Hazard and Risk

Weather Forecasting and Insurance

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STEM and the Economy

SCIENCE IN PARLIAMENT

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Summer 2010

The Journal of the Parliamentary and Scientific Committee

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SCIENCE IN PARLIAMENT

SiP

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

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

Andrew Miller MP
Chairman, Parliamentary and Scientific Committee

I wish to record from the outset the gratitude of the readers of SiP to the valuable contribution made by Dr Brian Iddon over a five year period in the last session, thus ensuring the success of the journal which has become an important contribution to the better understanding of science and engineering in Parliament and elsewhere. As both science and engineering are widely seen as one of the main drivers very likely to be important in economic recovery, so the readers of SiP will be seeking information and advice on increasingly relevant but potentially complex STEM related issues across the political spectrum.

I am also particularly pleased to be able to report that following the elections for the posts of the Select Committee Chairs on Wednesday 9 June, I was elected by the House to be the Chair of the Science and Technology Committee. The Committee can now start its work as the remaining members have recently been nominated by the House. Please see the report from the HoC Select Committee on S&T in this issue for further details. At the time of writing we hadn't been fully constituted to enable us to agree a formal programme but I would like to see the Committee focussing attention on helping to maintain the strength of the UK's science base and also improving public understanding of some of the challenging scientific issues facing us today. As this is the first Parliament where Select Committee Chairs have been elected rather than appointed, this is also of particular significance for and recognition of the important contribution made by the Parliamentary and Scientific Committee and this journal in particular.

The journal brings together a rich mixture of contributions from Parliamentarians with important views on the role of Science in Parliament, with the leaders of STEM based organisations on the other, combined with summary reports on the Discussions and Debates held on the Parliamentary Estate and which are open to all of our 250 Member Organisations. It is a unique and valuable resource, which is free to publish the views of scientists, engineers and those with an interest and need for scientific information, independently of political persuasion, but recognising the vital need and opportunity to bring all these aspects together under one cover.

I look forward to combining these ongoing interests with my new duties which include a full spectrum of the Government's roles and responsibilities for STEM.

After a very difficult time in hospital, readers will be greatly relieved to learn that Mrs Annabel Lloyd is now recovering at home from a serious operation and hopes to be back with us sometime within the next few months.

This issue is devoted primarily to the assessment of and response to risk and the distinction between risk and hazard.

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Professor Jane Plant (who is married to Professor Peter Simpson, Scientific Secretary of the Parliamentary and Scientific Committee) agreed to pay for the front cover of Science in Parliament for advertising her book *Eating for Better Health,* to be published in August, when a prior sponsor withdrew at short notice.

WHAT PRICE SCIENTIFIC INTEGRITY?

Countess of Mar

In the 21 years that have elapsed since I was poisoned by organophosphate (OP) sheep dip I have learned a huge amount about the history, science and political consequences associated with this group of chemicals. I cannot say that I like what I see. Several hundred shepherds and, maybe, thousands of Gulf War Veterans who had an OP dip formulation sprayed on their tents, bedding and latrines during their service in 1991-2, suffer long-term health effects.

Insofar as sheep dips are concerned, it was convenient for the Government to respond to my numerous questions on the subject by, firstly, saying that the products were safe. When this failed, they blamed the farmers for not knowing that OP's were poisonous – there were no warning labels on the containers! Then it was farmers' failure to wear recommended protective clothing or to invest in engineering controls. Interestingly, when the phenol disinfectant was removed from the formulation in 1992, at the height of reported adverse reactions, the reported incidence of adverse effects plummeted. As any chemist knows, phenol rots rubber, so the advice to wear rubber gloves, boots and aprons was not helpful. Later advice to wear complete waterproof protective suits and respirators was impractical for hard labour on a warm day.

