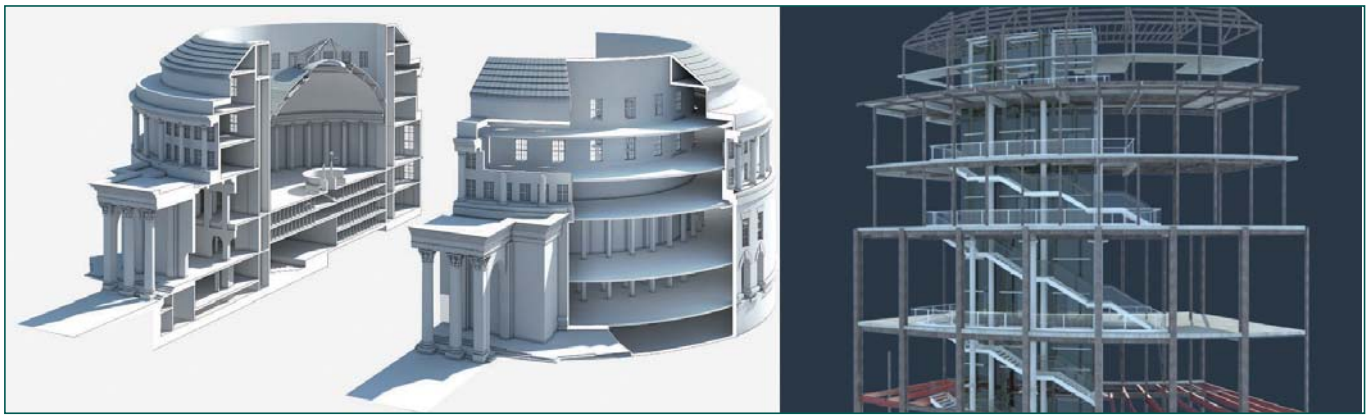
... drive up standards ...

buildings, more quickly and efficiently, with far less process waste.

These techniques are also critical to the successful implementation of a wider off-site manufacturing strategy. The benefits of off-site construction

its carbon impact in infrastructure. In this area, less carbon can equate to less capital cost, and indeed to lower whole-life costs. There is now a challenge to realise this for buildings.

For an industry to be sustainable it is important for



include greater precision and quality, reducing overall time in manufacture and assembly, and safer and cleaner working conditions.

We have in the UK a world-class science and research base that supports the development of innovative solutions in a number of priority areas. These solutions need to be exploited across the industry.

clients to provide as much visibility as possible of the workload ahead. A better understanding of the shape of future work prospects in all the

... implementation of digital techniques ...

key markets provides business with a basis to make investment decisions. Government has been publishing a pipeline for infrastructure and construction

opportunities since 2011, and is now working to make this easier for businesses to use.

GROWTH

The global construction market is increasing rapidly – over 4% per year to the end of the decade – with substantial growth in emerging economies.

... making this industry a great place ...

Transforming the UK construction industry provides significant opportunities for global trade.

The UK has a reputation for architecture, design and engineering. We lead the world in sustainable construction solutions and in digital engineering, and we have a strong reputation for our collaborative forms of contract and ethical business practices. These all provide great opportunities for economic growth.

To achieve this there must be a resilient supply chain. The

ability of construction companies to access the right type of finance is vital. There is a significant problem with cash flow in the industry –

addressing this is therefore a key priority if we are to bring about an industry that drives growth across the entire economy.

LEADERSHIP

Developing the strategy is one thing; taking it forward in partnership between industry and Government needs clear and strong leadership. To this end, we have created a new body to own and implement the strategy – the Construction Leadership Council.

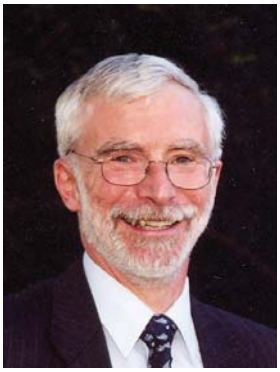
The new Council is co-chaired by Vince Cable and by Sir David Higgins, and comprises representation from across the industry. The task of the Chief Construction Adviser is to work with the Council and with industry bodies to make this strategy happen.

Construction 2025 is about transforming construction to deliver projects with better value, faster, with lower carbon emissions and with more products and materials sourced and built in Britain. The task of

making it happen is not just for government, not just for industry, but requires a joint desire, joint resourcing and joint commitment. With this true sense of collaboration – of partnership – we will achieve radical change for 2025.

1 This is an extract taken from the JCT Povey Lecture given by Peter Hansford on 14 November 2013. Lecture notes can be downloaded in full from http://www.jctltd.co.uk/povey-lecture.aspx

Mathematics research – why is it important? And the IMA – what is it for?



Tim Pedley and Nigel Peake, Department of Applied Mathematics & Theoretical Physics, University of Cambridge

In 2014 the Institute of Mathematics and its Applications (IMA) celebrates its 50th anniversary. We will describe what the IMA has done later in the article, but first we want to address a bigger question: why is mathematics research important to the UK?

We start with some numbers. In 2012 Deloitte, commissioned by the EPSRC and the Council for Mathematical Sciences[1] (CMS), completed an analysis[2] of the effects of mathematics research on the UK economy. Their conclusions are striking. In 2010, mathematics research directly contributed 2.8 million jobs and £208 billion in Gross Value Added (GVA) to the UK economy (the latter being 16% of the total GVA), spread over a wide range of sectors. There is no surprise that large contributions were identified in banking & finance (£27 billion) and computer services (£19 billion). Perhaps more surprisingly there were almost equally significant contributions to pharmaceuticals (£16 billion) and construction (£13 billion). 80% of all UK jobs in the R&D sector and 50% in aerospace can be identified with the mathematical sciences. These tangible financial effects are matched, or arguably exceeded, by the contributions of mathematics research to the public good, through improved healthcare, national security, the entertainment industry, et cetera.

How does mathematics research have such a large effect on the UK economy and national life? The answer is that mathematics is a ubiquitous part of the physical and virtual infrastructure of the 21st century; it plays a key role in design, manufacturing and optimisation as practised by the whole gamut of UK industry; it underpins uncertainty forecasting and future planning; and it is at the heart of national and cyber security. Let us look at three examples from the last 50 years of mathematics research in action. These are all taken from 'Mathematics Matters', the IMA's recent series of one-page case studies[3].

Internet shopping: stopping the scammers. The dangers of online fraud are well-known to anyone using the internet, but the cost to UK business is enormous (in 2009 £60 million was lost by UK banks in online phishing attacks alone). The secure transfer of data online is done using Public Key encryption, a technique originating in mathematical number theory and developed by the mathematician Clifford Cocks working at GCHQ in 1973. Given that half of UK retail shopping may be done online by 2020, the need for more secure means of data transmission is self-evident. Work by mathematicians on 'unbreakable' quantum codes continues apace[4].

... a technique originating in mathematical number theory ...

Advancing the Digital Arts. The UK is a world-leader in computer-generated images and animation for the movie industry. Annual sales by UK companies are at least £375 million. One key mathematical challenge here lies in describing complicated moving objects by using only a limited amount of data (see figure for an example of a mathematically generated object), or in simulating physical phenomena like flowing water or smoke. In the latter case the equations describing a rushing torrent are much too difficult to solve fully, even on the world's largest computers. Part of the mathematician's art is to develop equations which give an answer which 'looks' right to the cinema audience, but is much easier to solve!

Modelling an Epidemic Emergency. In recent years the UK has been hit by a number of major outbreaks, such as the swine flu epidemic in 2009. Nationwide action was supported by mathematicians and epidemiologists working to understand the spread of infection and mitigate its effects.

A key mathematical issue here lies in coping with the large uncertainties inherent in understanding mass social interaction. In 2009, mathematical models were developed from an early stage, and continuously refined as the epidemic progressed and more data became available, allowing realistic forward planning of health services.

least through journal publication and specialist conference organisation, much of which spans the industry-academia interface.

- Policy and public engagement – working with government and research councils to enhance the public profile of mathematics and (applied) mathematical research.

... equations describing a rushing torrent are much too difficult to solve fully ...

We now want to change tack and talk about the Institute of Mathematics and its Applications[5]. The IMA is

"…the UK's learned and professional society for mathematics and its applications. The IMA exists to support the advancement of mathematical knowledge and its applications and to promote and enhance mathematical culture in the United Kingdom and elsewhere, for the public good."

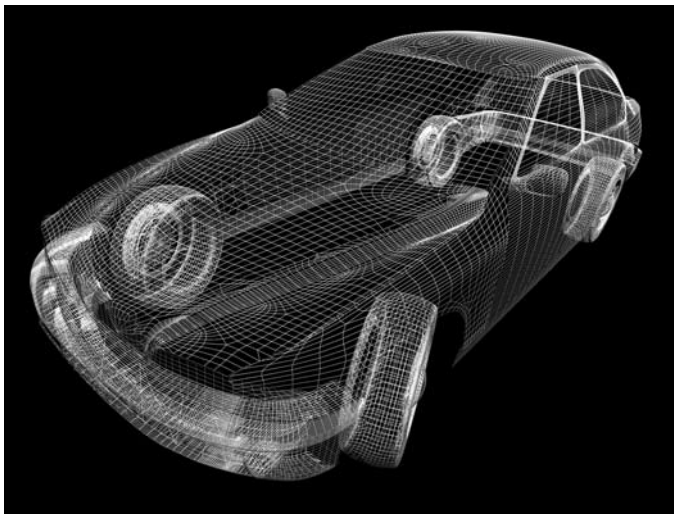
Major activities include:

- Professional affairs – helping companies design graduate training schemes in mathematics and helping individuals with their professional development, culminating in Fellowship of the IMA and designation as a Chartered Mathematician.
- Education, both in schools and in higher education – participating in national mathematical bodies such as the Joint Mathematical Council and the Advisory Committee on Mathematics Education, curriculum design, contributing to the HE-STEM programme, offering the Chartered Mathematics Teacher recognition (instituted in 2008).
- Research – supporting mathematical research in industry and universities, not

Since the IMA was founded, the nature of applied mathematics research has changed a lot. In 1964, most was in areas of classical physics – mechanics (of fluids and solids) and electromagnetism – with practical applications in various branches of engineering, meteorology, astrophysics, etc. There are now many more fields in which mathematics is being applied – biology, chemistry and economics, to name but three. In addition, there have been enormous developments in the mathematics that can be applied – dynamical systems theory and chaos, partial and stochastic differential equations, control theory, optimisation theory, and numerical analysis, which underpins the computing that forms a central part of applied mathematics research today. The development of new mathematics, driven by major applications, will not slow down. Many challenges are brought into being by 'Big Data'; the new fields of compressed sensing and imaging (in which crucial information can be recovered from big data sets using few measurements, and images ranging from home photographs to medical brain scans are analysed and improved[6]) are all cases in point.

The original motivations have not gone away. Virtually every new problem involving the flow of fluids requires new mathematics – not necessarily using new techniques, but needing experience in translating real problems into mathematical form, and being able to derive an appropriate solution. This can only be provided by a good applied mathematician. This brings us to the greatest challenge that we face today: how can we increase the supply of good applied mathematicians?

What is a good applied mathematician? It is someone who knows a lot of mathematics at the appropriate level, but in addition has experience and facility at translating problems from outside mathematics into mathematical form, solving the mathematical problem, and interpreting the answer. It is necessary first to clarify the problem to be translated. Understanding a phenomenon can rarely be achieved by trying to simulate everything about it.



However, it is a common observation that even the brightest students, coming to university from some of the best schools, lack experience of applying mathematics to problems they have not seen before. Part of the trouble is that their teachers don't have this experience either. What is the answer? Anyone planning to teach sixth-form mathematics should be required to practise applying mathematics to something they haven't seen before as part of their training. Such practice should be a central part of mathematics at A-level, not just as part of an easy-to-avoid option; the same should be the case in undergraduate mathematics degrees. With any luck, after a few years our colleagues in industry will have even more reason to hire mathematicians than they have now.

What about the next 50 years? The one thing we can say with absolute certainty is that the opportunities for the application of mathematics will grow and grow, and in the UK we must position ourselves to exploit these opportunities to the full. In doing this the IMA's role in promoting applied mathematics, and in training and supporting the next generation of applied mathematicians, will be crucial.

References

1 CMS is the umbrella body representing the UK learned societies in mathematics. http://www.cms.ac.uk/

2 See http://www.epsrc.ac.uk/newsevents/news/2012/Pages/mathscire search.aspx

3 http://www.ima.org.uk /i_love_maths/mathematics_matters.cfm.html

4 http://www.cam.ac.uk/research/news/quantum-sealed-envelope-system-enables-perfectly-secure-information-storage

5 http://www.ima.org.uk/

6 http://www.damtp.cam.ac.uk/research/cia/research/

PUTTING UK PHARMACOLOGY ON THE MAP – NOW AND IN THE FUTURE

Katharine Richardson
Head of Communications and Membership, British Pharmacological Society

With over 3,000 members, the British Pharmacological Society is the primary UK learned society concerned with research into drugs and the way they work. The Society has, at its heart, the development and promotion of pharmacology and of its members who are training and working in academia, government, industry and the health service. Many of its activities are underpinned by the significant impact that drug discovery and development has on the health and wealth of the UK.

The British Pharmacological Society undertook the largest survey ever conducted with our members in order to improve our understanding of pharmacologists' needs, now and in the near future. As a result of the survey findings, the Society's leadership is committed to building greater awareness of the existing contributions of UK pharmacology to wider society and the economy, while advancing career opportunities for members to ensure breakthroughs continue in the future.

Feedback from British Pharmacological Society members

- 97% of members agree with the Society's mission to promote and advance pharmacology, including clinical pharmacology
- 89% of members are likely to recommend joining the Society to colleagues and peers who are not members
- 77-85% of members agree the Society should be doing more to raise awareness of pharmacology across various external audiences, including Government, universities and schools

Full results available from www.bps.ac.uk

RECOGNISING THE ACHIEVEMENTS OF UK PHARMACOLOGY

It was with great pleasure that the British Pharmacological Society supported a special parliamentary reception in December 2013 to honour four sites of special scientific interest linked to discoveries and contributions in pharmacology. The event formed part of the Society's new 'Putting UK Pharmacology on the Map' initiative and was the culmination of voting by MPs, peers and senior members of the scientific community. The back page of this issue includes photos of the Society's members and parliamentarians who were able to attend, including representatives of the House of Lords' and House of Commons' Science and Technology Committees, as well as the Rt Hon Liam Byrne MP, Shadow Minister for Universities, Science and Skills.

Andrew Miller MP and Stephen Metcalfe MP addressed attendees on the importance of the work of scientists, including pharmacologists, in terms of shaping the development of UK legislation and growing the economy. Andrew then kindly took on the role of Returning Officer and revealed the names of the winning sites, judged to have made outstanding contributions to the discovery and development of medicines:

• **AstraZeneca, Alderley Park:** Important advances made at Alderley Park during its 40-year history include anti-cancer treatments and the first

BPS BRITISH PHARMACOLOGICAL SOCIETY
Today's science, tomorrow's medicines

successful beta-blocker discovered by pharmacologist and Nobel Prize winner Sir James Black

- **The James Black Foundation, King's College London:** In 1988, in collaboration with Johnson & Johnson, Sir James Black established his own laboratory, primarily concerned with the development of drugs which inhibit the hormone, gastrin
- **The University of Strathclyde:** Two groups at Strathclyde developed new muscle relaxants, which have since been used extensively in anaesthesiology: one led by pharmacologist Bill Bowman, working in collaboration with Organon Laboratories; the other led by chemist John Stenlake, in collaboration with Wellcome Research Laboratories
- **Wadham College, The University of Oxford:** The British Pharmacological Society was formed in 1931, at a meeting of 19 pharmacologists at Wadham College. The Society aims to promote and advance pharmacology, including clinical pharmacology

These winners demonstrate that life-saving innovations have been accomplished by industrial, academic and NHS sites – and often through partnerships across these three sectors. Each site was awarded a special trophy to commemorate the outcome of the vote and the general consensus among attendees was that further sites that have helped to establish the world standing of UK pharmacology should be honoured in the future. The four winning sites are merely the tip of the iceberg when it comes to the achievements of UK pharmacology – in total 26 sites have already been nominated for consideration by British Pharmacological Society members!

ADVANCING THE FUTURE OF PHARMACOLOGY IN THE UK

While a third of our members are under 30 years old, the British Pharmacological Society recognises that continued investment in education, professional development and careers resources will not only support these members but also the future of pharmacology more broadly. It is worth remembering that the scientific breakthroughs in 2050 will be made by individuals who are currently undergraduates – or who haven't even left school yet!

The Society's forward-thinking approach includes activities addressing future skills provision, embracing technology and developing long term partnerships. For example, the Society is a committed member of the Drug Discovery Pathways Group (DDPG), which seeks to establish a networked community of skilled researchers to help revitalise the UK pharmaceutical sector, to provide exciting career opportunities for world-class scientists and to translate advances in biomedical research into safe and effective therapies that deliver benefit to patients and contribute to the UK's growth.

The Diploma in Advanced Pharmacology was established by the Society to extend the knowledge base of researchers who are either entering the field of pharmacology, or who wish to develop their expertise in this area. This programme has been developed by our members from academia and industry to provide an advanced pharmacological education whilst maintaining expected employee duties. Already 20 individuals have graduated, and feedback suggests that the Diploma has improved both their research and career progression.

The Society is also taking steps to provide increased opportunities and support for women in the profession. Our Women in Pharmacology committee is leading on a number of innovative initiatives for our many (36%) female members: a successful mentoring programme (in its ninth year), the AstraZeneca Prize for Women in Pharmacology (in its fifth year) and a newly-created career break membership category allowing members taking extended leave to retain all of the benefits of membership without cost and regardless of gender.

With more women than ever studying science in general, and pharmacology in particular, at university, it is the Society's hope that an increasing number will reach the pinnacle of the profession in the future. It is clear that alone we cannot solve gender imbalance in the workplace, but we are optimistic that our relatively small changes will go some way to effecting change on behalf of our members.

THE SUCCESSFUL SITES

Clive Morris, UK Strategic Implementation Lead at AstraZeneca: *"Alderley Park has a rich heritage of important advancements in the discovery and developments of life changing medicines and we are honoured to receive this prestigious award for our work. With an increasing number of life science companies being based at the site as we develop the Alderley Park BioHub, the site will hopefully continue to play an important part in the future of pharmacology in the UK."*

Professor Peter Hylands, Head of the Institute of Pharmaceutical Science, King's College London: *"We are delighted that the James Black Foundation, King's College London, has been recognised for its major contribution to UK Pharmacology. King's is proud to be associated with Sir James Black particularly his contribution to the development of gastrin inhibitors for the treatment of gastrointestinal diseases."*

Professor Philip Winn, Head of Strathclyde Institute of Pharmacy and Biomedical Sciences, University of Strathclyde: *"The University of Strathclyde is honoured to receive this award in recognition of the major contribution that the basic scientific research carried out here has made to the discovery and development of new, improved medicines. Our scientists will continue to carry out world-class research, leading to more new, useful drugs."*

Warden of Wadham College, Ken Macdonald QC: *"Since it was founded in 1610, Wadham College has seen many exceptional and world-changing scientists pass through its gates, including those famous seventeenth century polymaths who went on to found the Royal Society. We are delighted to have hosted the first meeting of the British Pharmacological Society back in 1931, and we continue to promote excellence in science and medicine through our talented students, our teaching and our research."*

INVESTING IN THE FUTURE OF SUSTAINABLE CHEMISTRY

Professor David Greenaway
Vice-Chancellor,
The University of Nottingham

Sustainability is becoming increasingly important in all areas of our life – and this is especially true in science where more and more emphasis is being placed on using greener alternatives. That is why The University of Nottingham is teaming up with pharmaceutical giant GlaxoSmithKline (GSK) to lead the way in the future development of sustainable chemistry.

The University has worked closely with GSK for many years and this innovative relationship was given a huge boost in 2012 after the announcement that the company was to donate £12m towards building a brand new facility at Nottingham – the GlaxoSmithKline Carbon Neutral Laboratory for Sustainable Chemistry. That commitment encouraged further support from the UK Research Partnership Innovation Fund and the Wolfson Foundation.

The brand new £20m facility will transform future research and teaching in chemistry, as well as pioneering new ways of building and running laboratories which not only respect the sustainability agenda, but shape it in innovative ways.

Construction has begun at the University's award winning Jubilee Campus, and it is due to open in 2015. The laboratory will provide unrivalled facilities for chemistry with a focus on sustainability that will be reflected in the building itself, which will incorporate the latest technologies to allow it to be carbon-neutral over its lifetime.

The building will be constructed from natural materials, and the energy required to run the laboratories will be met by renewable sources such as solar power and biofuel. Excess energy created by the building will provide enough carbon credits over 25 years to pay back the carbon embedded in its construction.

Sustainable chemistry is a vitally important area for the future and this commitment from GSK is a remarkable vote of confidence in both the University and the School of Chemistry.

The laboratories will focus on research that is of particular relevance to the pharmaceutical industry and which complements established expertise at the University. It will also deliver advanced undergraduate teaching and outreach to the wider scientific community to embed sustainable chemistry principles in the next generation of scientists.

As a centre of excellence, it will catalyse new collaborations with other institutions and industry partners and will bring together leading UK academics, postgraduate and postdoctoral researchers, and GSK chemists in developing expertise in sustainable chemical synthesis.

The Engineering and Physical Sciences Research Council (EPSRC) and GlaxoSmithKline are jointly contributing to the funding for new Chairs of Sustainable Chemistry, to be based at the GlaxoSmithKline Carbon Neutral Laboratory for Sustainable Chemistry.

The new Chairs will be responsible for developing and sharing best practice in green chemistry and catalysing new collaborations with other partners. Their role will be pivotal in attracting top UK academics, postgraduate and postdoctoral researchers to Nottingham. The first Chair is already in post and two others will join the Centre over the next year.

In addition to the new centre at Nottingham's Jubilee Campus, GSK employs more chemistry graduates from Nottingham than any other university in the UK, and fourth-year students have the opportunity to work on GSK projects as part of their programme.

GSK has also collaborated with the University as part of a new module – the first of its kind in the UK – introducing chemistry students to the medicinal chemistry skills the pharmaceutical industry requires, while also enhancing knowledge transfer between industry and academia.

These developments are helping to establish Nottingham as a pioneer and centre of excellence in sustainable chemistry.

More information about the GlaxoSmithKline Carbon Neutral Laboratory for Sustainable Chemistry can be found via http://www.nottingham.ac.uk/estates/developments/csc.aspx.

Artist's impression of the GlaxoSmithKline Carbon Neutral Laboratory for Sustainable Chemistry due to open in 2015.

FOUNDING FATHER OF TRIBOLOGY PETER JOST WINS TOP ACADEMY AWARD

Sixty years after he launched a whole new field of engineering, Dr Peter Jost has been honoured with one of the Royal Academy of Engineering's top accolades – the Sustained Achievement Award – for his vision and achievements in tribology, the science and engineering of interacting moving surfaces. What might appear to be mundane issues of friction and lubrication now have applications way beyond engineering, from medicine and dentistry to nanotechnology.

Tribology is central to managing the effects of friction and wear, confirmed by surveys done in Germany, the USA, Canada, China, the UK and Japan. Each concluded that investing in tribology could save up to 1.4% of GDP.

As a student apprentice, Dr Jost won the Sir John Larking Medal for his *Measurement of Surface Finish* Paper. In 2009, still very active following a successful industrial career, he co-launched the concept of Green Tribology, paving the way for the first Green Tribology World Congress with 2,000 attendees.

General Manager of international lubricants company Trier Bros at 29, he developed an innovative steam machinery lubrication method. This oil-free aqueous colloidal graphite lubrication system saved energy and water by preventing the boiler tubes scaling up, which had often caused them to burst. British Petroleum adopted the system at its five new refineries, as did Shell Tankers. The lubrication system became essential until reciprocating steam plant became obsolete.

One of Dr Jost's companies, Centralube, designed sophisticated, mission-critical engineering lubrication and allied systems for steel mills, refineries, space vehicles and forges, and for ships such as the *Class T45* Destroyers and the new aircraft carriers. Another, K S Paul, created and developed high technology coatings and lubricants including Poly-Butyl-Cuprysil (PBC), a versatile metallic-organic material winning the company a 1988 Queen's Award for Technological Achievement.

Centralube's ferrous industry interests led to Jost becoming the world's first steelworks lubrication engineering consultant. He resolved many design problems at Richard Thomas & Baldwin's new Llanwern integrated steelworks and his lubricant specification changes and integrated lubrication distribution systems resulted in substantial cost savings. International take-up included German and American steel works.

His advice to the UK government included the very significant 1966 DES Jost Report, which demonstrated that avoidable wear was costing the UK huge sums of money every year. It resulted in the setting up of several centres for tribology. He has authored more than 150 publications including a critical patent and a still classified paper.

Dr Ian Nussey OBE FREng, who nominated Dr Jost, says:

"Applying tribology saves energy and improves the reliability of

©RAEng

systems like engines, gearboxes, human joint implants, manufacturing processes and ship propulsion. Having initiated the concept, Peter comprehensively practised and promoted it. Sixty years on, his world-wide influence is unabated."

Dr Jost says:

"I am proud to be the ninth recipient of this honour, looking upon it as a demonstration that the Academy is a forward looking body"

Letter to the Editor

Sir,

The British Green Line

At least one organisation thought of something other than fireworks to mark the Millennium (SiP Autumn 2013 p11).

The Ordnance Survey thought of marking the meridian on the appropriate maps by a green line. The meridian line extends northwards from Greenwich through Royston and Boston to Grimsby and Withensea on the Humber estuary, and southwards from Greenwich to Peacehaven on the coast. A total distance of just over 200 miles.

As we inch our way towards metrication it is worth remembering that the French were just as slow as we are to adopt it.

In 1903 the President of the Institution of Electrical Engineers, Mr R K Gray, in his Address reminded his audience that 100 years after the convention which introduced the metric system in France and sixty years after it was nationally enforced in 1840 "the metric system with difficulty obtained currency even in the country of its official adoption".

and he identified the continuing use of some more practical measures:

"In France, precious stones are today bought and sold in carats; firewood in cordes; milk in pintes; gravel in toises; grain, potatoes and charcoal in boisseaux; wine in barriques, feuillettes, demi-setiers and chopines; wood for construction in pieds, pouces and lignes; beer in canettes and pots; sugar and coffee, among the poor people, in livres, demi-livres, etc. Cattle dealing is in pistoles and ecus, and not in francs. Finally, the French Government has just issued a twenty-five centimes piece, doubtless because it represents a quarter of a franc."

Robert Freer

Singapore's Success Story in Research and Development and a Decade of the Biomedical Sciences

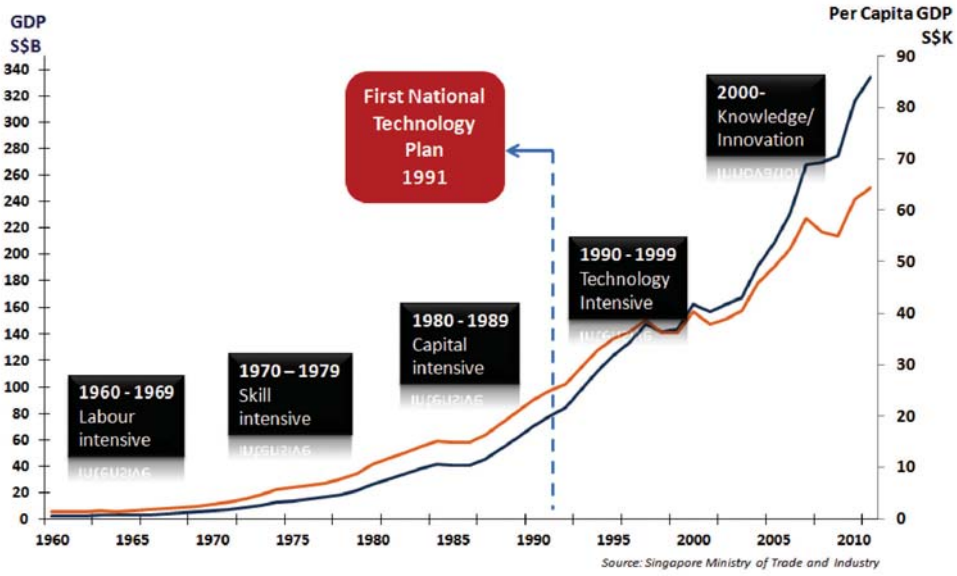
George K Radda

Lee Kuan Yew, the Founding Father and first Prime Minister of Singapore, said a few years before the independence of the country in 1965:

"I believe our future depends upon our ability to mobilise the qualities in our population to maximum advantage. It is the one thing we have which makes up for our lack of size and numbers, and it is of the utmost importance that, in the field of science and technology, we should lead the field in this part of the world."

Since that time, Singapore has evolved from a labour-intensive economy to a booming knowledge and innovation-based economy. The first National Technology Plan in 1991 focused on promoting R&D in the private sector and resulted in a dramatic increase in R&D expenditure.

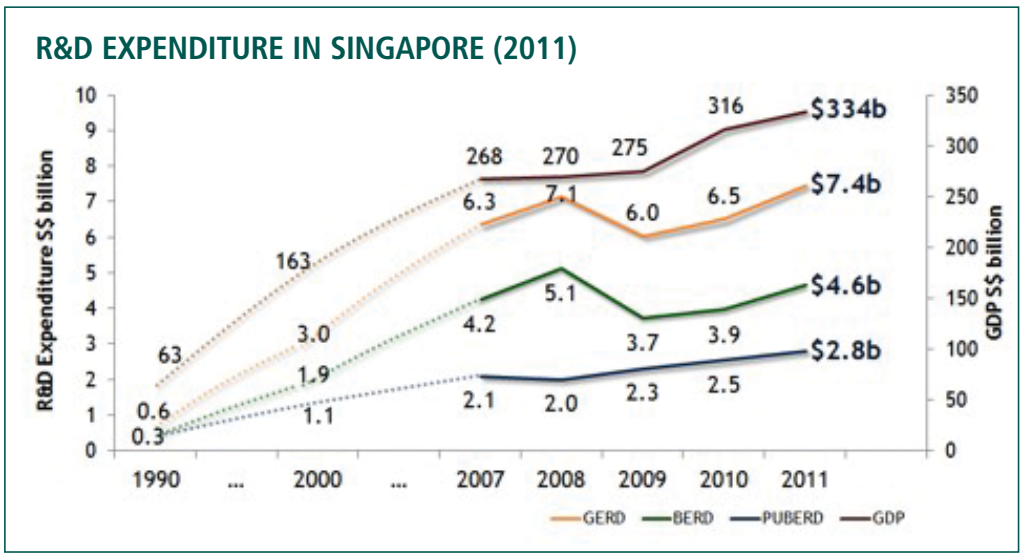
TRANSFORMATION OF SINGAPORE'S ECONOMY



Following Lee Kuan Yew's visionary statement, another bold step was taken in 2000 to establish the **Biomedical Sciences (BMS)** as a key pillar of Singapore's economy. **"Biopolis"** was established in 2003 as the key location with state-of-the-art infrastructure for biomedical research among public and private players. In just one decade, a small country of 5.3 million people achieved in BMS what others have taken generations to accomplish.

What had made this possible? I regard four aspects of the programme as key.

(I) The firm commitment of Government to R&D and its ability to provide the appropriate Research Governance. (II) The ability to take bold new initiatives that are implemented with speed. (III) The recognition for the need and mechanisms for building up talent at all levels



to support the research enterprise. (IV) The ability to integrate capabilities across different scientific disciplines, and between clinicians and scientists.

I Research Governance and Structure

Research funding comes from a variety of sources and agencies under the umbrella of a National Organisation.

The **Research, Innovation and Enterprise Council (RIEC)** is helmed by Prime Minister Lee Hsien Loong and is responsible for setting the broad research, innovation and enterprise strategies and directions for Singapore. The **National Research Foundation (NRF)** was set up in 2006 under the Prime Minister's Office to coordinate the research of different agencies, within a larger national framework, in order to provide a coherent strategic overview and to help advance Singapore's national R&D Agenda.

The **Ministry of Education (MOE)** oversees and funds academic research at the tertiary institutions as well as investigator-led research through the Academic Research Fund. Its focus is on research with longer time frames and driven by knowledge creation. The **Institutes of Higher Learning** comprise the Autonomous Universities (NUS, NTU, SMU and SUTD) and the polytechnics. MOE has also established five Research Centres of Excellence (RCE) in NUS and NTU since 2007, to drive globally competitive peaks of excellence within the universities.

The **Ministry of Health**, through the **National Medical Research Council (NMRC)**, focuses on scientific and health research, driving the translation of basic research to advance human healthcare. There are also **hospitals and academic medical centres** under the Ministry of Health, which engage in translational clinical research.

The **Ministry of Trade & Industry** is responsible for mission-oriented research through the close integration of the efforts of its research and economic agencies A*STAR, EDB and SPRING.

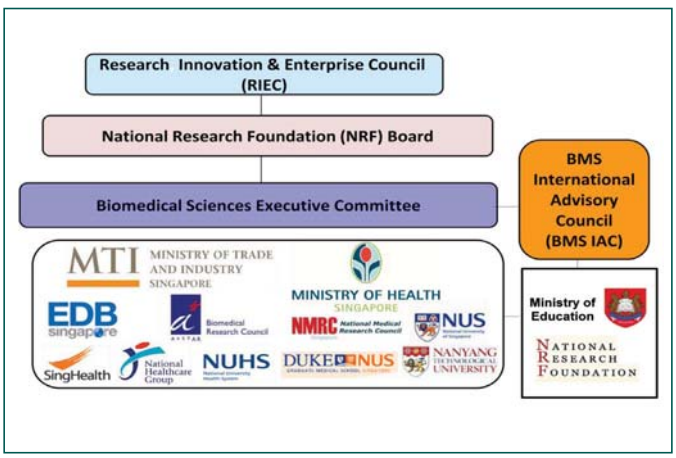
A*STAR is the lead mission-oriented R&D agency responsible for supporting Singapore's key economic clusters and developing industry-relevant talent. Under 18 research institutes, A*STAR nurtures public sector R&D across biomedical sciences and physical sciences and engineering. A*STAR works with the **Economic Development Board (EDB)** to attract multinational corporations and corporate R&D laboratories to Singapore. **SPRING**, another close partner of A*STAR, is the enterprise development agency for growing innovative companies and fostering a competitive small and medium enterprise sector.

The R&D planning cycle is over 5 year periods. The first was conceived in 1991 where S$2 billion was allocated for public research between 1991 and 1995. This was really the turning point where Singapore's R&D investments began rising significantly. In the latest 5th S&T plan, S$16.1 billion has been allocated for public R&D, over 8 times the budget of the first S&T plan. The focus is on fostering R&D which encourages greater public-private sector partnerships, as well as technology translation and commercialisation that bring along positive economic and societal impact.

II Singapore's Biomedical Sciences Initiative: a Bold New Venture

The Biomedical Sciences Initiative has been carried out within a well-coordinated governance framework.

The **BMS Executive Committee** functions as a



coordinating body for the overall planning of research as funded by the different Agencies and Ministries, and reports directly to the NRF Board. The Executive Committee draws on the combined experience of the **BMS International Advisory Council**, comprising renowned scientists for strategic advice and guidance.

The three phases of the BMS Initiative were centred around the concept of a "bio-city." One-north, a 200 hectare R&D and business park, was identified to be the home for **Biopolis**, a term coined by Nobel Laureate Sydney Brenner. "What I wanted is to have public-private research taking place at the same place." Mr Philip Yeo, Biopolis Tenth Anniversary publication. Today, as Chairman of A*STAR Mr Lim Chuan Poh said, "Biopolis is a thriving eco-system of public research institutions and corporate labs, and a vibrant community of local and international biomedical scientists carrying out world-class R&D."

Phase 1 (2000-2005): Building the Foundation. The first phase focused on establishing a firm foundation of basic biomedical research in Singapore. Five of BMRC's research institutes developed research in the areas of bioprocessing, genomics, molecular and cell biology, bioengineering and nanotechnology, and computational biology. Seven research buildings were completed in Biopolis, linked by sky bridges to encourage collaborations. The concept of co-location of public-private research institutes was also promoted.

Phase 2 (2006-2010): Strengthening Translational and Clinical Research. The second phase focused on strengthening translational and clinical research. BMRC launched consortia in key areas, such as the Singapore Bioimaging Consortium, Singapore Stem Cell Consortium and Singapore Immunology Network. On the manufacturing side, the biologics cluster was developed, with the spin-off of A-BIO from A*STAR's Bioprocessing Technology Institute in 2004.

In parallel with the activities of BMRC, the two main Universities NUS and NTU built up their strengths in the Biomedical Sciences, with major new efforts in Clinical Research at NUS. The Duke-NUS Graduate Medical School and 2 RCEs in the Biomedical Field were established.

... globally competitive peaks of excellence ...

Phase 3 (2011-2015): Capturing Opportunities for Greater Economic and Health Impact. The next phase focused on bringing economic, health and social impact for Singapore. Enhanced industry engagements were sought, with the establishment of BMS Industry Partnership Office as the one-stop coordinating office for multinational companies. Greater integration of research players was fostered. New opportunities in biomedical research were seized, such as in food and nutrition, and skin research.

Further advances in clinical research were made, for example through attracting clinician/scientists to the Medical Schools with generous grants. Several joint funding schemes between the Universities, Hospitals and A*STAR have been developed. At NTU, in partnership with Imperial College London, a third Medical School has been set up.

The results were good. R&D expenditure in BMS grew six-fold over the past decade, while BMS manufacturing output has increased nearly five-fold. Singapore has attracted investments from leading biopharmaceutical companies, such as Chugai, Novartis, Arkray, Fluidigm and P&G. Singapore has also become a leading location for commercial operations in BMS, with seven of the top ten pharmaceutical companies and all top ten medical technology companies having regional or global commercial operations based in SG.

One significant public-private alliance Singapore established in January 2010 is the Roche Hub for Translational Medicine, which focuses on expanding knowledge of disease biology to develop new personalised treatment approaches. With an investment of SFr100 million, the Hub is an example of how companies can leverage on Singapore's integrated network of biomedical sciences research institutes and academic medical centres. Another pioneering partnership is the collaboration between A*STAR's Experimental Therapeutics Centre (ETC) and Switzerland's Cytos Biotechnology to develop the H1N1 vaccine, which has already entered into Phase 1 clinical trials. The success of this research will have the potential to provide Singapore and the region with an independent supply of vaccine, which is especially crucial in times of outbreaks.

... greater public-private sector partnerships ...

III Building Talent for Rapid Action and Sustainability

The speed at which the BMS effort has been achieved relied on an open talent strategy in recruiting established Senior Scientists to set up and lead the Research Institutes in 2001.

Singapore has always been able to call on the best advice and support from the international scientific community and UK scientists have played major roles. The International Scientific Council, chaired from the very beginning of the BMS effort by Sir Richard Sykes, still plays an important role in giving advice to government. Its members include or have included Sydney Brenner and four previous or current Chief Executives of the UK MRC. Sydney Brenner, George Radda and Sir David Lane are still actively involved in making scientific contributions as well as having leading roles in the organisation of the BMS research developments.

At the same time, a long-term plan for training the best Singaporean students at major universities in the US, Europe and Asia was put into action. Since 2001 A*STAR has nurtured more than 1,100 Singaporeans through its range of scholarships and fellowships and by providing opportunities to "returning scholars". Today young PhDs work side-by-side with top scientists in a diverse research community.

In the past five years the Universities have also been actively recruiting faculty at all levels and training many PhD students. Singapore as a whole has a thriving BMS community and its challenge is to organise this in a strategic way. The BMS

research community has grown by 2.5 times, from 2150 in 2002 to over 5400 in 2011. Biopolis itself holds over 2500 public and private sector researchers of over 70 nationalities.

biologists with chemists, physicists and engineers. One example is the Silicon Biophotonics programme for cancer biomarker discovery. The team leverages on the Institute of Microelectronics' advanced silicon nano-fabrication technologies and molecular diagnostic device capability, and the Institute of Molecular and Cellular Biology's expertise in cancer research.

... unprecedented opportunities for collaborations...

IV Integration for the Future

Integrating Biomedical and Physical & Engineering Sciences

It is recognised world-wide that the integration and convergence of different scientific disciplines is key to future major progress in biomedicine, which will create innovations and products of value to companies. In A*STAR the biomedical and physical sciences and engineering capabilities are under a single agency and located within the compact one-north area. This gives unprecedented opportunities for collaborations and has proved to be attractive to companies in locating their R&D in Singapore.

Through A*STAR's Joint Council Office, many initiatives have been started to connect

One strategic area with large growth potential is Medical Technology. The MedTech programme leverages on the interdisciplinary capabilities of A*STAR Institutes, spanning electronics, precision engineering and biomedical sciences, and also links to the strong network of clinical researchers and companies. Thus, Singapore is positioned as the Asia MedTech Hub. By 2015, MedTech is expected to contribute $5 billion to manufacturing output.

Integrating with the Clinical Research Community

To bring scientific discoveries from bench to bedside and to make greater impact for human healthcare, Singapore fosters close collaboration between research institutions and the clinical community. The Translational and Clinical Research (TCR) Flagship Programmes, administered by NMRC under MOH, were started to bring clinicians and scientists to work together in specific disease areas.

... scientific discoveries from bench to bedside ...

The joint NUS/A*STAR Clinical Imaging Research Centre was one of the first cases of a major collaborative programme. Other examples include: the concerted programme in stratified medicine, a partnership between the Genome Institute of Singapore, and several public Healthcare Institutions; a comprehensive birth cohort study towards healthy outcomes, focusing on epigenetics, involving A*STAR's Singapore Institute for Clinical Sciences with NUH and KK Women's and Children's Hospital.

Conclusion

Singapore's R&D achievements were rooted in firm and dedicated government support, well-coordinated research governance, a daringness to implement bold new initiatives with speed, an open talent strategy, and efficient frameworks for the integration of scientific disciplines and research performers. All these factors can be encapsulated in Singapore's BMS Initiative.

As President Tony Tan stated in a dinner celebrating Biopolis' 10th Anniversary, *"The success of Biopolis and the BMS sector is symbolic of Singapore's commitment to anchor BMS as the fourth pillar of Singapore's economic strategy...The fact that this was achieved in 10 years could not have happened without the close cooperation of A*STAR, EDB and JTC, with strong support from MTI, MOH, NRF and many other agencies."*

ROCKETING SKY HIGH: UK & RUSSIA IN SPACE

Dr Julia Knights, First Secretary, Head Science & Innovation Network (SIN) – Russia

The UK's relationship with Russia has never been stronger in science and space. Our nations are ideally matched for collaboration. Russia accounts for 40% of rocket launches globally; the UK is world number one in small satellites, Europe number one in telecomm-unications satellites and has a strong upstream and downstream space industry. Both our nations share a goal to own 10% of the global space market by 2030.

In May 2013, our Science & Innovation Network (SIN) – Russia based at the British Embassy in Moscow provided high level briefing in liaison with the UK Space Agency (UKSA) for a meeting between President Putin and Prime Minister Cameron. They agreed to step up collaboration in science and Space.

SIN Russia put this agreement into practice by organising a UK Russia Ministerial Joint Committee Science & Technology co-chaired by the Secretary of State for BIS, Minister Cable and Minister Dmitry Livanov of Russia's Ministry of Education and Science on 17th October 2013, hosted by the Royal Society. A Statement was signed by both ministers with agreement to

step up collaboration in two of the UK's 'Eight Great Technologies' (Space and Life sciences) as well as energy efficiency, Arctic and climate science, accelerator science and particle physics.

SIN Russia showcased exciting space commercial and research projects and events at the Ministerial Joint Committee under the forthcoming UK Russia Year of Culture 2014 (which includes Space science) and the EU Russia Year of Science 2014. Highlights include the UKSA and the Russian Federal Space Agency (Roscosmos) agreeing to discuss an "Intergovernmental Agreement on Space" and the UK agreeing in principle to a Glonass (Russia's global navigation system) ground based station on UK soil. Major Tim Peake, our British astronaut will train at Star City in Moscow before his flight to the International Space Station in November 2015.

Celebrating the 20th anniversary of Helen Sharman's flight to the Mir Space Station with Cosmonauts Krikalev & Artsibarski at SIN Russia's Space Reception at the British Ambassador's Residence (From left to right: Dr Julia Knights, Head of SIN-Russia at the British Embassy-Moscow, Cosmonaut Alexey Leonov, Cosmonaut Sergei Krikalev, Dr Marina Sokolova in SIN-Russia & Cosmonaut Anatoly Artsibarski)

... Russia accounts for 40% of rocket launches ...

Two UK Satellites will also be launched together on a Russian Soyuz this Spring from Baikonur. "UKube-1", a shoebox-sized spacecraft known as a cubesat is the UKSA's pilot mission, built by UK spacecraft manufacturer Clyde Space Ltd in Glasgow. This will provide cost-effective access to space for innovative technologies whilst inspiring UK school pupils to take up STEM subjects and train the next generation of engineers and scientists.

"Tech Demo Sat-1" is a larger technology demonstration mission developed by Surrey Satellite Technology Ltd (SSTL) with funding from the UK's Technology Strategy Board, industry and academia. The payloads include suites for maritime, space environment, platform technology and air and land monitoring to enable measurements on sea state, ship tracking, meteorology, oceanography, climate science and space debris. UK partners include SSTL, Astrium, Surrey Space Centre, Mullard Space Science Laboratory, Rutherford Appleton Laboratory, SSBV, Cranfield University, Imperial College and Oxford University.

... our British astronaut will train at Star City ...

The UK's Rutherford Appleton Laboratory (RAL-Space) have also recently signed a contract with the Russian INASAN Institute of Astronomy to work with UK company E2V to deliver an £11 million electronics detector project for the Russian Spectrum-UV follow-on mission known as the World Space Observatory (WSO).

A "Russia Space Quest" exhibition at the London Science Museum will launch this November (2014) to highlight Soviet and Russian prowess in Space. This world-class six month flagship exhibition will include objects associated with Sergei Korolev's visionary engineering space programme and heroic cosmonauts including the first man in Space, Yuri Gagarin, and the first man to conduct a space walk, Cosmonaut Leonov. For the last two years, SIN Russia has been setting up meetings between the London Science Museum and Roscosmos and Russia's Deputy Prime Minister, Golodets, to facilitate the loan of priceless flown satellites and capsules for this exhibition, including first woman in Space, Valentino Tereshkova's descent module.

SIN Russia set up a "UK-Russia Year of Space" two years ago, and we delivered a raft of commercial outcomes including negotiating with Roscosmos to waive tax on UK imports of space equipment into Russia saving £50 million a year.