During the late 1990's alternative products and injectibles were introduced. The government required users of all dips to obtain a Certificate of Proficiency for the safe use of sheep dips, skull and cross bone warnings appeared on labels and concentrate containers were made safer for users, but only after a lot of pressure from campaigners. There was then the problem of what to do with those people who claimed that their long-term health had been adversely affected by OP's. There have been a number of epidemiological studies, all of which have shown subtle psychoneurological effects in the affected subjects. Some work has been conducted on the autonomic system effects in a few patients, but the results have always been accompanied by the rider that further research is necessary. There remain doubts and many questions as to whether long-term low level exposure to OP's causes ill health in humans in some scientists' minds.

This is where I have some difficulty on an intellectual plane. I am aware that there is scientific evidence of the chronic health effects in humans exposed to OP's that goes back prior to the 1950's, but none of the published material is from British scientists. The symptoms of chronic OP poisoning were described by researchers such as Lhos and Spiegelberg in Germany who published extensively on their studies of disabled nerve gas plant workers at the end of World War ll. Dr Patricia Bidstrup (Chemistry in Industry, 12 June 1954) also described symptoms in a patient exposed to TOCP – symptoms that many affected sheep farmers and Gulf war Veterans recognise today. I cannot understand why it is, when men and women are describing the same symptoms as those earlier workers, our scientists and politicians say repeatedly, that modern OP's are not as toxic as the earlier ones and therefore they cannot cause ill health. My response is that they are still very toxic; they still act in acetylcholinesterase as well as a number of other enzymes that we are not told about and that they also affect the mitochondria, the power houses of all living creatures. Where is the scientific curiosity that asks why thousands of people around the world suffer chronic ill health and early death after being exposed to OP products?

I understand that British expertise in OP's is more or less confined to scientists who have signed the Official Secrets Act. They cannot become experts until they have signed the Act because of the military connections – the modern generation of OP pesticides were developed from nerve gas research. When it is very obvious that there is expertise other than the home grown variety, why do members of the Government's Advisory Committees very rarely ask their scientific colleagues from abroad for assistance? If they are as independent as we are always told that they are, why is it that they seem so reluctant to pursue the truth when it is politically inconvenient so to do?

I have never believed that a court of law is the place to settle doubts about what is, intrinsically, a scientific and medical problem. Trying and failing with that route has been a stressful, expensive and unnecessary course for those who joined group actions in the last decade. What a pity it is that the Government and its advisers have never understood that what every one of my several hundred correspondents wants is not compensation, but recognition, diagnosis, treatment and prevention in the future. Perhaps if they had done, the OP story would have been different.

ENGINEERING THE FUTURE

Andrew Miller MP,
Chair,
Commons Select Committee
Science and Technology

I pay tribute to the Science and Technology Committee and especially to Phil Willis, my predecessor in the old Parliament, which took considerable interest in Engineering. In one year the Committee produced two major Engineering Reports: "Engineering: Turning Ideas into Reality", March 2009; and "Putting Science and Engineering at the Heart of Government Policy", July 2009. One of the conclusions was that the name be changed to the Science, Engineering and Technology Committee which the new Committee may wish to revisit.

The Report "Engineering: Turning Ideas into Reality" focussed on the relationship between Engineering and Government Policy and brought Engineering to the forefront. It demonstrated that policy makers, and members of the public, may both overlook the importance of Engineering and Engineers. Engineering isn't just a sub-discipline of Science. It is a vibrant pursuit in its own right which brings a different perspective to the table.

The fundamental purpose of Engineering is improving human life, as in healthcare, energy security, water supply, communications or capping oil pipelines; there is no doubt that Engineers are vital to the functioning of society. If one looks at the efforts of both military and civilian Engineers in Afghanistan – Engineers also improve governance by their efforts.

Engineers are the people that make things happen and because of its inherently practical nature, Engineering advice has to be of great value to Government. Sometimes Scientific advice alone just won't do.

This all seems so obvious. Yet the Engineering Report identified significant flaws in the way Government used, or did not use, Engineering advice. The report contains shocking examples where Government announced an objective without clearly showing how it was going to achieve it. For example Eco Towns would cost tens of millions of pounds, yet there was little evidence that they could achieve the aim to be "zero-carbon" towns as there was no Engineering input to the Eco Towns Steering Committee. Other examples of bad practice indicated a chronic devaluation of Engineering advice to Government.