We also held a series of joint world-class Space Science lectures. Outcomes include stronger links on instrumentation for the ESA/Roscosmos Exomars project between the UCL Mullard Space Laboratory and IKI, (Russia's Institute of Space); an MOU on SuperDarn and solar flares collaboration signed between Leicester University and the Institute of solar Terrestrial Physics in Irkutsk, Siberia; and a joint project satellite project designed to predict earthquake eruptions between UCL and the Institute of the Physics of the Earth and Russia's innovation hub. Finally last February, SIN-Russia organised for the Open University (OU) be the first to analyse the Chelyabinsk meteorite with Russia's Vernadsky Institute. Their joint results have been submitted to Science journal.

Dr Julia Knights is Head of Science & Innovation Network (SIN) - Russia at the British Embassy in Moscow. The UK's Global SIN network is funded jointly by the Foreign & Commonwealth Office (FCO) and the Department for Business, Innovation & Skills (BIS) with over 90 staff in 28 countries in 47 cities. For more information visit: https://www.gov.uk/government/priority/uk-science-and-innovation-network-sin-russia

For information on the EU Russia Year of Science 2014, visit: http://www.eu-russia-yearofscience.eu/en/1518.php

For information on the UK's Global Science & Innovation Network (SIN), visit: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/264713/bis-13-1331-uk-science-and-innovation-annual-report.pdf

Meeting of the Parliamentary and Scientific Committee on Tuesday 22nd October

SMART BUILDINGS RESEARCH – FOCUS FOR THE FUTURE

Dr Deborah Pullen
Group Research Director,
Building Research Establishment

The last 20 years have seen the expansion in innovative systems to create smart buildings, with the primary criteria being:

- a system which integrates the smart operational systems with the building fabric
- the system responds to internal and external changes, and finally
- there is a communication to the occupier to allow them to adjust the operation to meet their own needs.

This has led to many developments where the building fabric has incorporated smart products which improve performance and create a stable envelope to which management systems are applied. This needs to be able to be modified without an adverse effect on the performance.

They often include energy generation systems and controls for heating, lighting and power. Monitoring and metering are key features so that building controls can be adjusted and support billing and external support services such as maintenance. This could also support security and also assisted living which will be increasingly relevant to the ageing population.

In recent years the importance of considering the occupant when creating a system which is smart has become apparent, with wellbeing critical to a successful outcome. There are many examples where the room is either too hot or too cold and the controls too complicated.

THE SMART HOME

The first is the Smart Home, developed from 1998 and featured in a BBC programme called Dreamhouse. The focus was on highlighting technologies and products which might be found in a future home. Over the next 10 years thousands visited the house. It has stood the test of time.

BRE Smart Home, opened 2013

It had one of the first green roofs, an early photovoltaic array, a greywater recycling system, and a ground source heat pump and prototype intelligent

The work undertaken by BRE over the last 15 years has focused on evaluating the effectiveness of the whole system. The Innovation Park at BRE in Watford includes test bed buildings where the evaluation and dissemination have been developed. Two examples provide insight into the growing science-base in this field and the outcomes of experimental programmes.

BRE Innovation Park, Watford

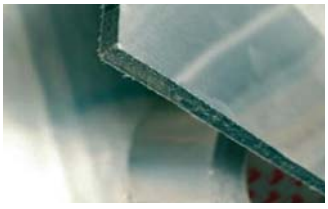
electronics – commonplace today. Devices to control temperature and water level in the bath to a pre-determined set-point, a clever feature then, but now adopted to improve safety for less able people.

The house has undergone an extensive retrofit. It tackles some of our key challenges: particularly the need for our homes to be more energy efficient, to adapt to the effects of climate change and to address the needs of the ageing population. Using design and building techniques, the retrofit has made the house 50% more energy efficient and halved its carbon emissions, upgrading it from an E to an A/B EPC rating.

One of the major differences in the retrofit project was that the house was designed as a whole system. Products were selected not only on individual performance but on the potential for them to work alongside other products.

Some specific innovative products used include:

Phase Change Materials have been on the market for a few years. They work on the principle that when the temperature rises above 22°C, the polymer/wax compound in the wall melts to absorb the heat, slowing temperature rise by up to 7°C. The wax solidifies when the room temperature falls to 18°C and the stored heat is released back into the room. This works well in areas where solar gain could be prevalent, and a few degrees can make a difference to comfort.



Phase Change Materials

Building Integrated Photovoltaics have also been installed on the roof and conservatory glazing panels that can produce electricity from light coming from either side, making them a flexible option.

The building control system includes sensors which allow responses to movements from occupants and more accurate monitoring of specific performance properties. There is also the opportunity for devices to communicate with each other.

The next stage is to carry out more detailed assessment of the system under experimental conditions, and with occupants. There is also the need to consider the economics around the installation of these systems both for the original builders and as retrofit solutions. Aspects of payback and skill needs in ensuring these systems are fitted correctly, and can easily be repaired, are a key element to achieving optimum performance and resilience.

THE NATURAL HOUSE

The development of the Prince's Foundation Natural House was to demonstrate that efficiency and sustainability could be delivered for a classically designed dwelling using many natural and renewable materials. The smart systems in this house are passive. They respond automatically to external changes without the need for external power. The driver is to create an environment which enhances the wellbeing of the occupants.

The building contains wool insulation, clay blocks, recycled wood internal flooring and partitioning. Its construction can be built using conventional skills. One of the major innovations is the passive air flow stack, a design which was first used in Victorian buildings. It uses no mechanical air flow or air conditioning.

TEST METHODS

Test methods used to assess performance of the internal environment include:

- temperature probes in the walls and in a range of locations around the building,
- the use of thermal imaging to consider gaps and
- various monitors which measure gases such as CO_2 and other volatiles.

The Prince's Foundation Natural House

These are considered as a collective assessment of the performance. Changing the levels of heating, lighting or air flow can be assessed.

Once the baseline and a check that all systems were working properly, an occupancy assessment was carried out. A couple moved into the house for 12 months. During this time similar indoor environment tests were carried out to track the change based on their activities. In addition, feedback from the occupants and overall experience of living in the house were obtained via a questionnaire. The house has performed very well, with new systems demonstrating enhanced performance for the people who live in it. Further work will look at resilience

REALLY SMART BUILDINGS

The attributes needed to achieve really smart buildings:

- They have to work as a whole system.
- They have to respond to changes, both in terms of daily operation but also seasonal and climatic changes over time.
- The importance of the occupant. The building has to work for them.

Thermal Image of The Natural House

- The systems have to be resilient to wear and tear and easy to upgrade.
- They have to form the building blocks of efficient operational cities of the future.

Finally, there is a need for multidisciplinary teams to work together with industry in applying their own speciality in developing effective complex systems.

SMART BUILDINGS AND PEOPLE

Doug King FREng FInstP FCIBSE FEI HonFRIBA
Building Performance Consultant, Doug King Consulting
Visiting Professor of Building Physics, University of Bath

INFORMATION

The term 'smart' is applied to a host of enabling technologies in modern buildings, the 'smart meter' being probably the most familiar. Examination of smart meter technology allows us to begin to understand interactions between people and technology applicable to both dwellings and commercial buildings.

The equivalent of domestic smart meters, meters that signal half hourly consumption data to the utility company, have existed for many years in commercial buildings. If equipped with an in-home display (IHD) or commercial equivalent, the building occupiers can also access the data. However, in both cases the term 'smart meter' is a misnomer, as the meter merely conveys information. It is up to the occupier to do something smart with that information.

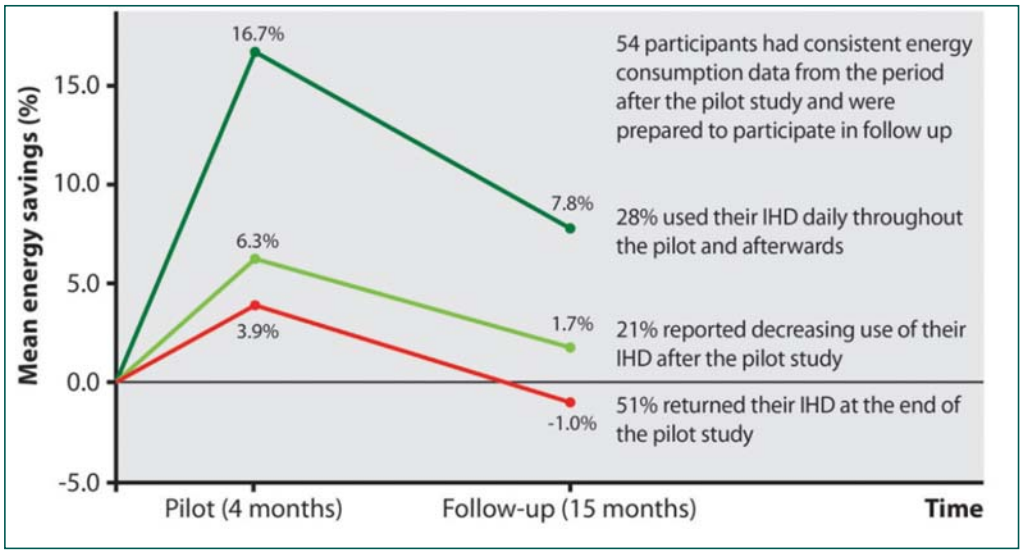
The presentation of data alone is of little value without context. Stevenson and Leaman (2010) said: "It is not enough to presume that the information from 'smart metering' will encourage people to reduce their energy consumption any more than a car speedometer will reduce speeding." A car speedometer provides information, but the driver must have knowledge of the speed limit in order to correctly interpret that information. Without significantly improved energy numeracy amongst the populace it is unlikely that the smart meter will deliver its full energy savings potential.

In-home displays (IHDs) need to present information in context in order to be useful. A PV generation monitor (right) can be easily calibrated against the size of array to present contextualised information. It is impossibly complex to calibrate an in-home display (left) against all the variety in UK households.

ENGAGEMENT

Van Dam, Bakker & Van Hal (2010) found that novelty appears to play a significant role in savings in short term trials of in-home displays. Revisiting households that had previously participated in a pilot study they found that the initial savings had generally not been maintained. Moreover, the lapse rate was more or less consistent regardless of how well the participants had engaged with their in-home display during and after the pilot study.

The study shows a lapse towards prior behaviour over time, but was unable to corroborate the hypothesis that the magnitude of energy savings achieved correlates to level of interaction with the in-home display. It is clear that, if we are to make the most of the opportunity of smart metering,



Results of a study by Van Dam et al (2010) suggest that energy savings achieved in pilot studies of in-home displays may be transitory regardless of the level of engagement by homeowners.

we need to understand better people's interpretation of, and response to, energy information and tailor it to their needs in both domestic and commercial situations.

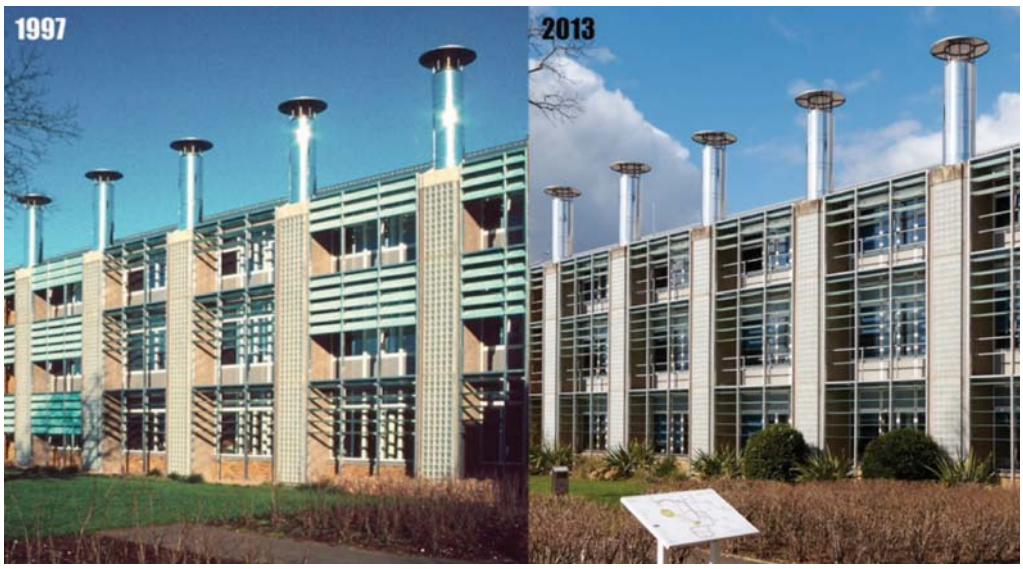
CONTROL

It is not only in-home displays that need to be designed with attention to the human interface. The control systems in commercial buildings are complex, yet the design effort put into the user interfaces is poor. Bordass, Leaman & Bunn (2007) found that: "If user controls are ambiguous in intent, poorly labelled, or fail to show whether anything has changed when they are operated, then the systems that lie behind them are unlikely to operate effectively."

Ambiguous controls create confusion and can lead to users distrusting the system or simply ignoring subsequent useful information or control signals.

User interfaces need to be engaging, where possible intuitive, and make it easy for individuals to do the right thing, particularly given the increasing tendency to install complex controls in domestic situations, where the understanding of control functions is poor.

Further, if control systems do not provide building occupants with the functionality and convenience that they expect, they will take actions to override the control systems in order to achieve what they consider to be more favourable outcomes.



Completed in 1997 as an exemplar of energy efficiency, The BRE Environmental Building featured external shades which were designed to respond automatically to changing daylight and over-heating conditions. However, over time the state of the art control system became obsolete and the actuators progressively failed and were not replaced. Instead, simple manual blinds were installed to control glare and overheating. Today, the louvres remain static and the building's occupants rarely adjust the blinds, even when daylight levels fall, as the lighting controls compensate by bringing the lights on even in the middle of the day.

Thus, it is common in commercial buildings to find thermostatic controls being used as on/off switches and for daylight sensors to be covered with sticky tape to ensure that the electric lights remain on.

MANAGEMENT

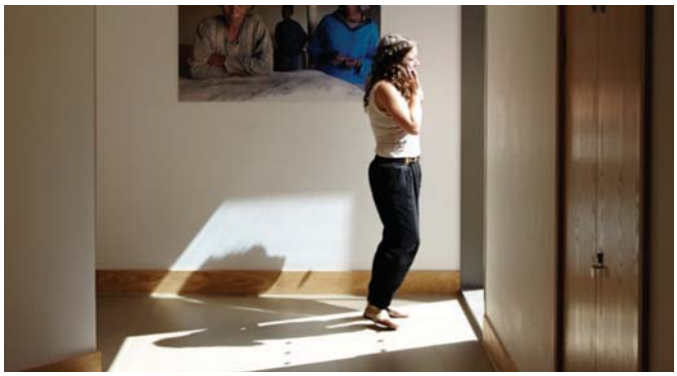
Building structures are designed for long lifespans, whilst smart building technologies will fail or become obsolete several times during that span. As with any information technology system, it is essential that a clear upgrade path is available and is followed throughout the life of the building. All too often, building controls become obsolete, making subsequent repair prohibitively expensive and leading to the controls being abandoned.

Cohen, Ruyssevelt, Standeven, Bordass & Leaman (1998) wrote: "The myth of [building] intelligence is that it is 'fit and forget': buy it, and the electronics will do the rest. The actuality is that it is very much 'fit and manage'. Complex engineering and control systems tend to work best in an environment in which the occupier can resource a high level of facilities and engineering management. Problems start to occur where sophisticated technology is applied in a management-poor environment."

DESIGN

To deliver smart buildings that sustain their smartness requires more thorough design than is presently the norm. Greater interaction is needed between the building's users and designers, both at project inception, to articulate requirements clearly, and after handover, to tune the systems and gather feedback. There also needs to be a much more robust system for communicating design and performance goals throughout the chain from design through delivery to operation.

Waide, Ure, Karagianni, Birling & Bordass (2013) wrote: "Building Automation Technology often fails to deliver its potential because those specifying the system have limited understanding of how it will be operated." They go on to assert: "The best design can only come from a thorough understanding of operation." In order to be truly smart a building must be



People will use buildings in ways that can never be anticipated by the designers. A smart building must be flexible enough to accommodate the needs and desires of the users without forcing them into compromises, which will result in them ultimately overriding the systems.

designed to be 'user centric'. It needs to accommodate the habits, needs, desires and capabilities of those who will use and operate it.

PROCUREMENT

Mapping the typical, mass market construction process onto a systems engineering diagram indicates that there are gaps in the key areas for the design of smart buildings.

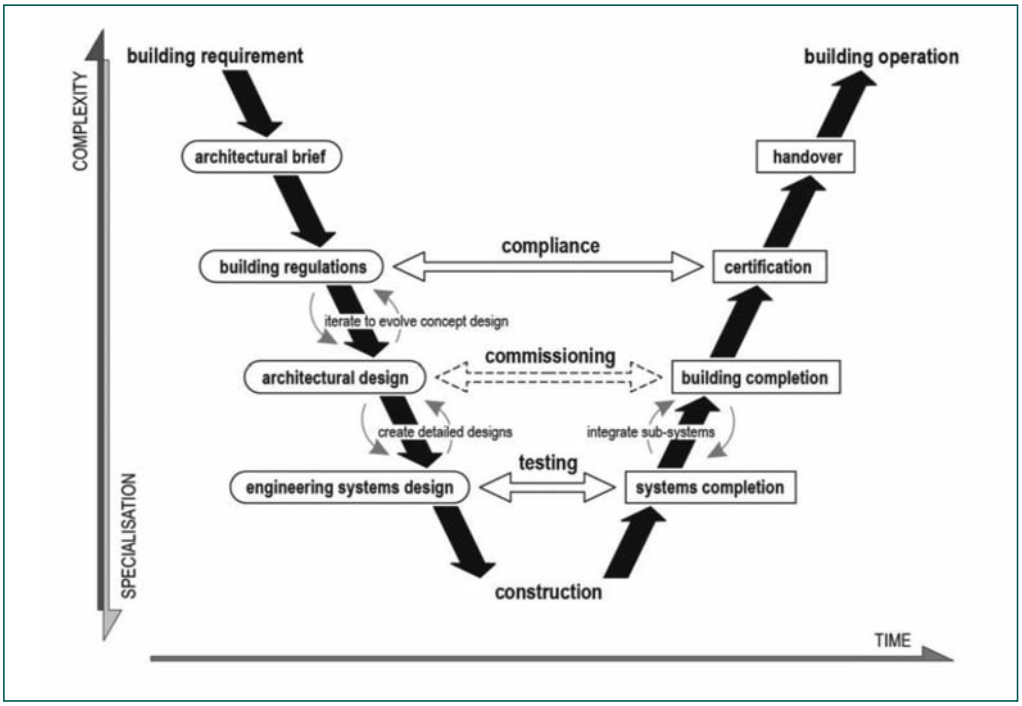
As an alternative one could propose a construction diagram, including confirmation of outcomes and feedback into subsequent designs, that may be capable of delivering genuinely smart and sustainable buildings.

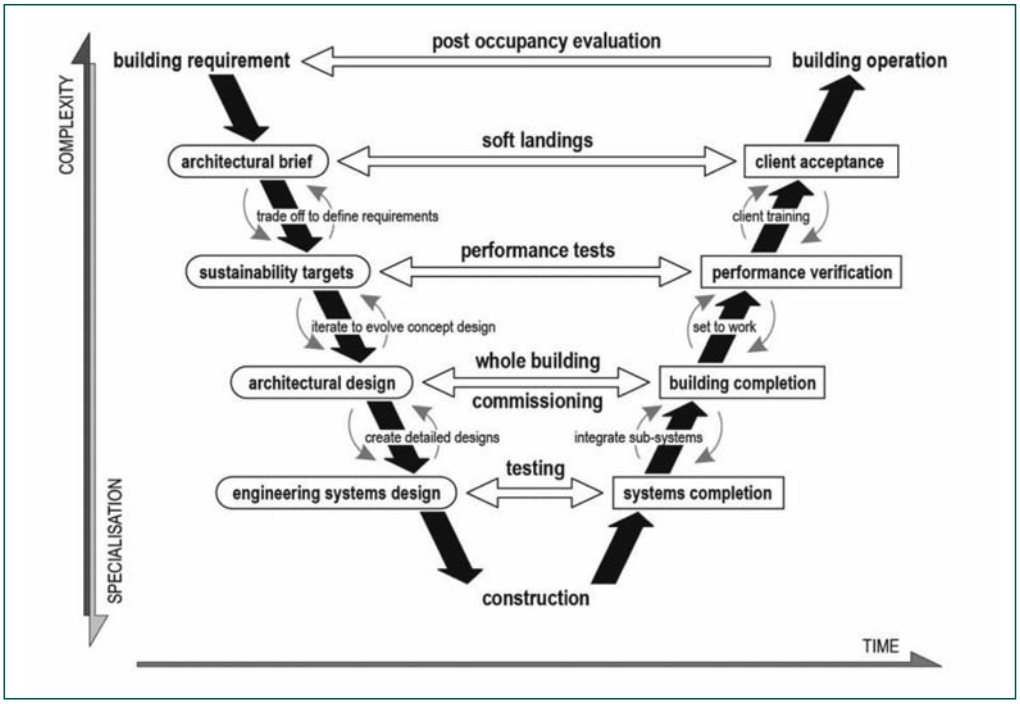
However, we need to acknowledge that the present methods of procurement in both the public and private sector do not allow the requisite interaction between users and system designers before and after the construction period. If we are to deliver smart and sustainable buildings we first need to address the shortcomings in the procurement process.

CONCLUSION

For a building to be smart, it must get the best from both its automated systems and from the intelligence and understanding of its occupants. It needs to be robust, cost-effective and not too complicated. Smart building design must account for the desires and capabilities of those who will use them.

This creates major challenges. Although there are exemplars, in typical UK construction scant attention is paid to human factors, to the design of the product, and to the creation of integrated systems. Shortcuts are taken in the installation, commissioning and handover. Provision of complete operating information and user training is rare. Systems designers do not learn from performance in use.





These challenges are not insuperable. However, they will need to be addressed if the benefits of smart buildings are to be realised. We need to improve skills and education amongst the designers, constructors and operators. We must put the users at the heart of smart building design and operation.

"A 'smart building' is one that doesn't make its occupants look stupid" *Adrian Leaman - The Useable Buildings Trust*

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SMART BUILDING SECURITY

Martyn Thomas CBE FREng
Vice-President, Royal Academy of Engineering

SMARTER AND BETTER

There are many definitions of a Smart Building: for example, it is "smart" to use rainwater harvesting to flush the toilets or to use self-cleaning glass for windows. Security only becomes an issue with another and rapidly growing "smartness" – the use of sensors, algorithms and control systems to make a building more responsive to its occupants and easier to manage.

Automation can bring many benefits. If the building management system knows that a room is unoccupied it can turn off the lights and turn down the heating. A chip in your entry pass can tell the security systems to open the door as you approach with your arms full of files. Wireless communication avoids expensive and unsightly cables, and allows CCTV, room status, heating, ventilation and air-conditioning to be monitored and controlled from wherever is most convenient, or even remotely.

Integration of systems multiplies the benefits. If the Building Management System (BMS) is integrated with office IT and phones, then putting a meeting in your calendar can book a room and ensure that it is open, lit and heated when you arrive, that your phone calls are redirected and your latest printing available on the nearest printer. In an emergency such as a fire, the AV systems can show the safest and quickest route to an exit and the BMS can make sure the relevant doors are unlocked, the windows set to clear smoke or avoid draughts that would spread the fire and tell the Fire Service which rooms and lifts are still occupied.

Architects are already planning greater integration between systems and between buildings. As Smart Buildings grow into Smart Neighbourhoods and Smart Cities, their BMSs could co-operate to manage demand on the electricity networks, exchange environmental data and co-ordinate with smart transport systems.

SMARTER AND MORE COMPLEX

Greater automation and greater integration increase the system complexity. A typical commercial building's heating, ventilation and air-conditioning installation could require the integration of 20-50 local control systems from 12-15 different manufacturers with an overall building control system that has to interface with the lighting control, fire and security and access control. The customisation will be done quickly and often by contractors who have won the job on a lowest cost tender. The building will be accepted from the developers, not by the final occupants (who may not have been involved at any point in the design and construction) but by the customer – perhaps an overseas investor or hedge fund. By the time it is fully occupied, some of the knowledge needed to manage the building optimally will have been lost; after a few years of maintenance and changing occupancy, the BMS and its connected subsystems may be very different from the original design and managed in ways not foreseen by the architect.

... a building more responsive to its occupants ...

MORE COMPLEX AND LESS SECURE?

As buildings become smarter, they will contain more automated systems, with increasingly complex interconnections. Such "systems of systems" create unexpected behaviour, new vulnerabilities and new management challenges. To quote an example given by Hugh Boyes of the IET at a Round Table organised by the RAEng , if building management systems operated by the facilities team are connected to systems operated by the corporate IT team, there needs to be clarity about who takes responsibility for protecting the security of the BMS, which has the characteristics of a control system rather than a typical enterprise computer system. The BMS may not be able to run a commercial virus checker or software firewall and there may be good reasons why it should not be connected to the internet to download updates and new virus signatures. Protecting the BMS from malicious software will need specific attention every time that a connected system is changed or upgraded.

Unplanned "emergent" behaviour of complex systems is well known in other application domains. For example, as

vehicle electronic systems have become more complex, there have been reports of uncommanded acceleration, of novel ways to break into the car (kick the front bumper to simulate an accident; the airbags fire and the doors unlock), and of drivers and passengers trapped inside. In one car model, the design of the electronics created a "sneak circuit" such that if the radio was on and a rear-seat passenger was opening their electric window at the same time as the brake pedal was pressed, the airbags fired. Other undesirable interactions have occurred in electronic healthcare systems and in air-traffic control; they are a known risk in all complex systems and may be latent in a system for years and then cause complex failures any time the system is reconfigured or updated.

Building management systems need to be secure not just against error but also against attack. There are many reasons why a building needs to be protected from becoming a target for organised criminals or some other malicious group. Buildings contain valuable property, both physical and intellectual. They house people responsible for major financial services, policing and government. They house hundreds or even thousands of people whose safety could be at risk. As building systems become more complex, cybersecurity becomes increasingly important. The National Security Strategy has identified "hostile attacks upon UK cyberspace by other states and large scale cyber crime" as a Tier One risk alongside international terrorism or an influenza pandemic. Unfortunately there is currently no way for a prospective occupant of a building to know what level of security it provides, as there are no effective security standards or certification regimes for Smart Buildings.

SMART BUILDINGS: THE RISKS

Many risks could arise from insecure "smart" building systems. If the BMS can be controlled by an unauthorised person, the physical security and safety of the building and its occupants is compromised and the organisations that occupy the building could suffer reputational and financial damage including loss of intellectual property, disruption to critical functions, and breaches of legal and fiduciary duties. Even a limited demonstration that a hacker could trigger the sprinkler system or control the lifts may be enough for successful extortion.

... Protecting the BMS from malicious software ...

A 2007 report from the US Government GAO gives examples of cyber attacks that have already occurred against control systems. *"In the spring of 2000, a former employee of an Australian software manufacturing organisation applied for a job with the local government, but was rejected. Over a 2-month period, this individual reportedly used a radio transmitter on as many as 46 occasions to remotely break into the controls of a sewage treatment system. He altered electronic data for particular sewerage pumping stations and caused malfunctions in their operations, ultimately releasing about 264,000 gallons of raw sewage into nearby rivers and parks."*

It is not widely understood that it is not possible to provide assurance that a system is secure by testing it (even though this has been well known by computer scientists for more than 40 years). Even a small software-based system can exist in hundreds of thousands of different "states", any of which might lead to a security breach. For any practical system, testing every state is impossible, so the best you can discover by testing is that the system ran these specific tests successfully but this tells you nothing about what might happen if the tests were run again, or in a different order, or with different inputs.

The consequence is that no-one can discover what vulnerabilities have been introduced (accidentally or deliberately) into the systems that control smart buildings, or who knows about them There is a strong international market for "zero-day" vulnerabilities (barely diminished by the recent dismantling of the *Silk Road* criminal website selling malware alongside drugs and weapons) so it would be surprising if developers were not creating vulnerabilities and selling them, with or without the active encouragement of those who might wish to exploit them at some time in the future.

This situation need not continue. Software engineers who work on regulated, safety-critical applications (such as aircraft control systems, nuclear power or railway signalling) increasingly use mathematically based "formal methods" that provide the ability to analyse the software they develop and to prove that it behaves as required for all possible inputs. The proofs can then be provided and demonstrated to a customer or regulator as required. Formal methods have been shown to be practical and cost-effective but they have not yet come into wide industrial use. It is highly unlikely that a commercial BMS and the control systems to which it is connected will have been developed using these methods, which is one reason why the vendors will not offer effective guarantees for their systems. Customers do not yet demand evidence of security when they specify systems (and if they did, probably no supplier could offer a compliant bid because of the weaknesses in their development methods and in their supply chain). This is a classic market failure where competition will not provide the stimulus to create the improvements that are needed.

CONCLUSIONS

The security of BMSs and related control systems should be seen as a strategic issue. Even if no current buildings are at risk, many more smart buildings will have been constructed by the time the market for secure systems has matured enough to allow architects to specify secure systems, for developers to acquire systems they know to be secure and for building occupants to have effective assurance about the level of protection that their building provides. Strategically, it would be better if UK industry were creating secure building management systems, rather than UK customers purchasing possibly compromised systems developed in countries that may not have the UK's well-being as a high priority.

Smart buildings: people and performance. http://www.raeng.org.uk/news/publications/list/reports/RAEng_Smart_Buildings.pdf

GAO report number GAO-08-119T Critical Infrastructure Protection: Multiple Efforts to Secure Control Systems Are Under Way, but Challenges Remain. http://www.gao.gov/assets/120/118147.html

See, for example, http://www.adacore.com/sparkpro/tokeneer

SMART BUILDING NETWORKS

Ian Taylor and Andrew Comer

Ian Taylor is a former MP and is ex-Chairman of the P&SC. He is Chairman of Living PlanIT SA. Andrew Comer is a Partner of Buro Happold and sits on the Living PlanIT board.
www.living-planit.com
http://www.burohappold.com/thelivingcity/

INTRODUCTION

The debate on Smart Buildings should be conducted in a positive context. There is little accrued benefit to users, developers or public administrators if a smart building is a construction isolated from the urban built environment. If we get the balance right, the potential is awesome:

- By the year 2050 more than 70% of the world's population will live in cities consuming the bulk of the world's resources.
- The battle for environmental sustainability will be won or lost in our cities which consume more than 75% of the world's energy as well as contributing approximately 70% of greenhouse gases. *(Intel)*
- Urbanisation will happen despite the economic climate today – the test will be how intelligently it is designed, planned and executed. The main competitive edge for a city will be not just location but accessibility, its ability to enable people to connect and to live and work more creatively, with imagination and with better service delivery.

... ability to enable people to connect ...

- A city can have a neural system – interacting and connecting millions of sensors gathering the data and interacting with essential services.

Living PlanIT SA has endeavoured to find ways of coping with the leap forward in technologies by integrating them across urban areas and between and within smart buildings. The PlanIT Urban Operating System UOS™ enables a new class of applications to deliver innovative services and opportunities, embedded in the structure of the city with control systems, telemetry and real-time data. We provide the software integration which can ensure clever buildings become really smart and improve the way people work, live and play.

WHERE WE ARE NOW?

The term *smart buildings* is commonly associated with technology solutions such as Building Management Systems (BMS). Thirty years ago the price of microprocessors became economically viable enough to use them to control the equipment in buildings, which led to the creation of a new technology and market for BMS. In a typical BMS case small microcomputers are installed throughout a building to control associated equipment.

In addition to BMS, Building Information Modelling (BIM) has been introduced sporadically over the past decade, is now a key design process feature and by 2016 will be mandated by UK policy across all public sector building projects in the UK. Originally introduced to support design and construction efficiency, and the reduction of construction costs for building structures and mechanical, electrical and plumbing plants and networks, BIM is now being used as a basis to support specialist simulation analysis such as people movement and occupancy, microclimate and carbon reduction.

The term integrated Building Management System (iBMS) is used by Buro Happold to highlight an integrated intelligent system in a building. This system will reduce carbon emissions and control performance automatically. In addition, it will present actionable information to users that enables them to interact with the building in the most energy efficient and productive manner.

THE OPPORTUNITY

Living PlanIT and their consulting engineering partner, Buro Happold, both agree that the application and integration of technology will be key for smart buildings of the future.

... reduction of construction costs for building ...

The continuing reduction in microprocessor costs and size has made it possible to migrate the intelligence into increasingly smaller devices; it is now possible for a device to have its own on-board intelligence and support communication with surrounding devices. This ultimately allows machine to machine (M2M) communications and the opportunity relating to the **Internet of Things** (IOT) connecting devices, people and things. An example of this is highlighted in a Children's Hospital in Birmingham. McLaren Electronic Systems (Living PlanIT's strategic partner) implanted a communication system that transmits real-time patient information to doctors and nurses of the intensive care unit. While a child is being taken to the hospital, data are sent to specialists awaiting their arrival.

Predictive data analysis is already proving invaluable.

Buildings of the future gather individual user data, aggregate behaviour of people and use this information to respond to their needs. In conjunction with geo-spatial databases like GIS (Geographic information Systems) they will also be able to use real-time tracking information (from sensor and social networks) to optimise their operational management, ambient noise levels, mobility and connectivity, security and fire response. Buildings will be able to predict and even influence people's behaviour to minimise queuing, enhance retail and advertising revenues, and optimise use of resources, waste-to-energy and building systems dynamically. Buildings might enable feedback to their operators and managers to provide appropriate staffing and improve service levels.

The smart building of the Future © Buro Happold

PROJECTS

Thirty years of development have resulted in some modest examples based upon traditional approaches. Bluewater retail park in Kent used integrated intelligent systems as a key business enabler and this has subsequently been replicated in most of the large retail developments in the UK. Two other examples include the TfL HQ at Palestra, Southwark and One Angel Square, the new Coop headquarters in Manchester.

A project we are engaged in at London City Airport to implement a 'Smart Airport Experience' has been sponsored by the UK Technology Strategy Board. It aims to leverage the UOS™ as underlying technology to help the airport improve both efficiency and customer experience. Just like a city, airports require a common open operating system that allows for the sharing of data between inanimate objects, and presenting those data as information in the right way to the benefit of consumers.

... airports require a common open operating system ...

We have also recently begun a project in Brazil with a major developer, Convida, which fully appreciates the value of smart buildings in an urban context.

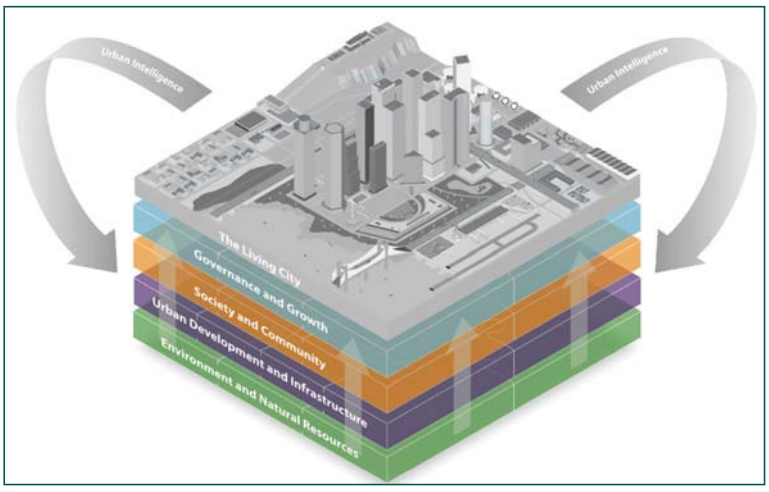
CONCLUSION

We believe that the following areas require focus in the smart building debate to ensure that the opportunity is maximised:

- Buildings should aim to minimise their carbon footprint and be environmentally responsible through sustainable design, construction and operation through the lifecycle of the building
- Buildings should collect appropriate data about both user behaviour and themselves (covering systems, environment and its structure) so they can respond accordingly.
- The use of BIM should be maximised and support operation and maintenance
- Automation and optimised control of building performance via an iBMS should enable users to focus on other areas of interest that may derive greater enjoyment, value and experience to themselves or their business
- The integration of fast, efficient ICT infrastructure (using common platforms) within the building and public realm
- Developing a new economic model to ownership and tenancy of buildings to ensure that there is an accrued, long-term benefit to investment in the planning and design of sustainable buildings

... accrued, long-term benefit to investment ...

The smart building movement has to link with wider opportunities to create maximum potential, namely ramping up the opportunity to initiate smart districts and smart cities. A smart building should not focus only within the building or plot demise. It should have the ability to share knowledge and experiences via the IoT and/or a City Operating Platform with other buildings and infrastructure within the city. This has its own considerations not least regarding: governance: business and economic planning: data privacy and security: resilience; creating transparency and trust; managing resources and the environment: ICT, infrastructure, citizen engagement and delivery of public services. However, these challenges and risks can be overcome through appropriate planning, design and operation. The benefits are huge.



The Living City © Buro Happold

Annual Luncheon of The Parliamentary and Scientific Committee

The Guest of Honour at the Annual Lunch on Tuesday 5th November 2013 was the Government's Chief Scientific Adviser, Sir Mark Walport

Sir Mark Walport

In his address, he made the following points:

"Thank you for the invitation to speak to you, and for your introduction.

Your reference to the controversy about neonicotinoids in my first few weeks illustrates a key feature of the job.

One of the main challenges of the job as Chief Scientific Adviser is the distinction between hazard and risk – two concepts which are often confused.

Our lunch has been surrounded by hazards. Salt is very dangerous if consumed in large quantities, and as for knives – we all know about how dangerous they can be.

Risk is of course hazard times exposure.

The specific issue I had to deal with was not whether neonicotinoids were hazardous to insects – they are designed to be so. The question is at the field levels used, do they kill insects which we do not wish to harm? Regrettably the evidence at present is simply not sufficient.

It is one of the problems of the job. Uncertainty is one of the issues.

We can sort such things out with more experiments. The scientific approach is not to take a reflex decision and to ban substances, but to go ahead and do the science. This will enable us to determine the correct answer.

Let me say a few words about the role of the Government Chief Scientific Adviser.

It is of course to advise Government about all aspects of science, engineering, technology, and social science as it applies to all aspects of Government policy. It is clearly a small job!

I thought I might start by considering what is it that Government cares about?

I think there are two things which governments really care about. The first is the health, well being and the resilience of us, the UK population. And the second is the economy.

These two issues then drive the agenda.

If we then think about what it is that drives the health, well being and resilience of populations it is to a very significant extent our infrastructure. It is our infrastructure that we take for granted, until it goes wrong.

Advanced societies fail to work very quickly when the electricity supply fails. Then we have cascading failures, and everything else stops. We survive by just-in-time supply lines. Supermarket shelves would empty very quickly and water would stop pumping.

So our built infrastructure is extraordinarily important to our resilience and wellbeing.

This includes energy, buildings, transport, cyber security and waste disposal.

Then there is also the natural world which is vital for humans.

This natural infrastructure includes weather, climate, biodiversity plants and animals.

These two sets of factors then drive the science and technology agenda. An important part in preserving our health and well being is identifying and managing national risks and emergencies.

Here I would like to pay tribute to my predecessor, Sir John Beddington, who, during his tenure, set up SAGE, Scientific Advice Groups in Emergencies, This is now an established part of our national resilience. It feeds science in to COBRA in emergencies.

On the economy, I don't think I need to persuade you that science and engineering are important.

I think that a key role of the GCSA and the Government Office for Science is to bring together Industry, Academia and Government so that we can try to get the best policies and the best environment for our truly great sciences and the utility and economic benefit which they bring.

Another important aspect of the Government Office for Science is to provide advice on Horizon Scanning and Foresight.

It is not just about getting advice when you are in trouble, it is also about working with the community at large to identify the future risks and opportunities. We have recently initiated a Foresight programme on "Future Cities" which I think is a very exciting topic.

There are two additional areas of the job which I think are important. One is making better use of both quantitative and qualitative analysis by Government, so using evidence properly.

There is also a role for the GCSA in providing leadership of the very few posts at Permanent Secretary level which works right across Government, and I think that is a key aspect of the role. I work closely with the Cabinet Secretary and with the Treasury, because they have responsibilities to work across Whitehall, and also with Number 10.

A lot of the job is about finding the right people to work with. I work closely with the Permanent Secretaries and that community, and I am trying to work out who are the people who get things done. One of the challenges is execution. It is one thing to have a good idea, it is quite a different thing to make sure it happens.

It has been pointed out to me all to often 'What can an ignorant medical scientist know about the physical sciences?' I point out what can an ignorant physical scientist know about the medical sciences. Any GCSA is going to have his or her own narrow area of expertise – it goes with being a scientist.

The work can only be done with a network of other advisers, and we have a terrific network of CSAs in almost every Department of Government. Between us we have most of the domain skills that are needed. For example, Robin Grimes is a Nuclear Physicist, and he is CSA at the Foreign and Commonwealth Office. Rod Smith is an Engineer, and he is in Transport. Between us we do therefore have most of the expertises, though not quite all of them.

Then there are many scientists in and around Government – Met Office, DSTL, Public Health England, and an important part of the role is as Head of the scientific community. And then there are of course many scientists, engineers and technologists outside Government – in the Academies, Universities, Industry, science advisory committees and councils (about 70 of them). The key challenge is how to effect results.

I would strongly recommend the key textbook for almost anyone in Government is Microcosmographia Academica, a great book written anonymously by Francis Cornford in 1908, because he feared that it might ruin his reputation as an academic, if his name were attached to it. It is only 40 pages long and readily available, and I encourage anyone who has not read it, to do so.

There is a fine balance between working inside and working outside Government.

People are sometimes disappointed if the GCSA does not make lots of statements publicly. I do of course think it is an important part of the role.

If we are really to effect change, we need to work effectively within government. I learned fairly quickly that if you want to change things, you need to work with Government Departments rather than doing things to other Government Departments. There is a partnership role in getting things done.

The other trick is getting other people to help – and learned academies and societies are very helpful here. They are often able to say things from an

Lord Jenkin, Andrew Miller MP and Professor Michael Elves

Rt Hon Liam Byrne MP

Stephen Metcalfe MP, Chi Onwurah MP and Dr Stephen Benn

Ms Fiona Nixon and Stephen Mosley MP

independent position, that are harder to say from inside.

The machinery, of course, is the Government Office for Science and the tools are:

- Foresight and Horizon Scanning
- Council for Science and Technology
- SAGE
- The office itself has a very strong team who provide expertise across a wide range

What is the work programme so far?

There have been cross cutting themes in several areas:

- Risk and resilience
- Energy and climate change
- Data and analytics
- Demography, lifecourse and cities
- Innovation and infrastructure
- Trade and finance

I will select just two of these:

Risk and resilience

We have the National Risk Register. I have only recently become aware of how many people near here who are spending their lives working on the safety and security of the population. The topics on which they are working include civil contingency planning – flooding, space weather, pandemics, terrorism – and considering prevention, mitigation, handling and clear up.

The challenge is to turn that risk register into a living document. A risk register is no use if it is six inches thick and sits on a shelf. The trick is to prevent things happening, as best as you can and mitigating the effects when things go wrong, and clearing up afterwards.

It is very difficult to find risks where there is not a significant science, engineering, technology aspect. We get the public engagement wrong on topics such as GMOs when we treat them generically. The question should be what gene, what organism, for what purpose. It is not that GMOs are either a good thing or a bad thing.

This is true for all technologies. Is nanotechnology a good thing? Clearly asbestos as a nanoparticle is not a very good thing.

In the case of synthetic biology, making a new toxin may not be very helpful. Developing an organism which could remediate arsenic in the environment would be a very good thing.

We tend to treat technologies as generic, whereas in fact they are specific. They are neither a 'good' thing nor a 'bad' thing – they are 'it all depends' thing.

There is a key role for science to play in diplomacy.

This was shown very clearly in John Beddington's advice after Fukushima. UK citizens in Tokyo were told they did not need to pack their bags and evacuate, because there was no significant risk from the plume from Fukushima. This was very important, not only for British citizens, but it also helped to calm the crisis in Japan. If you look at other countries' response to nuclear energy in the aftermath of Fukushima, the UK was the one country where public opinion remained steady.

Energy and Climate Change is undoubtedly one of the defining policy issues of our time. The IPCC report came out recently, and the conclusion is absolutely unequivocal. The effect of human behaviour on climate change is clear.

The challenge is to move from the science to the communication to the policy. There are some who are unwilling to face up to the policy conclusions and react by denying the science.

This is completely nonsensical. We have to agree the science. We then need to recognise that there is a whole range of policy decisions which are for all of us to decide – we are the electorate.

We could make the decision that we do not care about the world for future generations. It is a legitimate decision, although not one with which I personally agree, but it is for the population to decide. But we must not approach the issue by pretending that the science is wrong – it isn't.

Nick Pidgeon and his group in Cardiff have done good work looking at public values around energy. There are three concerns for the public. They worry about security of supply, affordability and sustainability. Any policy maker needs to look at the issues through all three senses simultaneously. We have set up an energy subgroup of CSAs and within CST, working with key Government Departments.

The job is fascinating, and I would like to record my thanks to all those who have already given me so much support."

Lord Jenkin

Lord Waldegrave and Lord Jenkin

Mrs Katriona Methven, The Lord Willis of Knaresborough and Dr Charles Evans

Baroness Perry and Dr Richard Worswick

Mr Ian Taylor with Sir Mark Walport

SCIENCE AND IMMIGRATION

Philip Duffy
Director of Immigration and Border Policy, Home Office

Science is inherently international. There is an oft-cited statistic that there have been 97 Nobel winners from Britain, five of whom came as refugees and eight came to continue their academic careers.

One only has to look at the author lists of a contemporary paper – sometimes in the case of physics running into three figures – to see that key discoveries are increasingly the work of many hands, often from different disciplines and in different countries. A cursory glance at the staff lists of any top UK institution will show how successful we have been in attracting top global talent to our elite institutions, not to mention the many foreign student scientists and PhD candidates, visiting researchers and exchange students who make our world-class universities diverse and successful.

Human mobility is intrinsically linked to Britain's ability to remain at the forefront of science and research. The Government understands this and wants to support British science and research. While it has not shied away from taking tough action on immigration abuse, it has consistently protected and enhanced the treatment of scientists and science in the immigration system, in recognition of the critical role science plays in the economy and wider society. This article sets out how the Government's support for science and research is reflected in the immigration system.

... supporting British science and research ...

SCIENTISTS AND RESEARCHERS

Immigration reforms since 2010 have explicitly taken account of the needs of scientists and researchers, even whilst restricting migration in other spheres.

... attracting top global talent ...