The Committee's recommendations received a mixed welcome. The Government agreed that Engineering advice in policy making was absolutely crucial. However, it differed from the Committee on how the use of it should be improved.

The Government rejected all the Committee's recommendations for appointment of Chief Engineering Advisers to Departments. It also discarded the proposal that there be a Government Chief Engineer. There is no Chief Scientific or Chief Engineering Adviser in the Treasury which sticks out like a sore thumb as the only Department without a CSO. It is a matter of serious concern that there is no formal route for scientific or engineering advice in what is probably the most important Department of all.

A key recommendation was that the Government Office for Science (or, as the Committee would have preferred, the Government Office for Science and Engineering) be placed in the Cabinet Office. This was not a new idea, the Committee previously suggested this in 2006. It still hasn't happened. When recognising the importance of the advice given to the Prime Minister by the Government Office for Science, this is a point that the new Committee may wish to reiterate.

However, it is not all doom and gloom. There is now a better understanding of Science and Engineering expertise within the Civil Service. Sir John Beddington, the Government Chief Scientific Adviser, has been working to identify and bring Scientists and Engineers, who are from similar professional backgrounds, together in a "career home" within the Civil Service.

However merely bringing people together is not, in my view, sufficient. Engineering expertise must also be specifically sought, valued and used in the Civil Service.

One impact of the Engineering Inquiry was the way it highlighted the need for the Engineering community to come together, which has manifested itself most notably in the formation of the "Engineering the Future Alliance". This brings together key Professional Organisations to speak with a single, strong voice to Government and to Select Committees.

Never before has the voice of engineers been so important. We are in a difficult economic climate and are undergoing a firm squeeze on public finances. There is a raging debate on the relationship between Science and Engineering and Economic Growth. The relationship is difficult to quantify, but one thing is clear. Engineering can provide a link from ideas leading to economic growth and a better future. As Lord Mandelson aptly put it: "If you really want to change the world, choose a career in Engineering. And I mean Real Engineering, not Financial Engineering."

It is the job of the new Science and Technology Committee to scrutinise Science and Engineering Policy and hold the Government to account. The Committee will be formed soon and I am keen that we get cracking on this very important job. I look forward to discussing how we can work together to improve the relationship between Engineering and Policy.

MAKING BRITAIN HEALTHY: UTILISING THE INNOVATION *IN VITRO* DIAGNOSTICS CAN PROVIDE TO THE NHS

Doris-Ann Williams
Director General British *in vitro* Diagnostics Association

The Department of Health has estimated that 70% of clinical decisions are linked to diagnostics. For years, patients have seen the benefits brought by innovative *in vitro* diagnostics, and they will continue to see many more in future.

Every time we see a patient brought into A&E on television, whether in a fictional programme or real-life documentary, one of the first things a doctor will do to treat them is to rattle off an order for tests using incomprehensible acronyms – U&E's, FBC, LFT FBC etc.* These represent a whole battery of very mundane but essential tests which are required to flesh out the clinical picture of what is happening in the patient's body, and are examples of just some of the *in vitro* diagnostics (IVDs) now commonplace in healthcare.

IVDs are tests performed on samples of body fluids or tissue, unlike *in vivo* diagnostics (x-rays, imaging etc) where the patient actually needs to be present for the test to be performed on them. Despite their name, IVDs are not only used for diagnosis but in a wide range of health contexts including: ensuring safety of the blood supply by determining blood type and screening for infectious agents; monitoring therapy; as a tool for managing chronic disease; screening the population (or at-risk sectors of the population) for disease. For doctors, even ruling out a possible cause can be as helpful as an actual diagnosis.

As in all the life science sectors, there have been significant advances made for IVDs over the last forty years. Until 1970 most tests were made and performed in NHS pathology laboratories, using very labour intensive bench-top techniques. During the 70s and 80s it became much more normal for routine tests to be bought in as commercial kits of reagents (chemical solutions used to detect the presence of a biological substance) with a validated protocol to follow – the "convenience ready meals" of day-to-day testing. In this heyday, the UK industry was at the forefront of global R&D with companies like Wellcome Diagnostics and Amersham International.