The Exceptional Talent route introduced in 2011 caters for world leaders in science, engineering, humanities and the arts. Exceptional scientists wishing to come to the UK need to obtain an endorsement from one of the Competent Bodies, which include the Royal Society and the Royal Academy of Engineering. Once here, the terms of the visa are generous: holders are not tied to a specific employer, have no specific salary requirements and can qualify for settlement after five years. From April, the route will be expanded to include technology experts, with the Tech City UK coming on board as a new Competent Body.

A further new route (Permitted Paid Engagements) allows certain professionals, including those visiting to give a lecture, examining students, and participating in or chairing selection panels, to use the visitor rules to come to the UK for up to one month without the need to be sponsored under the Points-Based System. This route was created in response to some very specific feedback that the previous arrangements simply were not working for science – imposing the types of requirement needed for longer stays on a scientist merely visiting the UK to support regular academic work was cumbersome and unnecessary.

The Government has also preserved the separate Tier 5 route for sponsored researchers, which allows them to come for up to two years, and relaxed the resident labour market test to make it easier for universities to recruit academic and research staff under Tier 2. In addition, the importance of academics and researchers has been recognised by exempting them from new earnings requirements for settlement.

Finally, it is worth noting that a number of science and engineering roles, particularly engineering roles, remain on the

Shortage Occupation List. That tells us that despite efforts to increase the UK supply, there are still genuine shortages of some skills where migration may be part of the answer. The Government recognises this, so employers can recruit migrants directly to roles on the Shortage Occupation List without first having to test the resident labour market.

STUDENTS

Student migration is of course far broader than just science, but overseas student researchers make up a significant proportion of the postgraduate community at many universities, and contribute to the viability of many science faculties.

First, it is important to be clear that there is no cap on foreign students. Genuine international students are very welcome to come to the United Kingdom. All the indications are that students are continuing to choose our world-class universities. Sponsored applications for visas to attend UK universities rose 7% last year. UCAS applications from non-EU students for courses beginning in 2013 increased by 6%.

The current student visa offer is a good one, and builds on some common sense reforms to what had been a problematic route. Those who wish to study here need a place, sufficient funds to maintain themselves and any dependants and an ability to speak English (at B2 level of the Common European Framework of Reference for Languages), which is the right level to enable students to make the most of the teaching offered at the UK's world-class universities, as well as to integrate into the student community and wider society.

On top of this, the system awards universities in particular a number of privileges, reflecting their contribution to the UK's international educational standing and the lower level of immigration abuse identified in the university sector compared to private colleges. They have flexibility on language testing,

... there is no cap on foreign students ...

their students have better work rights, and post-graduates can bring dependants. It is gratifying, therefore, that we continue to see rises in arrivals of the most talented foreign students. Recent UCAS data (published 24 October 2013) shows applications from top international undergraduates continue to rise. Applications to medicine, dentistry and veterinary courses, and all courses at Oxford and Cambridge, beginning in 2014 are up 10% compared to the same period last year.

POST-STUDY AND GRADUATES

It is a myth that international students can no longer remain in the UK to work, after graduation. Any student who obtains a graduate level job paying a minimum of £20,300 can stay on a Tier 2 work visa. There is no limit on the number of these places, which are exempt from the cap on economic migrants. The employer does not need to test the UK labour market, provided the job is at the right skills level and the individual is paid an appropriate UK salary for their occupation. And the salary levels are set at only the 10th percentile of UK earnings for each occupation, for these new entrants to the labour market – compared with the 25th percentile which is the general rule when recruiting from abroad.

Students completing a PhD or other doctoral qualification at a UK university can stay for an additional year under the Tier 4 Doctorate Extension Scheme. This scheme was set up in April 2013, and allows completing students to work, gain experience in their chosen field, or set up as an entrepreneur, again with no limit on numbers. There is also provision for graduates who wish to undertake a period of professional training relating to their degrees, before pursuing a career overseas, to do this by switching into an appropriate Tier 5 scheme. This is not a route to permanent stay, but there are no salary requirements (other than the National Minimum Wage).

... the unique needs of international science ...

Finally, graduates who wish to stay to develop a business idea can do so under the Graduate Entrepreneur scheme, the first in the world of its kind. All they need is an endorsement from their Higher Education Institution that they have a genuine and credible business idea, to have graduated, and to have enough funds to support themselves. In April 2013 we doubled the number of places on the scheme, creating an additional 1,000 places for those who have completed an MBA in the UK.

DELIVERING BETTER SERVICES

So recent immigration reforms have taken account of the unique needs of international science in a number of ways. But an effective immigration system also demands good customer service. The experience of using the immigration system was an area of great focus in 2013, with the abolition of the former-UK Border Agency and its replacement by two new Home Office structures – UK Visas and Immigration (UKVI) and Immigration Enforcement. In doing this, part of the Home Secretary's rationale was to create in UKVI an organisation with a culture of customer satisfaction, focused on dealing swiftly and efficiently with visa applications from legitimate travellers. Under the leadership of Sarah Rapson, UKVI is well on the way to eliminating backlogs in in-country applications, and is looking to improve online applications through gov.uk, and introduce "plain English" service standards. And for those who travel frequently – as many scientists do – I hope you will see a transformed experience at the UK Border, with queue times at Heathrow in particular immeasurably improved compared with 2011-12.

... elminating backlogs ...

Immigration is both complex and controversial, but when it comes to supporting the UK's globally-successful scientists, the Home Office continues to listen and do what we can to help.

IMMIGRATION POLICY AND STEM – a view from the universities

Ian Haines
Executive Secretary, UK Deans of Science
Emeritus Professor, London Metropolitan University

UK UNIVERSITIES, PLC – A SUCCESSFUL EXPORT BUSINESS

In a comprehensive analysis of the contribution of education to the UK economy, London Economics estimated that in 2008-09 the value of overseas trade and investment in UK education totalled £14.1bn[1]. The largest single factor was higher education, contributing £7.9bn. Adjusting for changes in student numbers and inflation, the income from higher education in 2011-12[2] was approximately £10bn of which £5.5bn came from fees and other spending by students.

Non-UK students make up differing proportions of new enrolments in the various modes and levels of study (Table 1)[3]. At undergraduate level the proportions are quite low but the total numbers fairly large. At postgraduate level many programmes would not be viable if numbers of non-EU full-time students dropped significantly.

The effect of international students on the employment of staff in universities is generally overlooked. In 2011-12, 17% of all students were non-UK-domiciled which led to the employment of a similar proportion of university staff – approximately 30,000 academic and 33,000 non-academic staff.

SIGNIFICANCE OF NON-UK STUDENTS TO STEM SUBJECTS

While the above data illustrates the importance of non-UK students, postgraduate taught enrolments in some STEM subjects are even more significant (Table 2). However, the impact of non-UK students is much more than a matter of numbers and income. They contribute to an international curriculum in taught programmes and research. Many reach positions of considerable responsibility on return to their home countries. If such export value were being generated by a company in any other sector of the economy, the government would act to preserve it at any cost, but the coalition's actions and rhetoric have done nothing to support universities in an increasingly competitive environment.

Table 1. New Non-UK Enrolments in all Subjects by Domicile in 2011-12[4]

Mode of study	Total number	Non-EU	Other EU[3]
Full-time postgraduate	120060	46%	12%
Part-time postgraduate	12015	7%	4%
Full-time undergraduate	88185	11%	6%
Part-time undergraduate	18060	4%	2%
All	238320	15%	6%

WORDS AND ACTIONS ON IMMIGRATION

Risk to the UK's attractiveness to international students surfaced before the 2010 general election with much hyperbole about reducing 'net immigration to tens of thousands' and clamping down on bogus students and colleges. *The Coalition: our programme for government* stated: 'We will introduce an annual limit on the number of non-EU economic migrants admitted into the UK

Table 2. STEM PGT enrolments by subject and domicile 2011-12[5]

	Number of students	Non-EU %	Other EU %	UK %
Mathematics and computing	21,340	49%	9%	41%
Engineering and Technology	38,740	49%	13%	38%
Physical sciences	7,840	29%	10%	61%
Architecture, building, planning	7,365	24%	8%	68%
Veterinary science, agriculture	2,320	21%	11%	67%
Medicine, dentistry	7,740	19%	7%	74%
Biological sciences	10,220	14%	8%	78%
Subjects allied to medicine	14,575	10%	4%	86%

to live and work', and the need to 'minimise the abuse of the immigration system', citing as the only example abuse of the student visa route. The stage could hardly have been set more negatively for recruitment of international students, including those from mainland Europe.

Following the election, revisions to immigration rules were published on eight occasions in 2011 and ten in 2012. Of particular significance for higher education were:

- closing the Post-Study Work Route which allowed non-EU graduates completing their studies to remain in the UK for two years to obtain work experience, replacing it with a more restricted scheme
- reducing the numerical cap on skilled workers
- increased checks on English language capabilities – although skills in English are essential they may be over-specified for some students in STEM where mathematics and technical skills predominate
- introduction of a new category of 'exceptional talent'.

CAUSE AND EFFECT?

In the decade up to 2010, international student recruitment increased steadily. However, this did not continue (Table 3), with significant reductions, especially in postgraduate programmes. Official numbers for 2012 are not yet available but many believe the downward trend continued. The effect on certain STEM subjects between 2010 and 2011 was very serious with non-EU postgraduate recruitment down 8%, engineering and technology 10% and computer science 14%. Specific examples quoted by members of UK Deans of Science include the non-EU entry to an MSc in biosciences from 2008 to 2012: 100+, 60+, 30+, 10+, 10. Another university gave figures for postgraduate registrations from India before and after withdrawal of the Post-Study Work Route: computer science down c 50% and engineering down c 65%. Such changes make business planning impossible and can jeopardise a Faculty's ability to retain experts in a particular field, seriously affecting its research and teaching capabilities.

Table 3 New Enrolments in all subjects by domicile, 2008 to 2011

Year of first enrolment		Non-EU, % change over previous year	Other EU % change over previous year
2008	Postgraduate	+16%	+9%
	Undergraduate	+13%	+1%
2009	Postgraduate	+12%	+12%
	Undergraduate	+12%	+4%
2010	Postgraduate	+8%	+5%
	Undergraduate	+8%	-1%
2011	Postgraduate	-2%	-2%
	Undergraduate	+2%	-1%

The anti-immigration rhetoric is only part of the story. Limited space prevents a more detailed analysis taking into account the changes in the attractiveness of other international locations, including the substantial investment in university development in countries that have been main sources of the UK's recruitment. However, review of the press in such countries illustrates the negative side of what has happened. To give just one example, in *The Economic Times of India* in May 2012 (repeated on many websites) an Indian Birmingham University student is quoted as saying that if he had been in India when the Post-Study Work had stopped he would not have applied to the UK.

UK Deans of Science has many recent examples of difficulties, including:

- inability to appoint a non-EU external examiner even if s/he were not paid a fee
- a highly prestigious MSc scheme based on three day sessions in the UK plus 6 weeks of internet-based work. Candidates would fly in for the UK-based sessions but the course team could not find a legal way for this to happen
- a Chinese MSc candidate refused entry as she already had Masters – studied in Mandarin!
- a student refused entry who had sufficient funds in a bank account when he applied but the money had reduced in value due to currency fluctuation
- a student refused because only one month stipend was in his bank account though the stipend was guaranteed to be paid every month
- queues of students outside a Central London police station on enrolment day due to the requirement to report to a police station.

The Coalition may not have intended its immigration rules to cause such effects, but politicians are not judged solely by their actions but the *impressions that they give in their public statements.* Never was this more significant for universities than in relation to immigration.

THE FUTURE

Recent changes in immigration policies (October 2013) included:

- powers to refuse Tier 4 extension applications where the applicant cannot speak English (a reasonable criterion) but, rather oddly, removing the English language requirement for intra-company transferees
- a Tier 5 exchange scheme allowing some students to work as interns, though limited to a small number of countries and prioritising applicants with some form of British overseas citizenship
- expanded checks to ensure applicants for work and student visas are genuine, that they intend to meet the conditions of leave they apply for.

It remains to be seen what effect this will have, but the first reference to them in the Indian newspaper, the Deccan Herald, was headlined: *'Indian students to the UK: Welcome or not? Universities are wooing Indian students, but the UK Border Agency does not seem to be waiting with open arms to issue visas. The mixed signals are playing havoc with young lives'.*

A category that has come in for criticism is Tier 1 (Exceptional Talent) which allows up to 1,000 entrants a year if endorsed by one of four national organisations[6]. In the first year this permitted 72 entrants while over 700 'talented' sports people were given visas. Clearly, exceptional talent should not be interpreted as 'likely to win a Nobel Prize'. Perhaps the recipients of some

prestigious awards and fellowships should have automatic right to entry under this category.

The Coalition must reverse the negative impression of its attitude to 'foreigners'. This article concentrates on the university sector but the increased difficulties for students joining FE colleges will impact on universities soon. It is worth noting too that in STEM subjects, including electronic and computing engineering, the percentage of academic staff [7] who are not UK nationals varies between 41% (in physics) and 33% (in biosciences) [8]. Any further fall in international interest in our universities could threaten the viability of STEM departments and courses. Departmental business planning and research collaborations could be at risk. University science departments work hard to maintain their international presence. What is now needed is for all government departments to ensure that their policies support them. Science is international and we must keep our STEM borders open to the world.

Footnotes

1 Estimating the Value to the UK of Education Exports, June 2011,

2 2011-12 used as this is the latest date for which data are available at the time of writing

3 The term 'other EU' denotes those students from the EU, but not UK-domiciled

4 Higher Education Statistics for the United Kingdom, 2011/12, HESA 2013

5 Data supplied by UUK

6 Arts Council England, British Academy, Royal Academy of Engineering, Royal Society

7 Professors, senior lecturers, lecturers and researchers

8 Academic Physics Staff in UK Higher Education Institutions, IoP, December 2013

AN IMMIGRATION POLICY FOR SCIENCE

IS OUR IMMIGRATION SYSTEM CREATING BARRIERS FOR SCIENCE?

Ian Robinson
Fragomen

Immigration is always in the news, Parliamentarians will know that better than anyone.

This morning I read reports about Eastern European criminals, a botched deportation and the impending (as I type) right of free movement for Romanian and Bulgarian nationals. Yesterday I spent my lunch reading about an asylum seeker on hunger strike.

I have spent ten years working in immigration most recently concentrating on the rules for bringing skilled foreign workers to the UK. Only once can I remember the media reporting that it was too hard for workers to get in, rather than worrying about it being too easy.

In 2010 the Campaign for Science and Engineering (CaSE) ran an excellent campaign on the issues that the UK's immigration policy was creating for science. CaSE combined current experience with the risks that could be realised as immigration law was reshaped and otherwise tightened.

The Times did a great job of nationalising the issue. One morning I would read about scientists being sent home; the next it would be Nobel Prize winners expressing deep concern about the prospect of a cap on scientists and other foreign workers.

The campaign made a real difference. The cap on skilled workers was implemented – as was inevitable – but scientists were prioritised ahead of other workers. Science was also given a new visa category for exceptionally talented researchers and all manner of other carve outs and exceptions. The system wasn't perfect but it was much better than it might have been.

In October 2013, three years after the campaign began, the Parliamentary and Scientific Committee had a fresh look. The questions for debate were reasonably simple – is UK immigration policy causing problems for science and if so what should Parliament and policy makers be thinking about.

For the last two years I have worked for a City law firm, helping businesses in all sectors to bring staff to the UK. For the eight years prior I had been a Home Office official, and had led on the development of migrant skilled worker policy for two years until 2011.

Going from one side of the fence to the other is an interesting experience. It was only after making the jump that I knew how little I understood about my own policy area. Systems we thought were reasonably straightforward are much more complex in real life. Our transparent Points Based System becomes a little more opaque with every idiosyncratic case.

None of this means that the system doesn't work well.

As an official we were encouraged to be intellectually curious, looking at other policies

elsewhere in the world.

I now work with a variety of multinational corporations and get to see how they operate across numerous countries. It is good to be able to see how effective the UK's visa system is as compared to other countries in Europe.

So what does this have to do with science and is our immigration policy causing difficulties?

My own view is that we are in good shape but the Home Office can do more to help.

If you are a large organisation with a base here, whether in academia or industry, the system should work well for you. We have one of the world's only objective regulatory frameworks for immigration. The UK's system is calibrated to provide absolute certainty when all requirements are met. My colleagues overseas have to manage their way through subjective processes that are at best predictable and at worst erratic.

... the system needs to work better ...

Those requirements are rarely onerous for skilled workers. Evidential requirements are robust but straightforward and we can comfortably get an application together in a couple of days. Elsewhere in the world it can take weeks or months.

Once you've selected a new employee or an assignee a visa will normally be issued in two to 15 days; you can see from the map that the same cannot be said elsewhere on the continent.

This is all important to multinational corporations. When a pharmaceutical company needs to initiate a project urgently, senior management will look at how quickly international experts can be moved and start work. A three week wait for a UK visa is a compelling factor if it can take twice as long for other jurisdictions.

If everything is rosy why did the issue need to be discussed in Parliament?

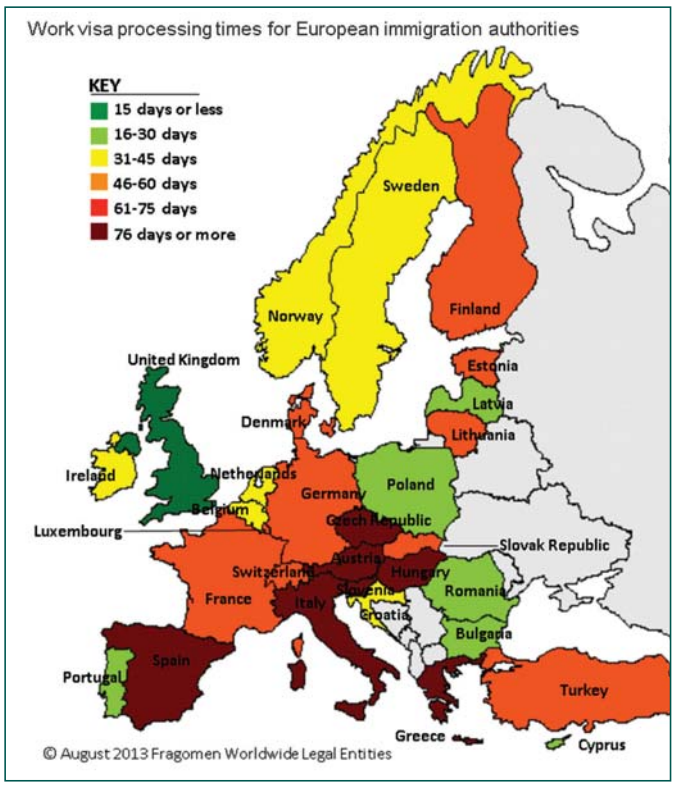
For science there are three areas where sensible changes in policy or approach would make a huge difference. After that anything else would be a bonus.

Firstly the system needs to work better for smaller and newly formed research centres. Labs sponsoring an overseas scientist for the first time have to apply for a sponsor licence, wait for a Certificate of Sponsorship and apply for a visa.

It can be four months before the scientist can come to the UK and start work. During that time a project can slip, an opportunity can be missed or the scientist may look for a different employer.

There are various ways to speed up the system and I would urge ministers to consider them. I favour a simple system of third party sponsorship. My colleagues prefer temporary admission visas. Either way we are talking about highly qualified people so any immigration risk is low.

Secondly, more thought is needed on the Exceptional Talent visa. The principle behind the visa is fairly simple – entry clearance officers cannot be expected to know who the world's best scientists are so the experts get to pick them. If the Royal Society think that, for instance, a Canadian immunologist is extraordinary then the Home Office will give him a visa.



The Home Office's overseas posts can issue visas faster than other European countries

The concept is great but the execution has been poor. The visa was created with a view to hundreds of scientists using it every year. In two years the number hasn't yet topped 100.

This is not necessarily an issue for the Home Office. Ministers did their job when they empowered expert bodies to endorse talented individuals. It is now up to the scientific community to work out how they can use it properly.

The Arts Council administer the same visa system and our experience has been uniformly positive. If it can work for a body that takes in as diverse a group as ballet dancers, film actors and poets it has to be possible for expert researchers.

The final issue is rather more abstract. It is clear to me that the UK's immigration system is a lot better than big and small business think. Business leaders tell me it is slow and cumbersome or complicated and uncertain. This perception may be honest but it is not accurate. The system does work.

There has to be space for the Home Office and the scientific community to do some myth busting. This might mean the Home Office doing more to publicise the speed it can issue a visa relative to other countries; the scientific community could do more to publicise what works and less to castigate the politicians where it doesn't.

This is not easy – it would only take one bad headline to turn the effort on its head, but surely it has to be worth a go?

This returns me to my opening comments. All too often the press find room to report where our immigration system is not working. I am not naive enough to think that this will change any time soon but it is a shame that nobody seems willing to talk about where it does work.

People like me have a part to play in this. Personally I can't see a better starting point than science.

SUB-SEA MINING

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

ENVIRONMENTALLY RESPONSIBLE DEEP SEA MINING

Mary Vayou MSc
Research Director Designate,
BMT Group Ltd

Deep sea and its sub-sea floor contain a vast reservoir of renewable and non-renewable physical and biological resources that are rapidly gaining scientific and economic interest. There are mineral resources (hydrothermal sulphides, polymetallic nodules and manganese crusts), huge quantities of gas-hydrates buried along continental margins, and biological resources of the deep sea floor with biotechnological and pharmaceutical applications. Related to hydrothermal systems, there is a potential for natural hydrogen from serpentinisation reactions, which may be used as an energy source. These resources have increasingly been attracting attention due to the imbalance of existing resources' distribution around the globe, affecting industrial production, energy security, seafood consumption and many other areas of maritime relevance. This is particularly true for Europe, which, though once self-sufficient in ore-production and metals, is nowadays heavily reliant on imports owing to lower-cost mining in other countries.

... potential for natural hydrogen ...

Creating a viable future, economically, socially and environmentally, is critically dependent on sustainable management of deep sea and sub-sea floor resources, as outlined in the Commission Communication [1] on tackling the challenges in commodity markets and on raw materials. Recently the EU passed extensive marine environmental protection legislation, with the clear goal that standards need to be established for the environmentally sustainable extraction, transport and use of resources taken from the oceans.

The international legal framework also comprises a whole range of relevant treaties and institutions, including: the United Nations' Convention on the Law of the Seas (UNCLOS) with fundamental goals to establish a legal order to facilitate international communication and to promote, inter alia, the peaceful uses of the seas and oceans, equitable and efficient utilisation of their resources, conservation of their living resources, and the study, protection and preservation of the marine environment; the Convention on Biological Diversity (CBD); the UN Fish Stocks Agreement; the Convention on Migratory Species (CMS); the European Marine Strategy Framework Directive; the Antarctic Treaty System; Regional Seas conventions and action plans, Regional Fisheries Management Organisations (RFMOs); the International Maritime Organization (IMO); the International Council for the Exploration of the Sea (ICES); The Convention for the Protection of the marine Environment of the North-East Atlantic (OSPAR); the Atlantic Strategy; the Blue Growth Strategy; the International Seabed Authority (ISA) and others.

... standards need to be established ...