Just as advances in digital technology revolutionised home computing, the advent of automated testing transformed pathology. Think about how incredible it now seems that in 1981 Bill Gates could say "640k of memory ought to be enough for anyone." There has been a similar leap forward in diagnostics. Today, most of the NHS laboratory workload is fully automated. This means more samples can be tested better and faster, and analysis time has been reduced from around a week to less than a minute.

Alongside the advances in technology we have seen a rapidly increased menu of tests evolve to provide more and more information to support clinical decision-making. There are now tests involved in every

disease process, with new biomarkers being identified constantly.

U&Es and FBC tests aren't especially cutting edge or exciting in and of themselves, but without the information they provide a clinical team would essentially be working in the dark. There are technology changes happening today which are right at the cutting edge of science and will become as routine as the U&Es over the next few years. Most of these advances are happening in two areas: point of care testing and personalised medicine.

Already many of the most essential tests can now be carried out in the hospital, actually at the bedside using point of care testing. While the science behind these is as complex as laboratory-run tests, the IVD industry has developed the technology to allow reliable, simple to perform and accurate tests to provide information with minimal delay in a critical setting such as in an intensive care unit or A&E department.
Increasingly, point of care testing is now being used in communities to diagnose and monitor patients away from hospitals and reduce readmissions. These tests appear more expensive than a laboratory test if examined only on a cost per test basis, but in a whole system context they can be both more cost effective and more beneficial to patients. With advances in fields like telemedicine, we will see this use extended further to allow monitoring of people with long term chronic conditions in their homes without the need for constant outpatient clinic appointments at a hospital.

Personalised medicine describes the process when a diagnostic test is used alongside a drug. These tests can be used to identify which patients will actually benefit from being prescribed a therapy – for example, a HER2 test to see if a breast cancer patient has the gene that allows the drug herceptin to have an effect – or monitor the use of the therapy and adjust dosage. When the knowledge of the human genome is overlaid onto this we begin to see truly amazing possibilities for the future regarding truly personalising medicine and targeting treatment for individuals. This also brings additional safety by minimising adverse reactions to drugs and, of course, saves money by preventing the prescription and use of drugs where they will not work. Already, we are at the point where drug companies are planning how they can provide a diagnostic test alongside a new drug.

IVDs also have the possibility to save money now for healthcare. This can be achieved by using tests to reduce the number of patients having not just unnecessary drugs, but also invasive and more expensive tests. For example, there is a simple test, Calprotectin, which differentiates between organic bowel disease and symptoms of irritable bowel, which is normally identified through a colonoscopy. Correct implementation of this test could stop up to 50% of patients currently being referred for unnecessary procedures and over £100 million to PCTs across England. The knock-on benefit of this would be that appointment slots for colonoscopy would be released. This would in turn release capacity to allow access for patients with bowel cancer symptoms, and perhaps could mean that the screening age for people for bowel cancer could in turn be lowered enabling more cancers to be diagnosed early. However, in order to realise all these benefits from a single, simple and inexpensive test (typically less than £20), the way funds are managed will need to be re-engineered, as will mindsets in the NHS. In this example the saving would be to the PCT by reducing the number of colonoscopies they pay a hospital trust to perform, but the trust would have to increase the laboratory budget in order to provide the test – impacting on the hospital's income and costing it more when it should be costing it less.

IVDs are constantly evolving to provide new tests and new ways of using existing tests to improve health, ensure patient safety and bring cost efficiencies to healthcare in the UK. The availability of diagnostics to identify target populations for drugs will rationalise therapy and enable the best value for money from the drugs budget. And point of care testing will bring real benefits to people by enabling more monitoring and disease management to be carried out in the convenience of their communities with less disruption to their daily lives.

*Urea & Electrolytes, Full Blood Count, Liver Function Tests – detailed explanations of these tests can be obtained at www.LabtestOnline.org.uk

THE BALANCED ECONOMY – THE NEED FOR STEM CAPABILITIES

Professor Geoffrey Le Grys
Formerly Director: Food Innovation Centre, Sheffield Hallam University
Emeritus Professor – Sheffield Hallam University
Honorary Professor – Universitatea Dunărea de Jos din Galați, Romania

This article is written on the premise that science and technology are the foundations upon which growth and the modern economies are built. As such, there needs to be a much greater emphasis in all communications of the benefits that science has given society and the role of scientists in wealth creation. People take the advances made by science and technology for granted whether they are in telecommunications, healthcare, transport, food supply, or IT, etc. Each and every one of these will be driven by science, technology, engineering and maths (STEM). Yet much of society seems to place little or no value on the role of scientists preferring the cult of the celebrity be it sport, the arts, TV, music or film (or even politics).

For many years concern has been raised by industry about the number and quality of young people coming forward for careers in STEM. This can be expressed as part of the wider issues of skills which many trace back to Jim Callaghan's Ruskin College speech in 1976. More recently we have specific reviews for STEM such as that undertaken by Sir Gareth Roberts[1] or from SEMTA[2]; the latter states *"In terms of the quantity of supply, the falling interest of young people in taking STEM courses is a serious strategic challenge, both for the UK…."* [3] The Dyson Review[4], which will underpin the Coalition's approach to ensuring the UK has a high tech future, reiterates many of these concerns identifying several issues including culture – the lack of esteem of scientists and engineers, education – getting young people excited about science and engineering, our inability to exploit knowledge and an alarming shortage of UK students taking engineering and technology postgraduate courses.

Actions in the past have often focussed on increasing the take up of STEM in core primary and secondary curriculum in schools; however, there is a need to convert enthusiastic youngsters into mature, effective professional scientists and engineers. These are the people who will drive the generation of new knowledge which will underpin innovation and the country's production of new products. It is the dearth of these people that now confronts industry and the country with the majority of the most able students deserting STEM careers.

This threat is now compounded by several factors: firstly, the major expansion of science education in other countries, particularly in India and China; secondly, the willingness of global companies to move R&D facilities to regions and countries that have the available talent pool; and thirdly, the distorting effects of salaries and bonuses in other sectors of the economy especially financial services which attracts talent from careers in STEM.

The remainder of this article focuses on the careers paths and career prospects for the most able young people; those who will be leaders in their field no matter what profession they follow. Equally all industries and sectors will need their talents if they are to succeed in the modern global economy. The pathway chosen for an individual will be decided on a balance of financial reward, recognition, personal interests and ambition tempered by opportunity. Let's examine the three possible choices presented to a 'first class graduate' starting out on their career: a) management trainee into a blue chip multinational company; b) fast stream entry into the civil service; and c) a research career begun with a PhD programme at one of our premiere universities.

The graduate management trainee in a blue chip company[5] is enticed with statements such as *"entering their future leaders programme"* and *"We offer world-class development opportunities in a fast-paced,*

challenging work environment". These programmes abut the graduates to a range of opportunities in which to shine. The outcomes for the many will be, by their late 20s, management of a significant function with the rewards and lifestyle to match. For those that remain within the company or similar business environment the possibility of the path to senior director roles and above is a realistic expectation,

The fast stream career in HM Civil Service[6] has similar early foundations with a programme that *"will enable you to develop quickly and move posts more frequently than you would ordinarily expect."* Obviously prospects for any individual will depend on talent but there is the expectation for the best that a grade 7 appointment would be possible by their late 20s and promotion to the senior civil service a realistic expectation. The fast stream is available for specialist science graduates both in the MOD and other departments; however, these roles are often primarily managing science and procurement rather than 'doing' science.