Scientific exploration has led to the discovery of various types of deposits, but modern mapping exists over only a small portion of the seafloor. For example, on the Azores Plateau and along the Mid-Atlantic Ridge there are several recognised hydrothermal fields (sources for copper, zinc, gold and silver, high technology metals among others) and plume driven anomalies hosting massive sulphides. Between

mainland Portugal and the Azores region, there are about 250 seamounts and guyots with recognised occurrences of iron-manganese crusts. Abyssal plains have revealed occurrence of nodules (sources for nickel, cobalt, Platinum Group - PGM). Gas hydrate deposits are recognised from south Portugal to north of Norway along the deeper sections of continental margins in most cases linked with deeper petroleum systems.

On the extraction front, only a limited number of companies are exclusively dealing with sub-sea mining. However, many of those already involved in oil and gas exploration and extraction, have launched innovation initiatives and follow the developments closely. To date, far reaching plans to start mining have been made by Nautilus Minerals and UK Seabed Resources – a subsidiary of the British arm of Lockheed Martin, whereas Chatham Rock Phosphate Ltd aims to start in 2015 with mining phosphates at approximately 400m depth.

... opportunity to capitalise in the global market...

Nevertheless, European companies are world leaders in technologies such as dredging, drilling, cutting, transport and ROV manufacturing and operation, which will be essential when large scale offshore mining takes off. There is an opportunity for them to capitalise in the global market for production technologies, operational expertise, Environmental Impact Assessment techniques and technologies and equipment and know-how.

Much about the composition and distribution of the resources on and within the sea subsurface, their quantitative importance for chemical cycles and biological activity, and the potential impacts of exploitation on ocean chemistry and ecosystems remains incompletely understood. Studies indicate that removal of the target substrate will lead to local alteration or destruction of the sea floor and its associated fauna, suspension and sedimentation of sediments and will have a footprint that easily could affect areas several times larger. With nodules, sediment plumes may smother fauna and alter the seabed changing habitat and inhibiting recovery. With massive sulphides, the oxidation of released plume sediment may also have toxicological effects.

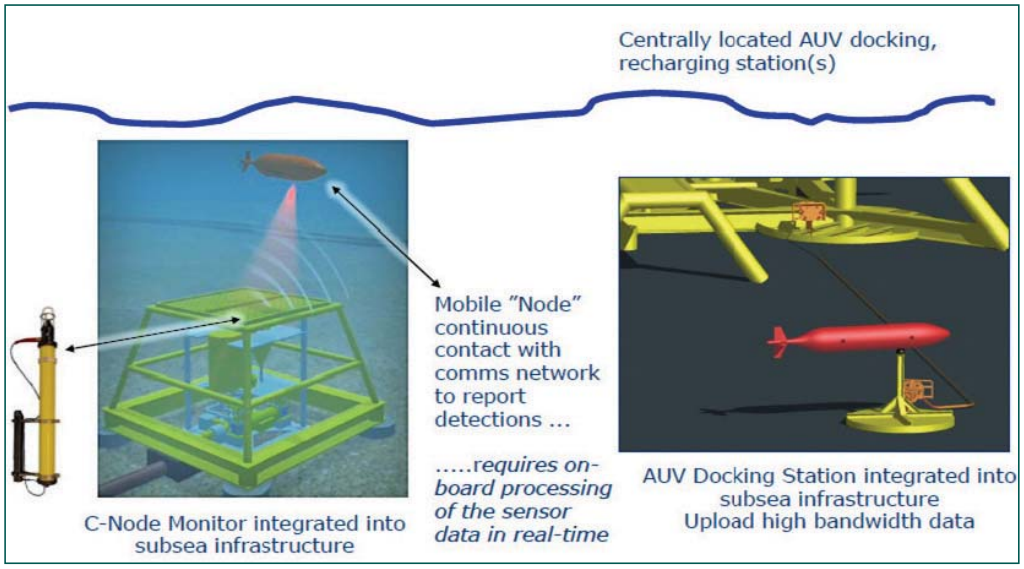
The need to maintain ecosystem integrity is key,

... already involved in oil and gas exploration...

although this may not always be possible with localised reserves. The common occurrence of endemic species on localised hydrothermal massive sulphides may seriously limit the options for conservation in one area to compensate for biodiversity loss in another (UNEP 2007)[2]. Impacts will strongly depend on local hydrodynamic conditions as well as on the activities conducted, the sensitivity of the environment and its potential for recovery. Despite emerging studies on the impact of deep-sea mining in the Pacific, our knowledge of the ecosystem/habitat resilience to deep-sea mining is limited and biased by site specifics. Current techniques and methodologies are not well suited to monitor the mining activities and measure environmental changes not only locally but also over vast areas. Deployment of research equipment still depends on scientific cruises and is prone to high cost. In order to meet environmental monitoring requirements, new techniques able to operate over long periods independent of frequent power supply and data recovery are needed.

... new techniques able to operate over long periods ...

Observatories are key emerging tools to understand the ocean and the complex physical, biological, chemical, and geological processes taken place at the sea-floor. They have evolved rapidly over the last decades by means of programs and projects based on new instrumentation and permanent



Mobile Autonomous Monitoring System with the use of AUVs

underwater networks. The main on-going initiatives at global scale are in Canada (NEPTUNE), USA (OOI[3] - Ocean Observatories Initiative), Japan (DONET[4], - Dense Oceanfloor Network system for Earthquakes and Tsunamis), Taiwan

... sediment plumes may smother fauna...

(MACHO[5] - Marine Cable Hosted Observatory) and Europe (through ESONET-NoE[6] - European Seas Observatory Network of Excellence and recently with the infrastructure project EMSO - European Multidisciplinary Seafloor Observatory).

In these networks, most oceanographic instruments on the seafloor are not connected with the surface: they run on batteries and store data locally. Scientists have access to their data only after recovery of the instrument. This makes it impossible to adjust monitoring protocols until after data have been analysed and equipment redeployed. Though still in the future, the development of Mobile Autonomous Monitoring Systems using Autonomous Underwater Vehicles, as the one shown, would solve the above challenges and provide the necessary information to close the gap in real time understanding of deep-sea mining impact.

... real time understanding of deep-sea mining impact...

Responsible exploitation of this resource is directed by a need to fill knowledge gaps in resource appraisal and environmental and ecosystem functioning. Similarly, there is a need to develop protocols and technologies to mitigate against undue impacts. To achieve this will require work directly with industry towards these common goals. The very high costs of equipment and mobilisation means that Environmental Impact Assessment activities must be integrated at all stages to optimise synergies, as in the offshore hydrocarbon industry. There is a need to shorten the feedback time in design-operations cycle to reduce impact at source and increase operational efficiency.

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SUB-SEA MINING

DEVELOPMENTS IN SEAFLOOR MINING TECHNOLOGY

Michael Jones
Managing Director, Soil Machine Dynamics Ltd

BACKGROUND

Soil Machine Dynamics (SMD) is a leading subsea engineering company specialising in the design of subsea remote control systems for the oil and gas, telecommunications, defence, scientific, renewable and mining sectors. The company has developed since 1971, as a spin out from the University of Newcastle upon Tyne, gaining a reputation for supplying innovative equipment for the burial of pipelines and cables. In 2003 SMD entered the work-class Remotely Operated Vehicle market and is now the world's number one manufacturer. SMD has recently expanded from deep-sea trenching into seafloor mining equipment. It has received five Queen's Awards for both International Trade and Innovation, with three of those awarded consecutively since 2011.

This article focuses on the technology being developed by SMD for the Seafloor Production Tools (SPTs) for Nautilus Minerals Inc (NMI) for their Solwara 1 copper/gold deposits in the Bismarck Sea, off Papua New Guinea.

Solwara 1 Project

As economic surface resources are gradually depleted, the search for replacement mineral commodities is shifting towards new environments such as seabed mineral deposits. Nautilus Minerals Inc is a pioneer in the exploration of the seafloor to find economically attractive massive sulphide deposits. NMI is developing the world's first deepwater copper/gold deposit for commercial extraction known as Solwara 1. The deposit is a massive sulphide formed around hydrothermal vents. It

lies in the Bismarck Sea at 1600m depth between New Ireland and New Britain in the territorial waters of Papua New Guinea. More details can be found at www.nautilus minerals.com

The solution for recovering the ore from the seafloor (figure 1) comprises:

- Production support vessel – which provides the operational base for deploying the riser and lift system and the seafloor production tools. It also dewaters the ore, and stores it until it is offloaded to transport vessels.

... flexibility with respect to the mining conditions likely to be encountered ...

- Riser and Lifting System – which comprises a steel riser and a subsea slurry lift pump.
- Seafloor Production Tools – three remotely operated machines which cut and collect the ore and feed it to the subsea lift pump.

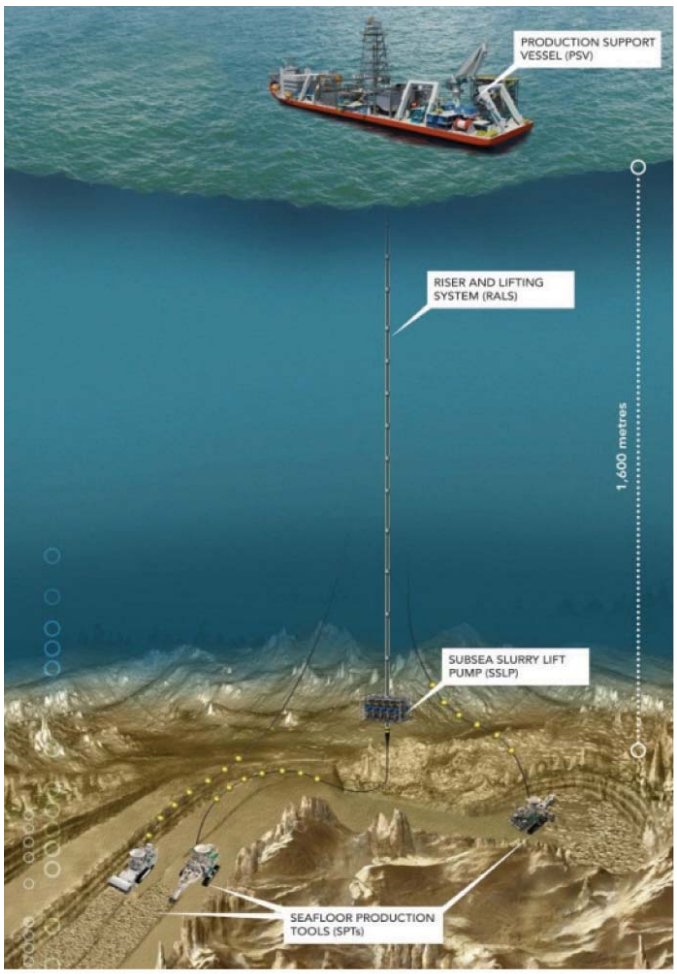


Figure 1: Ore recovery system – Courtesy of Nautilus Minerals Inc

Seafloor Production Tools

The seafloor production tools which are currently being developed by SMD for delivery in 2015 comprise three remotely operated mining vehicles: the Auxiliary Cutter, the Bulk Cutter and the Collection Machine. These are illustrated in Figures 3 to 5. The philosophy has been to leverage technology developed by SMD in their deep water remotely operated heavy duty trenching systems (figure 2). This technology has been combined with proven techniques such as continuous miners and road headers used in underground mines and in shallow water dredging used for extracting sediments. They have been designed to provide flexibility with respect to the mining conditions likely to be encountered. At the same time, commonality of components has been built in wherever possible, minimising the amount of critical spares to be carried for successful remote operation.

The first of these tools, known as the Auxiliary Cutter (AC), is the pioneer machine which will be used to level remnant thermal chimneys, provide access and prepare initial benches for the other production tools. The machine weighs 250 tonnes and uses 600kW counter-rotating cutter-heads on a swinging boom. It moves on heavy duty tracked undercarriage and has two spuds for stabilisation during cutting operations. A pump collects the cut ore and moves it to stockpiles on the seafloor for further processing.

... The drum cutter of this machine will be the largest ever built ...

The second is the primary production tool, the Bulk Cutter (BC). This is a heavy duty tool which runs on tracks. The drum cutter of this machine, which is based on existing technology, will be the largest ever built. The BC operates on the pre-mined bench with the drum engaged in the ground in front of the machine. The machine, like the AC has a collection system which pumps the cut material to

Figure 2: SMD heavy duty remote controlled subsea trenching machine, RT1 – Courtesy of Deepocean Ltd

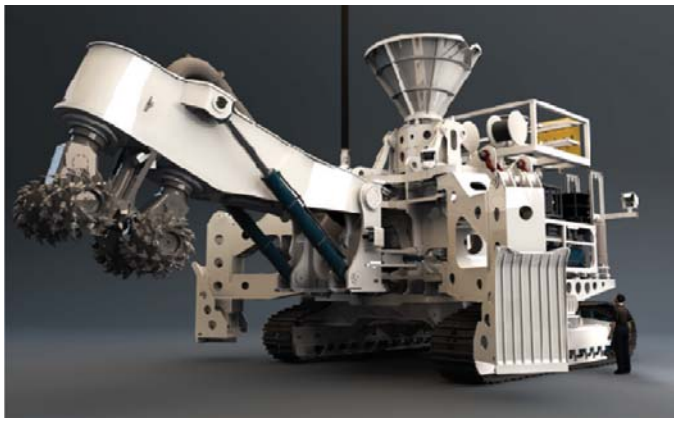


Figure 3: Auxiliary Cutter – Courtesy of Nautilus Minerals Inc

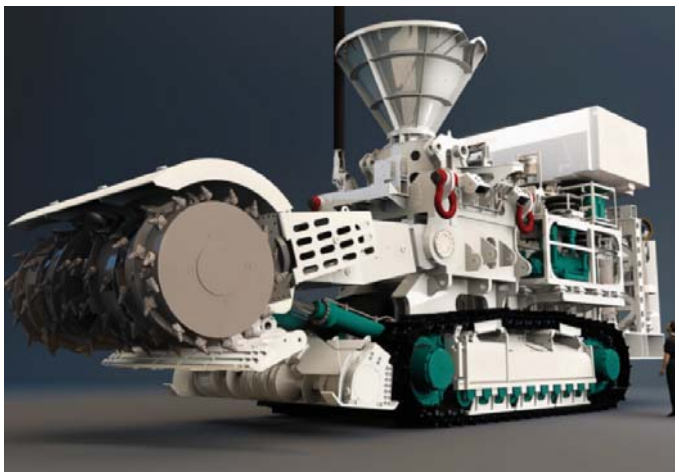


Figure 4: Bulk Cutter – Courtesy of Nautilus Minerals Inc

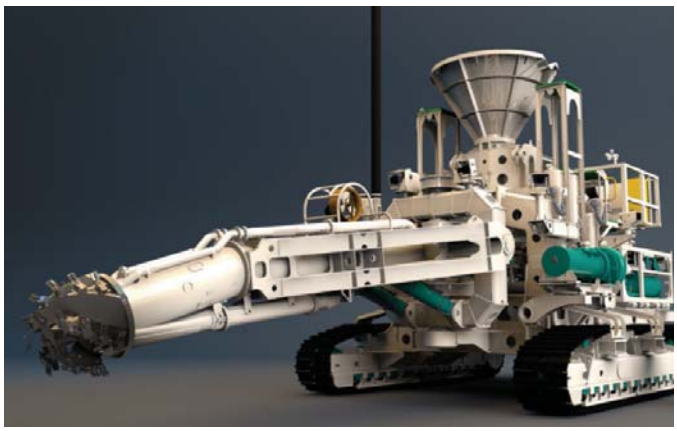


Figure 5: Collection Machine – Courtesy of Nautilus Minerals Inc

stockpiles ready for extraction as a slurry by the Collection Machine (CM). The CM is connected to a riser transfer pipe. It collects stockpiled ore and pumps it through the flexible transfer pipe to the subsea lifting pumps. From there the ore is pumped through the riser and up to the support vessel. This machine has a crown cutter on a ranging boom used to collect pre-mined ore. It also has a bank of dredge pumps used to mobilise the ore slurry. Due to its permanent connection to the subsea pump, which is in turn connected to the vessel, the CM's operating

... minimise dispersion of sediments ...

range and that of the vessel is inextricably linked.

The design of the SPTs and their operation is based around minimising impact on the environment. For instance biodegradable oils are used, and the cutting and collection systems have been designed to minimise dispersion of sediments in the water column.

Remote Control System

With a subsea system operating a mile below the vessel connected only by an umbilical, ensuring that the vehicles are reliable and the operator is aware of the position and status of the vehicle is paramount. The water depth, seascape and mining process make all of these criteria challenging. Using SMD's years of experience of developing control systems for subsea vehicles an ergonomically designed "active chair" with monitor wall has been chosen to guarantee that the operators can monitor and control the vehicles comfortably for long periods of time. The chairs are designed around the concept of a pilot and a co-pilot for each vehicle. The pilot is concerned with the primary driving and production requirements of a vehicle, whereas the co-pilot is more involved in monitoring and recording events. Both active chairs contain a mixture of joysticks, push buttons and touch screen controls (figure 6). The operator's control screens are based around SMD's standard software control platform, with a number of operational, status and logging screens being available. The operator screens can be navigated around via the touch screen or roller ball controls mounted in the arm of the active chairs.

Figure 6: Pilot Control – Courtesy of Nautilus Minerals Inc

To allow the pilots to see what is going on during mining operations in addition to standard survey equipment and cameras a novel 3D sonar system is fitted to each vehicle. The system utilises nine imaging and profiling multi-beam sonar heads to allow the operator to see around the vehicle and measure cut depths accurately. As well as providing real time sonar images to the pilots, the system also provides a virtual seascape with the vehicles mounted upon it and the cutting or suction heads articulated so that the pilot can see what is happening on the seabed.

SUMMARY

This programme is one of the most exciting offshore engineering projects currently being undertaken. There has been interest from the subsea and mining industries and a high level of cross-industry co-operation throughout the project. This will enable the dawn of a new industry to extract minerals from the seafloor. The UK subsea industry, with 53,000 employees and worth £8.9 billion per annum in services and products, is already a world leader in technology for deep water oil and gas exploration and production. The UK is uniquely positioned to be at the forefront of a developing market in subsea mining.

... system also provides a virtual seascape ...

THE ENVIRONMENTAL IMPACTS OF DEEP SEA MINING

Daniel Brutto MBA MSc
BSc (Hons)
Director, Marine Ecological Surveys Limited

The idea of extracting minerals from deep seabed environments fomented in the 1960s, following reports by Mero [1] that large volumes of high grade metalliferous nodules could be found on the seabed across vast swathes of the oceans. However, initial enthusiasm for the idea dissipated and the concept drifted out of vogue as research demonstrated that the extent of resources appeared to have been over-estimated and global metal prices declined considerably. This combination of factors meant that the economic arguments which supported the industry, and which had once sounded so compelling, were undermined and riven with flaws. The nascent industry became less attractive to developers and progress during the 1980s and early 1990s was negligible.

However, the idea of deep sea mining is again moving up the marine industry agenda with activity within the industry gaining significant momentum. This upturn in momentum is being driven by the scarcity and the accessibility of terrestrial resources. Metal prices, while volatile, are moving upwards across medium to long-term time horizons, increasing the economic viability of the industry.

... initial enthusiasm for the idea dissipated ...

The focus of the industry is on three principal resources, namely [2]:

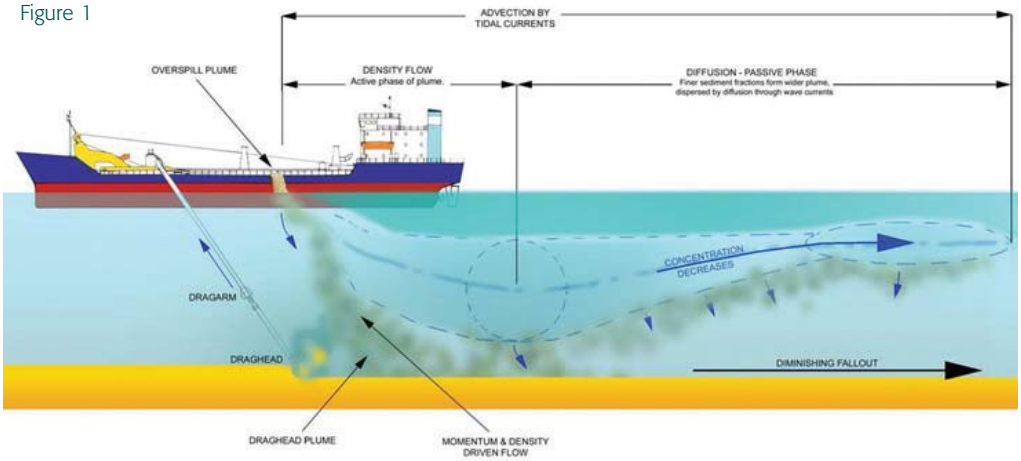
- Seafloor Massive Sulphides (SMS);
- Polymetallic Nodules; and
- Cobalt-rich Ferromanaganese Crusts.

Each of these deep sea mineral resources are found across distinct environments, with SMS deposits occurring at hydrothermal vents, polymetallic nodules typically being found on the abyssal plain and cobalt-rich ferromanganese crusts usually found on the flanks of sea mounts. There is interest in exploiting each of these resources, with progress across the three resources at different stages.

Presently, the greatest levels of activity are being directed towards exploiting SMS and polymetallic nodules, with Nautilus Minerals gearing up to exploit SMS deposits in the Bismarck Sea [3] and numerous entities engaged in the exploration of nodule concessions found in the international waters of the Clarion-Clipperton Fracture Zone [4]. To date there has been lesser interest in the exploitation of cobalt-rich ferromanganese crusts, however, activity in this area is beginning to grow [5].

Despite increasing interest and activity within the sector, the industry remains in a nascent state. We do not yet live in a world in which deep sea mining

Figure 1



is a reality. Hence, there is much that we do not yet know about how this industry will interact with marine environmental resources. However, there is a great deal that we do know, or which we can reasonably assume, through looking at analogous industrial activities undertaken within shallower waters.

In essence, the fundamental principles which will support the deep sea mining industry represent an extrapolation of those used within other marine extractive industries which rely on dredging techniques to extract materials from the sea floor, be it for the purposes of extracting sand and gravel for cement manufacture or the creation and maintenance of shipping channels. Such activities have been well studied by companies such as Marine Ecological Surveys Limited [6] and the ways in which these activities affect the environment are comparatively well understood.

Figure 1 provides an outline of the physical impacts which marine extractive industries typically impose upon the marine environment. The physical environmental impacts of dredging-related industries comprise both primary and secondary effects. Primary physical impacts are those associated with the removal of the substrata from the seabed and are restricted to the immediate footprint of the active operational zone. Secondary impacts comprise those which can be devolved further afield and include the following;

... industry remains in a nascent state ...

- The creation of sediment plumes within the water column;
- The deposition of any sediments mobilised within any plumes;

Gardline's Ocean Reliance, a multirole survey vessel

- Acoustic effects;
- Toxic effects caused by the mobilisation of toxic substances.

Each of the above can affect the environment in different ways, depending on the environmental sensitivities of the area concerned. For example, in shallow, low turbidity environments plumes have greater potential to impact adversely on the environment than plumes created in deeper waters in areas of greater turbidity. This is because of the importance of light in shaping the ecosystems found in shallower, low turbidity environments compared to deeper, higher sediment environments.

... mobilisation of toxic substances ...

The above example indicates that to be able to predict the impacts of marine extractive projects it is vital that, in addition to understanding the physical impacts of such projects, one possesses an understanding of the environmental resources. In traditional marine extractive industries such environmental resources have been comparatively well studied, hence scientists have a correspondingly strong ability to predict their environmental impacts.