The route for a professional scientist will almost always involve the training role as well; in this case it is called a PhD programme and this is essential to a future as a 'world class' researcher.[7] The days when young people undertook a PhD on a meagre grant have thankfully now gone, although the salary or stipend is still significantly below that of the fast stream or graduate traineeship in industry. However, for the scientist's career this is only at the first step and is followed by one or two post-doc positions. The post doc is only obtaining their first substantive post in universities, industry or an executive agency when the management trainee or fast streamer is well established in their career. Examination of the appointments pages of New Scientist or other sources of vacancies often show extremely poor rewards given the length of training and experience of the post doc. Certainly there is no significant campaign by companies to recruit world class young researchers comparable to that for MBAs where graduates from the world's top business schools can expect salaries in excess of £75,000[8]; a sum beyond the dreams of all post docs, essentially, at the same stage of their careers.

The early careers of scientists in universities have been examined and severe shortcomings reported[9] including high levels of dissatisfaction and poor salaries. Perhaps the most damning statement from this report is summed up in the following statement *"We are concerned that the feelings of dissatisfaction with scientific careers are filtering into the wider science base and possibly into the education system as a whole. Post-doctoral researchers are often the first point of contact for PhD students and undergraduates following project-based courses. Even schools may feel the effects, as children assess the attractiveness of future careers from advisors and others when choosing which 'A' level options and degree courses to follow. People working at the frontiers of discovery are ambassadors for science whatever their eventual careers."* This undermines much of the good work that is happening in schools to improve the take up of science education.

Many science based companies, and in earlier times, the civil service, professed to have parallel career structures and rewards for the specialist and general managers. The custom, however, is more honour'd in the breach than observance for several reasons. Firstly, as expressed above, the starting points tend to be different; secondly, criteria for establishing level of a role for a manager tends to be focussed on tangible measures such as budget, number of reports and financial authority, etc. Whilst for the specialist measures associated with level are more intangible such as quality or reputation; thirdly managers performance criteria have measures such as keeping within a budgets which limits the progress of team members (i.e. the specialist they are managing); fourthly talent management programmes, common in larger organisations, are primarily the preserve of the manager, not the specialist scientist; and lastly, the ethos of senior levels of leadership and management comes from the paradigm that scientist can only do science – management and leadership are the preserve of the generalist or those with a background of law, accountancy and marketing, etc.

There are no simple solutions and, certainly, no quick ones. We must break down the attitudes implicit in the recent consultation – A Vision for Science and Society – that the public view of science is focussed on the negative and that scientists are somehow separate from the rest of society. If there aren't significant changes, then the UK science base will enter a downward spiral and the CP Snow's 'two cultures' will be confirmed. If change is to occur we need concerted effort by employers of science graduates (which includes government and other public bodies) to make career choices to scientists as attractive, if not more so, than other professions. In particular they need to:

- demonstrate the value they give to highly skilled scientists by giving salaries, standing and career structures that match generic managers at the same state of the careers;
- identify role models, materials and (statistical) data that give positive image to the science professions;
- find ways (prizes only seem to have an impact within the specialist community) to publicly recognise the work and contribution of young scientists early in the careers rather than at retirement.

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4 Sir James Dyson (2010) Ingenious Britain – Making the UK the leading high tech exporter in Europe

5 Taken from the recruitment pages of a major multinational.

6 The Civil Service recruitment web site

7 Being 'world class' is essential for reputation and funding within the present UK system.

8 Source - FT Global MBA rankings – top 5 UK business schools

9 Council for Science and Technology (2007) – Pathways to the future: the early career of researchers in the UK

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UK SCIENTIFIC EXCELLENCE SERVES THE WHOLE PLANET

Professor John Beddington, the Government's Chief Scientific Advisor

National Science & Engineering Week (12-13 March 2010), with its celebration of UK science and its theme this year of 'Earth', is a good opportunity to focus on the value and relevance of the Met Office to the UK and the wider world.

The Met Office is a notable British science success story, operating from a UK domestic research base that is second only to the US on the majority of leading indicators.

The information the Met Office provides is of great value to the UK and also of global importance. Accurate forecasting will be crucial in resolving uncertainties over the way events such as droughts, monsoons and *El Nino* affect specific localities. For example, the Met Office is the Volcanic Ash Advisory Centre for the North Atlantic. They conducted crucial modelling analysis during the disruption to air traffic caused by the Eyjafjallajökull Volcano eruption, providing essential information on the spread of the ash plume.