As the environmental resources of the deep sea have been less well studied our ability to predict the impacts of deep sea mining activities is less robust. We are unfamiliar not only with the majority of animals which are found in the deep, but with their life histories, their distributions, and their ecology. Hence, our ability to understand how they might respond to anthropogenic disturbance is limited.

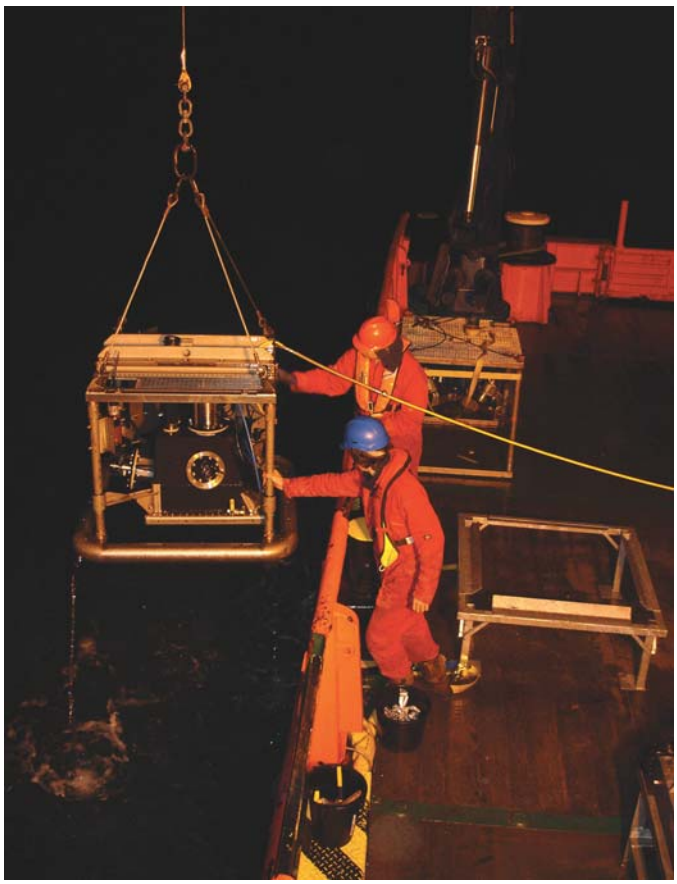
... the majority of animals which are found in the deep ...

Our present lack of knowledge of the potential ecological impacts of deep sea mining has led to the development of a view within certain quarters of the prospective industry as controversial. Notable anti-deep sea mining campaigns, including the Out of Our Depth Campaign and Greenpeace's Deep Seabed Mining campaign, have been launched in response to growing industry activity.

In the light of these sensitivities and the unknowns pertaining to deep sea mining, it is vital that the industry operates in an open manner, and that operators seek a collaborative approach to working with scientists, industry regulators and the general public.

Developing a robust understanding of the environmental impacts of deep sea mining will necessitate making direct investments into research into specific issues by a range of organisations, separately and collectively, at a range of different levels. For example, companies may be required to undertake Environmental Impact


Emptying a 0.1m2 Hamon Grab During a Research Cruise



Retrieving a seabed camera

Assessments (EIA) on a project by project basis and may need to commission detailed research into specific areas. At higher levels industrial operators may wish to collaborate in order to progress strategic research programmes, the results of which may help to overcome industry-wide barriers. Regulators may wish to commission research to inform the decision-making processes.

It is encouraging that efforts are being made to address knowledge gaps pertaining to the environmental impacts of the industry at numerous different levels. For example, within Europe programmes such as the Managing Impacts of Deep Sea Resource Exploitation (MIDAS)[7] project have been established to examine the industry from a variety of perspectives, whilst Nautilus have established the Nautilus Cares[8] programme and seek to work with teams of experts to address stakeholders' concerns about their activities.

Whilst these early efforts at developing a better understanding of the composition, structure and function of the ecosystems which will be affected by the deep sea mining industry are to be applauded it is important that research is not only continued, but accelerated and co-ordinated. This will ensure that funds are used effectively, allowing our understanding of the environmental impacts of the industry to keep pace with the industry, ensuring that environmental issues do not act as an unnecessary brake on progress. The Marine Aggregates Levy Sustainability Fund[9] model developed in the UK to administer research into the environmental impacts of marine aggregates extraction would serve as a fine example to follow in terms of progressing strategically valuable research in this space.

The nascent deep sea mining industry represents an opportunity to gain access to the mineral resources required for economic development. There is much that we can assume about the industry in terms of the way in which it will impact the marine environment based on our knowledge of other industries. However, it is evident that the industry must work hard to ensure that the right knowledge of the environments within which it will operate is developed through commissioning primary research, with the results disseminated across all appropriate stakeholders. This will allow the industry to demonstrate its credentials for responsible development whilst contributing to the reduction of the uncertainties pertaining to consenting and licensing processes providing developers with greater certainty in terms of the likely acceptability of their proposals to decision-makers and increasing the potential for making successful investments.

Separating Infauna from Seabed Deposits

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1 J. L. Mero (1965). The Mineral Resources of the Sea. Elsevier, Amsterdam, The Netherlands.
2 http://www.isa.org.jm/files/documents/EN/ Brochures/ENG6.pdf
3 http://www.nautilusminerals.com/s/Projects-Solwara.asp
4 http://pang.org.fj/wp-content/uploads/2013/03/CCZ_Sep_2012_offcial_withAPEIs.pdf
5 http://www.isa.org.jm/en/node/914
6 www.seasurvey.co.uk
7 www.eu-midas.net
8 www.cares.nautilus minerals.com
9 www.cefas.defra.gov.uk/ alsf.aspx

The MESL Macrofaunal Lab Identifying Benthic Fauna

SELECTED DEBATES

Listed opposite (grouped by subject area) is a selection of Debates on matters of scientific interest which took place in the House of Commons, House of Lords or Westminster Hall between 8th October 2013 and 20th January 2014.

A full digest of debates and PQs on scientific issues during the 2013/14 session of Parliament can be found at http://www.scienceinparliament.org.uk/publications/uk-digests/

AGRICULTURE, ENVIRONMENT, FOOD & FISHERIES

Badger Cull	11.12.13	HoC 106WH	Chris Williamson et al
Badger Vaccines	16.10.13	HoC 306WH	David Morris
Badgers: Bovine Tuberculosis	9.12.13	HoL GC138	Lord Knight of Weymouth
Farmland Bird Population	15.1.14	HoC 297WH	Sir John Randall
Fishing Industry	12.12.13	HoC 378	Frank Doran et al
Food Contamination	17.10.13	HoC 338WH	Miss McIntosh
Natural Capital (England and Wales)	21.10.13	HoC 96	Graham Stuart

FOREIGN AFFAIRS AND INTERNATIONAL DEVELOPMENT

Global Food Security	9.1.14	HoC 177WH	Sir Malcolm Bruce
Millennium Development Goals	23.10.13	HoL 1061	Baroness Jenkin of Kennington
United Kingdom and China	7.11.13	HoL 328	Lord Dobbs et al

HEALTH

Children: Sport	12.11.13	HoL GC 278	Baroness Massey of Darwen
G8 Summit on Dementia	28.11.13	HoC 497	Tracey Crouch
Mesothelioma: Research Funding	16.1.14	HoL GC240	Lord Alton of Liverpool
New Psychoactive Substances: EUC Report	11.11.13	HoL 574	Lord Hannay of Chiswick
Olympic Legacy (S&T Report)	11.12.13	HoL GC153	Lord Krebs et al
Psychoactive Substances	11.11.13	HoC 756	Norman Baker
Rare Diseases	17.12.13	HoC 177WH	Jim Shannon

EDUCATION AND SKILLS

Education: Contribution to Economic Growth	5.12.13	HoL 353	Baroness Morgan of Huyton
Engineering Skills (Perkins Review)	10.12.13	HoC 32WH	Peter Luff

MISCELLANEOUS

Immigration	11.12.13	HoC 73WH	Andrew Turner et al

HOUSE OF LORDS SCIENCE AND TECHNOLOGY SELECT COMMITTEE

The members of the Committee (appointed 16 May 2013) are Lord Dixon-Smith, Baroness Hilton of Eggardon, Lord O'Neill of Clackmannan, Lord Krebs (Chairman), Baroness Manningham-Buller, Lord Patel, Lord Peston, Baroness Perry of Southwark, Lord Rees of Ludlow, the Earl of Selborne, Baroness Sharp of Guildford, Lord Wade of Chorlton, Lord Willis of Knaresborough and Lord Winston.

Waste and the bioeconomy

The Committee launched an inquiry into waste and the bioeconomy in July 2013. The Call for Evidence closed on 27 September. The inquiry is collecting evidence on the technology used to exploit bio-waste and waste gases to generate high-value products. It aims to assess the potential for this technology to enable bio-waste and waste gas to replace current feedstocks, and the potential contribution this could make to a bioeconomy. Oral evidence sessions were held in autumn 2013 and will conclude early in 2014. The Committee will report shortly thereafter.

Scientific infrastructure

The Committee launched an inquiry into scientific infrastructure in May 2013. The call for evidence closed on 22 June. Oral evidence was taken across June and July on the large and medium-sized scientific infrastructure currently available in the UK with a particular focus on: future needs and strategic planning, funding and governance arrangements, international partnerships and partnerships with industry. The Committee published its report on 21 November 2013. A Government response is expected in January 2014.

Regenerative medicine

The Committee launched an inquiry into regenerative medicine in 2012. A group from the Committee visited the California Institute for Regenerative Medicine. Oral evidence was taken from October to March 2013. The Committee reported on 1 July 2013 and a Government response was received on 1 October.

Nuclear follow-up

In July 2013, the Committee undertook an evidence session with Professor David Mackay, Chief Scientific Advisor at the Department of

Energy & Climate Change, to follow up on its November 2011 report, *Nuclear research and development capabilities*. A further session was held with the Minister for Energy, Rt Hon Michael Fallon MP, on 10 December 2013.

Science spend

In May 2013, ahead of the Comprehensive Spending Review, the Committee held a one-off evidence session on the topic of science spend. This resulted in a letter being sent to the Chancellor of the Exchequer on 4 June 2013 calling for an increase in the science budget. In a separate but related development, on 4 December 2013, the Committee wrote to the Rt Hon David Willetts MP, Minister for Universities and Science, to seek clarity on claims that had surfaced in the media suggesting that the ring-fenced science budget may be used to shore up the Department's budget in other areas.

Open access

The Committee undertook a short inquiry into the implementation of the Government's open access policy. It issued a call for evidence to key stakeholders. The Committee took oral evidence in January 2013 and published its report in February. The report was debated on 28 February. It followed this with a letter to RCUK expressing concern about its revised open access policy in March. A Government response to the report was published in May 2013.

Sports and exercise science and medicine

In May 2012, the Committee launched a short inquiry into sports, exercise science and medicine to consider how the legacy of London 2012 could be used to improve understanding of the benefits exercise can provide for the wider public, and in treating chronic conditions. The Committee explored how robust this science is, and how lessons learnt from the study of athletes can be applied to improve the health of the population generally. The Committee published its report on 17 July 2012. The Government response was received in October 2012 and a debate held on 11 December 2013.

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.

HOUSE OF COMMONS SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY

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

The current members of the Science and Technology Committee are:

Jim Dowd (Labour, Lewisham West and Penge), David Heath (Liberal Democrat, Somerton and Frome), Stephen Metcalfe (Conservative, South Basildon and East Thurrock), Andrew Miller (Labour, Ellesmere Port and Neston), David Morris (Conservative, Morecambe and Lunesdale), Stephen Mosley (Conservative, City of Chester), Pamela Nash (Labour, Airdrie and Shotts), Sarah Newton (Conservative, Truro and Falmouth), Graham Stringer (Labour, Blackley and Broughton), David Tredinnick (Bosworth) and Hywel Williams (Plaid Cymru, Arfon).

Andrew Miller was elected by the House of Commons to be the Chair of the Committee on 9 June 2010.

CURRENT INQUIRIES

Clinical Trials

On 13 December 2012, the Committee announced an inquiry: Clinical Trials. The Committee invited written submissions by 22 February 2013.

The written and oral evidence received in this inquiry is on the Committee's website. A report was agreed and was published on 17 September. The Government response was published as a special report on 29 October 2013.

The European and UK Space Agencies

On 15 February 2013, the Committee announced an inquiry: The European and UK Space Agencies. The Committee invited written submissions by 12 April 2013.

The written and oral evidence received in this inquiry is on the Committee's website. A report was agreed and was published on 28 October. The Government response is expected early in 2014.

Climate: public understanding and its policy implications

On 28 February 2013 the Committee announced an inquiry: Climate: public understanding and its policy implications. The Committee invited written submissions by 22 April 2013.

On Wednesday 9 October the Committee took evidence from Rt Hon the Lord Deben, Chairman, and David Kennedy, Chief Executive, Committee on Climate Change; Rt Hon David Willetts MP, Minister of State for Universities and Science, Department for Business, Innovation and Skills; Rt Hon Gregory Barker MP, Minister of State for Climate Change, Department of Energy and Climate Change, Professor David MacKay, Chief Scientific Advisor, and David Warrilow, Head of Science, Department of Energy and Climate Change

On Wednesday 6 November the Committee took evidence from Professor Sir Mark Walport, Chief Scientific Adviser to HM Government and Head of the Government Office for Science.

Pre-appointment hearing for Chair of Natural Environment Research Council

On Monday 21 October the Committee took evidence from Sir Anthony Cleaver, Chair-elect of the Natural Environment Research Council.

The written and oral evidence received in this inquiry is on the Committee's website. A report was agreed and was published on 23 October.

Government Horizon Scanning

On Wednesday 23 October the Committee took evidence from Alun Huw Williams, Principal, SAMI Consulting, Doug McKay, Vice President, International Organisations, Shell International, and Natalie Day, Head of Policy, Oxford Martin School, University of Oxford; Dr Martyn Thomas, Royal Academy of Engineering, Jonathan Cowie, former Head, Science Policy, Institute of Biology, and Professor Ann Buchanan, Academy of Social Sciences.

On Wednesday 27 November the Committee took evidence from Fiona Lickorish, Head, Institute for Environment, Health, Risks and Futures, Cranfield University, Jessica Bland, Technology Futures Analyst, Nesta, and Marcus Morrell, Senior Futures Analyst, Arup; Professor Burkhard Schafer, Professor of Computational Legal Theory, Edinburgh School of Law, Professor Paul Newman, Mobile Robotics Group, University of Oxford, Nick Reed, Intelligent Transport Systems UK, and Dr Graeme Smith, Business Manager, Connected Services, Control and Electronics, Ricardo UK Ltd

On Wednesday 4 December the Committee took evidence from Sir Mark Walport, Government Chief Scientific Adviser, and Jon Day, Chair, Horizon Scanning Oversight Group, Cabinet Office

The written and oral evidence received in this inquiry is on the Committee's website. A Report is being prepared.

Women in STEM careers

On Wednesday 16 October the Committee took evidence from Dr Bryn Jones, Visiting Fellow, School of Physics, University of Bristol, Jenny Marsden, Principal Physicist, Hull and East Yorkshire NHS Trust, and Dr Nicola Patron, Head, Synthetic Biology, Sainsbury Laboratory.

On Wednesday 30 October the Committee took evidence from Dr June McCombie, former Chair of IOP Project, Juno Panel, Institute of Physics, Sarah Dickinson, Manager, Athena SWAN Charter, Equality Challenge Unit, Professor Dame Julia Higgins, Chair of Diversity Programme, Royal Society, and Dr Pia Ostergaard, Senior Fellowship Advisor, Daphne Jackson Trust; Professor Uta Frith, Emeritus Professor of Cognitive Development, University College London, representing Russell Group, Professor Jane Powell, Deputy Warden, Goldsmith's, University of London, representing 1994 Group, and Clem Herman, Senior Lecturer, Computing and Communications, Open University.

On Monday 4 November the Committee took evidence from Dr Lesley Thompson, Engineering and Physical Sciences Research Council (representing the Research Councils UK), and David Sweeney, Director, Research, Innovation and Skills, Higher Education Funding Council for England.

On Monday 18 November the Committee took evidence from Rt Hon David Willetts MP, Minister of State for Universities and Science, Department for Business, Innovation and Skills.

The written and oral evidence received in this inquiry is on the Committee's website. A report is being prepared.

GO Science Annual Review 2012-13

The oral evidence received in this inquiry is on the Committee's website.

Antimicrobial resistance

On Wednesday 18 December the Committee took evidence from Dr Pat Goodwin, Society of Biology, Professor Laura Piddock, British Society for Antimicrobial Chemotherapy, Professor John Threlfall, Society for Applied Microbiology, and Professor Sharon Peacock, Cambridge Infectious Diseases Initiative, University of Cambridge.

The written and oral evidence received in this inquiry is on the Committee's website.

REPORTS

Clinical trials

On 17 September 2013, the Committee published its Third Report of Session 2013-14, *Clinical trials*, HC 104.

Pre–appointment hearing with the Government's preferred candidate for Chair of the Natural Environment Research Council (NERC)

On 23 October 2013, the Committee published its Fifth Report of Session 2013-14, *Pre–appointment hearing with the Government's preferred candidate for Chair of the Natural Environment Research Council (NERC)*, HC 702.

Work of the European and UK Space Agencies

On 28 October 2013, the Committee published its Fourth Report of Session 2013-14, *Work of the European and UK Space Agencies*, HC 253.

GOVERNMENT RESPONSES

Government Response to the Committee's report 'Water quality: priority substances', the Committee's First Report of Session 2013–14

On 12 September 2013 the Committee published the Government Response to the Committee's report on Water quality: priority substances.

Health Research Authority Response to the Committee's report 'Clinical trials', the Committee's Third Report of Session 2013-14

On 29 October 2013 the Committee published the Health Research Authority Response to the Committee's report on Clinical trials.

Research Councils UK Response to the Committee's report 'Forensic science', the Committee's Second Report of Session 2013–14

On 26 November 2013 the Committee published the Research Councils UK Response to the Committee's report on Forensic science.

Medical Research Council Response to the Committee's report 'Clinical trials', the Committee's Third Report of Session 2013-14

On 5 December 2013 the Committee published the Medical Research Council Response to the Committee's report on Clinical trials.

FURTHER INFORMATION

Further information about the work of the Science and Technology Committee or its current inquiries can be obtained from the Clerk of the Committee, Stephen McGinness, or from the Senior Committee Assistant, Darren Hackett, on 020 7219 2792/2793 respectively; or to: The Clerk of the Committee, Science and Technology Committee, House of Commons, 7 Millbank, London SW1P 3JA. Enquiries can be e-mailed to scitechcom@parliament.uk. Anyone wishing to be included on the Committee's mailing list should contact the staff of the Committee. Anyone wishing to submit evidence to the Committee is strongly recommended to obtain a copy of the guidance note first at www.parliament.uk/commons/selcom/witguide.htm. The Committee has a website, www.parliament.uk/science, where all recent publications, terms of reference for all inquiries and press notices are available.

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 daily. They also provide support to Commons Select Committees, and produce longer notes and research papers which can be accessed on line at http://www.parliament.uk/topics/topical-issues.htm

Opposite are summaries of some recent briefings.

For further information contact:
Sarah Hartwell-Naguib
Head of Section
Tel: 020 7219 1665
email:
hartwellnaguibs@parliament.uk

RECENT PUBLICATIONS

Water Bill (2nd Reading Briefing)

RP 13/67

Water resources are under significant pressure in parts of the UK and water supply constraints are predicted to spread in future. Future investment in the sector may place considerable upward pressure on water bills.

The Water Bill aims to deliver more resilient water supplies and lead to cheaper and more efficient management of water resources in the longer term. The provisions include:

- extending competition by enabling all non-household customers to choose their water and sewerage supplier and enabling more companies to provide water and sewerage services;
- a new flood insurance scheme for domestic properties; and
- a new duty for the regulator to focus on the long-term resilience of water supplies.

Water Bill: Committee Stage Report

RP 14/1

During Committee Stage a significant number of Government amendments were made to the Bill. Important amendments include clauses to introduce a flood insurance scheme for domestic properties and the creation of an independent consumer dispute resolution scheme.

CAP reform 2014-2020: EU Agreement and Implementation in the UK and in Ireland

RP 13/64

The Common Agricultural Policy reform for 2014-20 is in its final stages of EU negotiation and overall agreement was reached on the main elements in June 2013. The main provisions will be implemented in January 2015. 2014 will be a transition year.

This paper sets out the reactions to the new reform package and emerging implementation decisions of the British Isles. It indicates where the key differences and common approaches are emerging and also considers the possible trajectory of future CAP reform.

The agreement allows Member States and their regions an unprecedented, and welcome, amount of flexibility in terms of how they implement the CAP provisions to allow them to tailor the policy to their particular agricultural needs. This means that the implementation of decisions taken within the UK and in Ireland have the potential to differ considerably, despite the intra-UK and international (UK/Irish) shared borders. The increasingly multi-national nature of food production, processing and retailing means that the differing approaches have the potential to impact upon the farming and wider agri-food industries, particularly within neighbouring jurisdictions. It is now commonplace for food to be produced in one region/EU Member State, be processed in another and then marketed or sold in many others.

Food Banks and Food Poverty

SN/SC/6657

Food banks ("foodbanks") provide food to people in acute need, often following referral by a health or social care professional, or other agency. In the UK, food banks are run by volunteer-based organisations, redistributing food donated by

consumers, retailers and the food industry. The largest network is co-ordinated by The Trussell Trust which has 400 food bank banks UK-wide. A Church Action on Poverty report (May 2013) estimated that over 500,000 people in the UK were reliant on food aid.

Food bank use has been increasing steadily since 2005. In the period April-September 2013, over 350,000 people received food from Trussell Trust food banks – triple the number helped in the same period in 2012. These figures have led the Trussell Trust to call for an inquiry into the causes of food poverty and the surge in food bank usage. A range of experts has also warned in the British Medical Journal (December 2013) that UK food poverty "has all the signs of a public health emergency that could go unrecognised until it is too late to take preventive action." A new All Party Parliamentary Group on Hunger and Food Poverty (co-chaired by Rt Hon Frank Field MP and Laura Sandys MP) will now investigate "the root causes of hunger and food poverty" and the increase in British demand for food banks.

Marine Conservation Zones in England

SN/SC/6129

There are significant pressures on the marine environment around the UK. Networks of marine protected areas have been shown to be effective at protecting the marine environment and in some cases may deliver significant economic benefits.

Marine Conservation Zones (MCZ) are being introduced under the Marine and Coastal Access Act 2009 to protect nationally important marine wildlife, habitats, geology and geomorphology. They will sit alongside other marine protected areas such as those designated under European law.

Controls on damaging activities may be required in some MCZ. As a result their designation may be controversial in some cases.

Carbon capture and storage

SN/SC/5086

Carbon capture and storage (CCS) is a potential way of 'decarbonising' electricity generation. As a form of 'low-carbon' generation under the current Energy Bill, CCS would allow the continued burning of fossil fuels. However, the 'emissions performance standard' introduced by the Bill also allows unabated gas to 2045; some feel this is not set low enough to incentivise CCS.

CCS generation is not yet proven on a large scale, and nor is storage long-term, despite a series of UK Government and EU incentives. In March 2013 Peterhead (Aberdeenshire) and the White Rose Project (Yorkshire) were named as the preferred bidders in the latest UK CCS Commercialisation Programme Competition.

Water bills in the south-west

SN/SC/5894

This provides information on water bills in the south-west, which are significantly higher than in other parts of England. It describes the Government's solution to the problem: a payment allowing a £50 reduction of South West Water customer bills from April 2013.

Planning for onshore wind farms

SN/SC4370

This sets out issues to do with the planning process for onshore wind development and proposals for reform. It applies only to England.

The planning process used to determine onshore wind development will depend on the size of the proposed development. Wind farms which have an output of over 50MW will go through the development consent process as set out in the Planning Act 2008 and will be determined by the Secretary of State. Wind farms under 50MW will be determined by the relevant local planning authority, under procedures set out in the Town and Country Planning Act 1990. There are also some permitted development rights for small domestic wind turbines, where planning permission would not be required at all.

Planning policy for onshore wind is contained in a number of documents, principally the Government's National Planning Policy Framework, the National Policy Statement for Renewable Energy Infrastructure and Planning practice guidance for renewable and low carbon energy. Local authorities will have policies on onshore wind development in any up-to-date local plan for a particular area.

ACTIVITIES

There has been a number of staff changes in SES. Patsy Richards has left to become Head of Customer Services in the Members' Library, Sarah Hartwell-Naguib has replaced Patsy as the new Head of Section. Oliver Bennett is leaving as he is going to Myanmar (Burma) to help set up the Myanmar Parliament Library and Research Department. Sandy Gill and Chris Watson have also left. We wish them all the best and thank them all for their hard work.

Our Food and Agriculture specialist went on a study trip to Brussels in October with staff from the EFRA Committee to discuss CAP reform, food labelling and animal health legislation with European Commission and Parliament officials (including the Library) and the Secretariat of the European Agriculture and Rural Development Committee (COM AGRI).

Our Food and Agriculture specialist spoke at the Parliament Talks Food outreach event in Bradford in October 2013 explaining how the Library works and what kind of work Parliament is doing on food issues and the enquiries we are getting in the Library. This was attended by members of the public as well as those from the food retail sector.

The sections twitter account (@commonsSES) has now been running for 3 months and has 245 followers. The aim is to engage with Members and the science community. We tweet on parliamentary business and interesting news updates relating to our subject areas.

Second Joint Research Paper

On 20 November 2013 we published a standard note, CAP 2014-2020: EU Agreement and Implementation across the UK and in Ireland, prepared jointly with the parliamentary/assembly research services in the devolved administrations and in Ireland (the Oireachtas Library and Research Service). This note was the second research briefing to be published on the Internet by our Irish equivalents, largely prompted by the fact that it is usual practice for the other administrations to publish such work.

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (POST)

RECENT POST PUBLICATIONS

Antibiotic Resistance in the Environment

October 2013 *POSTnote 446*

Disease causing bacteria are becoming increasingly resistant to antibiotic drug treatment. Diseases once controlled by antibiotics are re-emerging as serious risks to human health. This outlines the hazards posed by resistant bacteria, the sources of resistance in the environment and measures that may reduce these risks globally.

Negative Emissions Technologies

October 2013 *POSTnote 447*

If emissions of greenhouse gases are not sufficiently mitigated, it may become necessary artificially to accelerate the rate at which they are removed from the atmosphere in order to restrict global warming. This provides an overview of technologies that could remove atmospheric CO_2 and summarises the environmental, social and economic issues they raise.

Urban Green Infrastructure

November 2013 *POSTnote 448*

Urban green infrastructure is a network of green spaces, water and other natural features within urban areas. A green infrastructure uses natural processes to deliver multiple functions, such as reducing the risk of flooding and cooling high urban temperatures. This summarises research evidence of the effectiveness of green infrastructure, and challenges to its implementation.

Minimising the Harms of Khat

November 2013 *POSTnote 449*

The Government has decided to control the herbal stimulant khat as a Class C drug under the Misuse of Dugs Act 1971. Earlier this year, the Advisory Council on the Misuse of Drugs (ACMD) found insufficient evidence to justify a ban. This summarises the evidence on the impact of khat on health and possible social harms in the UK and comparable international experiences of legislation and control.

Special Educational Needs

December 2013 *POSTnote 450*

In 2013, one in five pupils in England were identified as having special educational needs (SEN). The Children and Families Bill will reform the provision available for these. This summarises the nature and diversity of SEN and discusses the support and outcomes for affected children and their families.

Epigenetics and Health

December 2013 *POSTnote 451*

Epigenetics refers to factors that regulate the activity of genes. These can contribute to a host of human diseases from cancer to mental illness and knowledge of epigenetics may help to reduce disease risk in ageing populations. This examines how recent advances in this field can be used to develop new treatments, inform public health policy, and contribute to the UK economy.

CURRENT WORK

Biological Sciences – HIV Prevention in the UK, Minimum Age of Criminal Responsibility, Greenhouse Gas Emissions from livestock, Telehealth and Telecare, Transparency of Clinical Data, Surveillance of Infectious Disease, Electronic Cigarettes and Stroke.

Environment and Energy – Intermittent Electricity Generation, Demand-Side response, New Nuclear Power Technologies – update, Short lived Climate Pollutants and Climate Change Feedbacks.

Physical sciences and IT – Unmanned Aerial Vehicles and Big Data.

Social Sciences – Social media and big data.

CONFERENCES AND SEMINARS

Energy Storage Breakfast

On 8 October POST hosted a breakfast briefing on Energy Storage, supported by the Research Council-funded Energy Storage Research Network. This was POST's first trial of a breakfast briefing and was attended by 4 MPs and 6 peers. The experts introduced three areas for open discussion and questions. The event was chaired by Alan Whitehead MP, with speeches from Keith Maclean, Policy and Research Director, SSE; Professor Richard Williams, University of Birmingham; Gareth Evans, Head of Engineering, Ofgem; Toby Peters, COO, Highview Power Storage; Jonathon Radcliffe, Centre for Low Carbon Futures; Craig Lucas, Head of Engineering, DECC.

Climate Science: The Fifth IPCC Assessment Report

On 15 October, POST hosted a seminar in conjunction with the Royal Society and the All Party Parliamentary Group on Climate Change on the first of new IPCC reports on the scientific evidence for climate change. This provided MPs, Peers and parliamentary staff the opportunity to debate the report with experts. It was chaired by Lord Oxburgh and presentations were made by: Professor John Pethica FRS, vice-president of the Royal Society, Professor John Mitchell FRS, University of Reading, Professor Keith Shine FRS, University of Reading, Professor Corinne Le Quéré,

Director of the Tyndall Centre, Professor Sir Brian Hoskins FRS, Director of the Grantham Institute, Professor Tim Palmer FRS, University of Oxford and Professor Stephen Belcher, Head of the Met Office Hadley Centre.

Allergy

On 16 October, POST hosted a seminar in conjunction with the All Party Parliamentary Group for Allergy on trends in the prevalence of allergic disease and the underlying causes, provision of clinical allergy services and commented on progress made since the House of Lords Science and Technology Committee's report on the topic in 2007. This provided MPs, Peers and parliamentary staff the opportunity to debate the issues with experts. It was chaired by Baroness Finlay of Llandaff, Member of the House of Lords and Vice-Chair of the All Party Parliamentary Group for Allergy, Chair, Lords Science & Technology Sub-Committee on Allergy (2006-07). Presentations were made by: Dr Adam Fox, Consultant Paediatric Allergist, Guys' & St Thomas' Hospitals, Dr Matthew Doyle, General Practitioner, Cambridge, and Ruth Holroyd.

Celebrating the CERN Collider

On 11 November, POST hosted a reception in collaboration with the Science Museum, celebrating the launch of Collider, a major touring exhibition on the Large Hadron Collider at CERN. This provided MPs, Peers and parliamentary staff the opportunity to meet leading figures including Nobel Prize winner Professor Peter Higgs and Dr Steve Myers, CERN's Director of Accelerators and Technology. Guests also had an opportunity to see a preview of the Science Museum's exhibition and hear from the curators about the challenges of recreating the world's greatest experiment for visitors. They were invited to explore and interact with exhibits provided by some of the UK's leading particle physics groups whilst hearing from them about their latest research. Presentations were made by: Adam Afriyie MP, Chair of the POST Board, Ian Blatchford, Director of the Science Museum Group, Dr Steve Myers OBE, CERN's Director of Accelerators and Technology, Alison Boyle and Harry Cliff, exhibition curators and Dr Andrew Taylor, Executive Director of the Science and Technology Facilities Council National Laboratories.

Future of the Census

On 25 November, POST hosted a meeting in conjunction with the House of Commons Library, the Royal Statistical Society, the All Party Parliamentary Group on Statistics and the Office for National Statistics on proposed changes to the census. This provided an overview of the options presented in the consultation and an opportunity to discuss the issues with experts. The meeting was chaired by Andrew Miller MP, Chair of the HoC Science and Technology Committee. Presentations were made by Pete Benton, Office for National Statistics, Professor David Martin Professor of Geography at Southampton University, Deputy Director of the Economic and Social Research Council UK Data Service, Professor Chris Skinner Professor of Statistics and Head of Statistics Department, London School of Economics and Piers Elias Demography and Modelling Officer, Tees Valley Unlimited and co-Chair of the Local Authority Population Statistics Liaison Group.

STAFF, FELLOWS AND INTERNS AT POST

Fellows

Danny Heptinstall, University of Aberdeen, British Ecological Society
Jodie Symington, University of Newcastle, Institution of Chemical Engineers
Ben Taylor, Kings College London, Arts and Humanities Research Council
James Livingstone, University of Edinburgh, Arts and Humanities Research Council
Gabrielle Samuel, Brunel University, Wellcome Trust Ethics and Society Programme
David Ross, University of Edinburgh, Institute of Physics
Harry Holkham, University of Leicester, Biotechnology and Biological Sciences Research Council
Faye Smith, University of York, British Psychological Society
Yvonne Collins, University of Cambridge, Biotechnology and Biological Sciences Research Council

Staff

Dr Caroline Kenny, POST Social Science adviser, will join POST on 26 February 2014 from the Institute of Education at the University of London.

INTERNATIONAL ACTIVITIES

On 20-22 November, Lydia Harriss attended a Technology Assessment Practitioners Training Workshop in Lithuania. Organised by the EU-funded PACITA project (Parliaments and Civil Society in Technology Assessment), the workshop brought together science policy advisers from parliaments and other institutions across Europe to share best practice.

On 18 and 19 November, POST hosted a two day workshop on agricultural biotechnology for a delegation of MPs from the Ugandan Parliament Science and Technology Committee. The delegation had discussions with academics, representatives of Defra and DfID and Select Committee staff to inform scrutiny of the implementation of Uganda's National Biotechnology and Biosafety Bill. The delegation attended a lunch with MPs and Peers, hosted by the CPA and a meeting of the APPG on Agriculture and Food for Development.

On 9-11 December, Aaron Goater attended a planning meeting in Nairobi, Kenya for a capacity building programme. The three year 'SECURE Health' programme, awarded funding from the Department for International Development in November 2013, will strengthen capacity to use evidence in health policy making in Kenya and Malawi. It involves academic and non-governmental organisations: African Institute for Development Policy; East, Central and Southern Africa Health Community; FHI 360; Kenyan Consortium for National Health Research (CNHR); Malawian RSC College of Medicine. POST will collaborate with these organisations and host and train 1-2 fellows per year from the Kenyan and Malawian parliaments.

Science Directory

Research Councils UK

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

EPSRC

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. Twenty-nine 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 supporting scientists and engineers world-wide. The Research Council operates world-class, large-scale research facilities and provides strategic advice to the UK Government on their development. The STFC partners in two of the UK's Science and Innovation Campuses. It also manages international research projects in support of a broad cross-section of the UK research community, particularly in the fields of astronomy, nuclear physics and particle physics. The Council directs, co-ordinates and funds research, education and training.

Alzheimer's Research UK

Defeating Dementia

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Alzheimer's Research UK is the UK's leading dementia research charity. Currently, we support 130 projects worth over £21.5m. As research specialists, we fund pioneering research at leading universities across the UK and the globe with the aim of defeating dementia. Our expertise helps bring 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 ABPI is the voice of the innovative pharmaceutical industry, working with Government, regulators and other stakeholders to promote a receptive environment for a strong and progressive industry in the UK, one capable of providing the best medicines to patients.

The ABPI's mission is to represent the pharmaceutical industry operating in the UK in a way that:

- assures patient access to the best available medicine;
- creates a favourable political and economic environment;
- encourages innovative research and development;
- affords fair commercial returns

AIRTO

airto
making innovation happen

Contact: Professor Richard Brook OBE FREng
AIRTO Ltd: Association of Independent Research & Technology Organisations Limited
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AIRTO – The Association for Independent Research and Technology Organisations – is the foremost membership body for organisations operating in the UK's intermediate research and technology sector. AIRTO's members deliver vital innovation and knowledge transfer services which include applied and collaborative R&D, frequently in conjunction with universities, consultancy, technology validation and testing, incubation of commercialisation opportunities and early stage financing. AIRTO members have a combined turnover of over £4bn from clients both at home and outside the UK, and employ over 40,000 scientists, technologists and engineers.

AMPS

AMPS
The Association of Management and Professional Staffs.

Contact:
Tony Harding
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Branch Office Address:
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Salford
M50 3SG.

Website: www.amps-tradeunion.com

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

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

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

Biochemical Society

Advancing Molecular Bioscience

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The Biochemical Society exists for the advancement of the molecular and cellular biosciences, both as an academic discipline and to promote its impact on areas of science including biotechnology, agriculture, and medicine. We achieve our mission though our publications and journals, scientific meetings, educational activities, policy work, awards and grants to scientists and students. The Biochemical Society is the largest discipline-based learned society in the biosciences with 6800 members.

The British Ecological Society

British Ecological Society

The British Ecological Society
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Website: www.BritishEcologicalSociety.org
Ecology into Policy Blog
http://britishecologicalsociety.org/blog/
Twitter: @BESPolicy

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

British In Vitro Diagnostics Association (BIVDA)

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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www.foodafactoflife.org.uk

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

BPS BRITISH PHARMACOLOGICAL SOCIETY

Today's science, tomorrow's medicines

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

The British Psychological Society

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The British Psychological Society is an organisation of over 48,000 members governed by Royal Charter. It maintains the Register of Chartered Psychologists, publishes books, 11 primary science Journals and organises conferences. Requests for information about psychology and psychologists from parliamentarians are very welcome.

The British Society for Antimicrobial Chemotherapy

Mrs Tracey Guise
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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 4,000 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.

Brunel University

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Brunel is a world-class university based in London. Our distinctive mission combines teaching and research excellence with the practical and entrepreneurial approach of our namesake, Isambard Kingdom Brunel.

Brunel works closely with business to bring social and economic benefit by undertaking groundbreaking research to find solutions to major problems and producing graduates with the knowledge and skills sought by employers.

Cavendish Laboratory

The Administrative Secretary, The 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

Chartered Institute of Patent Attorneys

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Website: www.cipa.org.uk

Members of CIPA practise in intellectual property, especially patents, trade marks, designs, and copyright, either in private partnerships or industrial companies. Through its regulatory Board, CIPA maintains the statutory Register. It advises government and international circles on policy issues and provides information services, promoting the benefits to UK industry of obtaining IP protection, and to overseas industry of using British attorneys to obtain international protection.

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.

EngineeringUK

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

The Food & Environment Research Agency

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

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

GAMBICA Association Ltd

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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

The Geological Society
serving science & profession

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The Geological Society is the national learned and professional body for Earth sciences, with 11,000 Fellows (members) worldwide. The Fellowship encompasses those working in industry, academia and government, with a wide range of perspectives and views on policy-relevant science, and the Society is a leading communicator of this science to government bodies and other non-technical audiences.

Glass and Glazing Federation

GGF
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

IFST

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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 around 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. Visit us at www.iop.org.

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. It accredits medical physicists, clinical engineers and clinical technologists through its membership register, organises training and CPD for them, and provides opportunities for the dissemination of knowledge through publications and scientific meetings. IPEM is licensed by the Science Council to award CSci, RSci and RSciTech, and by the Engineering Council to award CEng, IEng and EngTech.

IChemE

ADVANCING CHEMICAL ENGINEERING WORLDWIDE

The Institution of Chemical Engineers

With over 38,000 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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Representing over 80,000 professional civil engineers around the world, ICE actively contributes to the development of public policy at all levels of government in areas concerning infrastructure, engineering and our quality of life.

Established in 1818, ICE is recognised worldwide for its excellence as a centre of learning, as a qualifying body and as a public voice for the profession. Our members design, build and maintain the infrastructure that keeps our country running.

Under our Royal Charter, we have a duty to provide independent, expert advice on infrastructure issues for the benefit of the public and to serve wider society. We are seen by Parliament and industry alike as the authoritative voice of infrastructure.

Institution of Engineering Designers

support inspire achieve

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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.

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

Institution of Mechanical Engineers

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

LGC

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

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

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

The Linnean Society of London

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

A Forum for Natural History

L'ORÉAL UK AND IRELAND

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L'Oréal employs more than 3,500 scientists world-wide and dedicates over €600 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. 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

The Science of Nature

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

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

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

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.

Nesta

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Nesta is the UK's innovation foundation with a mission to help people and organisations bring great ideas to life. We do this by providing investments and grants and mobilising research, networks and skills.

Nesta doesn't work alone. We rely on the strength of the partnerships we form with other innovators, community organisations, educators and investors too.

We are an independent charity and our work is enabled by an endowment from the National Lottery.

Nesta is a registered charity in England and Wales with a company number 7706036 and charity number 1144091. Registered as a charity in Scotland number SC042833. Registered office: 1 Plough Place, London, EC4A 1DE.

www.nesta.org.uk

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 only UK University with Ashoka U 'Changemaker Campus' status recognising our commitment to social innovation and entrepreneurship.

(*Guardian University Guide 2014)

The University of Nottingham

UNITED KINGDOM · CHINA · MALAYSIA

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With 42,000 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 90 per cent of all research of international quality according to the most recent Research Assessment Exercise, the University is ranked in the World's Top 75 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.

ROYAL ACADEMY OF ENGINEERING

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

Royal Botanic Gardens, Kew

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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. Kew is a non-departmental public body with exempt charitable status and receives approximately half its funding from government through Defra. The key strategic priorities of Kew's science programme are to:

- understand and conserve biodiversity
- accelerate discovery and global access to plant and fungal diversity information
- map and prioritise species and habitats most at risk
- promote sustainable local use of plants and fungi
- collect and store seed from 25% of plant species through the Millennium Seed Bank Partnership
- restore and repair habitats
- inspire interest in plant and fungal science and conservation

Kew's mission is to inspire and deliver science-based plant conservation worldwide, enhancing the quality of life.

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 CHEMISTRY

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The Royal Society of Chemistry is the world's leading chemistry community, advancing excellence in the chemical sciences. With 48,000 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 the oldest UK microbiological society and aims to advance, for the benefit of the public, the science of microbiology in its application to the environment, human and animal health, agriculture and industry.

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

SOCIETY FOR GENERAL MICROBIOLOGY

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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 of Biology

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

Society of Chemical Industry (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 27,000 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
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Tuesday 25 February
How do we value our Natural Capital?
Speakers: Professor Rosemary Hails MBE FSB, Science Director, Biodiversity and Ecosystem Science, Centre for Ecology and Hydrology, Professor Brett Day, University of East Anglia, Julian Harlow, Defra

Tues-Thurs 11-13 March
Oceanology International Exhibition
The Committee will have a stand

Monday 17 March
SET for Britain
Poster Exhibition and Competition for early-stage researchers

Thursday 20 March
National Science and Engineering Week Seminar
Marine Science
Speakers: Dr Brian Bett, National Oceanography Centre, Southampton; Professor Manuel Barange, Plymouth Marine Laboratory; Mike Jones, Soil Machine Dynamics; Dr Paul Bell, NOC Liverpool; Dr Carol Turley, PML; Dr Kevin Horsburgh, NOC Liverpool. The Rt Hon David Willetts MP, Minister for Universities and Science, will attend.

Tuesday 8 April
Hydraulic Facturing
Breakfast meeting

Tuesday 20 May
Research Councils 20th Anniversary

Tuesday 17 June
A Levels

THE ROYAL SOCIETY

Website: royalsociety.org

The Royal Society hosts a series of free events, including evening lectures and conferences, covering the whole breadth of science, engineering and technology for public, policy and scientific audiences. Events are held at the Royal Society's offices in London, at the Royal Society at Chicheley Hall, home of the Kavli Royal Society International Centre, Buckinghamshire and other venues.

Details of all our events can be found on our website at royalsociety.org/events

THE ROYAL INSTITUTION

21 Albemarle Street
London W1S 4BS.

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.

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY

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

THE INSTITUTION OF MECHANICAL ENGINEERS

The Institution of Mechanical Engineers plays a leading role in the international engineering community in providing advice to governments, industry and global society. Each year it organise some 300 technical conferences, seminars, lectures, debates and workshops around the UK and internationally, on key updates, developments or new techniques across 18 engineering and manufacturing sectors.

For details visit: www.imeche.org/events

THE LINNEAN SOCIETY OF LONDON

The Linnean Society, in Piccadilly, has a diverse programme of evening lectures and day meetings covering the natural world, encompassing science, history and art. Most meetings are open to the public and many are free. Please subscribe to our free email-based newsletter - Linnean-News or visit our website www.linnean.org where you will find full programme details and registration forms.

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NATIONAL SCIENCE AND ENGINEERING WEEK
14-23 March 2014

SET for BRITAIN

Presentations by Britain's Early-Stage Researchers
in Science, Engineering, Technology and Mathematical Sciences
at the House of Commons

Monday, 17th March 2014

Engineering and Mathematical Sciences Exhibitions
12.15 pm - 2.40 pm

Biological and Biomedical Sciences Exhibition
3.30 pm - 5.30 pm

Physical Sciences Exhibition (Chemistry and Physics)
6.30 pm - 8.45 pm

Presentation of Westminster Medal
9.00 pm

The Society of Biology, on behalf of the science and engineering community, is organizing the

VOICE OF THE FUTURE 2014

A unique opportunity for young scientists and engineers to participate in a *Science Question Time* with Members of the House of Commons Select Committee on Science & Technology, the Minister of Science, the Shadow Minister of Science and the Government's Chief Scientific Adviser

Wednesday 19 March 2014
The Boothroyd Room Portcullis House
House of Commons
9.00am – 12.00pm

NATIONAL SCIENCE AND ENGINEERING WEEK SEMINAR

Organised by the Parliamentary and Scientific Committee (P&SC) on behalf of the Department for Business, Innovation and Skills (BIS)

Thursday 20th March 2014
In the Palace of Westminster
10.00 am – 1.00 pm

MARINE SCIENCE

"Deep Sea Marine Biodiversity"
Dr Brian Bett
(National Oceanography Centre, Southampton)

"The Role of the Ocean in Securing Sustainable Food for 9 Billion People"
Professor Manuel Barange
(Plymouth Marine Laboratory)

"Mining the Sea Bed"
Mike Jones, (Soil Machine Dynamics)

The Rt Hon David Willetts MP,
Minister for Universities and Science,
will attend

"Marine Renewables"
Dr Paul Bell
(National Oceanography Centre, Liverpool)

"Ocean Acidification: The Silent Storm"
Dr Carol Turley
(Plymouth Marine Laboratory)

"Natural Hazards and Sea Level Rise"
Dr Kevin Horsburgh
(National Oceanography Centre, Liverpool)

BPS **UK PHARMACOLOGY ON THE MAP**

A new intiative celebrating the contributions of UK pharmacology to drug discovery and development

For more information please contact info@bps.ac.uk or visit www.bps.ac.uk