Against the backdrop of climate change it is no exaggeration to say that the work of the Met Office is not just world-beating but may be world-saving and in introducing the other contributors on this theme I can do no better than set out the nature of the challenge we face.

The Copenhagen Accord provided a commitment by signatories to hold the increase in global temperatures below 2°C, and more than 70 countries have submitted pledges to reduce emissions. Despite its shortcomings, the Copenhagen Accord is an important step forwards. For the first time, all of the world's largest greenhouse-gas emitters have signed up to a framework for co-operation on one of the biggest challenges of our time.

If we do not meet the target of holding global temperature rise below 2°C, the Met Office predict the impacts will be wide-ranging. The risks include an increased danger of forest fires in many parts of the world; reduced crop yields across the Americas and Asia; a reduction in run-off in the Amazon basin and elsewhere; rising sea levels; an increase in the frequency of drought events in the Mediterranean basin and other areas; the Greenland and West Antarctic ice sheets at increased risk of irreversible decline; and tropical cyclones becoming more intense and destructive. Rising levels of carbon dioxide will also drive ocean acidification, with a significant impact on fisheries. There are, of course, uncertainties in all predictions of future change, particularly on regional scales, and we must be sure to communicate these uncertainties accurately and effectively, but the evidence is clear that climate change is a problem we cannot ignore.

I am concerned by the number of people who, despite the compelling evidence that exists, doubt the threat that man-made climate change presents. Proper scepticism is part of the scientific process and should be welcomed, but ignoring what is clear from real-world observations cannot be justified. The hard science behind the forecasting and observation will be key to improving our understanding of the challenges we face. The Met Office and UK science have a crucial role to play in continuing to develop this, as well as in communicating the evidence effectively to a wide and sometimes sceptical audience.

. . . the evidence is clear that climate change is a problem we cannot ignore. . .

INTRODUCTION TO THE MET OFFICE

John Hirst Chief Executive, Met Office

Today, I want to give you an overview of the Met Office and what we do. Many people are unaware of the depth and breadth of our work, so I can usually guarantee that, at some point, the thought: *"Wow, I didn't know they did that!"* will cross your mind.

Our aim is: *"To be recognised as the best weather and climate service in the world"*. It's not enough for us to simply be the best. We want to be recognised as such by our customers, collaborators and competitors and we have set up benchmarking work to check our service and the value for money we give against the other leaders around the world.

Our strength comes, in part, from dealing with weather and climate as a combined entity. That is, literally, under one roof and using much of the same science. And we are the only institution in the world with this capability.

We're probably best known for forecasting the weather over the short term - 3 to 4 days. And we have measures that show our operational forecast accuracy over that period is the best there is.

The development of supercomputing and, with it, numerical modelling has come a long way in recent years. Climate science is now well established, with its core predictions now thoroughly peer reviewed and accepted by the vast majority of scientists. The challenging work is now in forecasting the outcomes that are possible across the world under different scenarios and communicating sometimes complex science to the public.

A new area of science is in the intermediate periods, from months to a decade ahead. The media coverage of the Met Office's seasonal forecasts has been extensive and not entirely complimentary; demonstrating a need for us to learn more about who may benefit from the science and how best to communicate it. Some sectors — financial markets and Operations Managers across industry — understand the real benefits of such science, even at this developmental stage but it is of less benefit, however, to a member of public deciding if they need an umbrella today.

We have many world-leading scientists working at the Met Office but, to ensure we achieve our best, we also work closely with others worldwide. This includes sharing our supercomputer with NERC; working closely with both UK and international academia; fulfilling our role as UK representative within the World Meteorological Organization; and working in conjunction with other countries' National Meteorological Services. For example, we're working with Bureau of Meteorology in Australia that uses our Unified Model under license, to develop and improve the model for our joint benefit.

All this research feeds through into the Met Office operations, which in turn drives the research so that we're constantly developing and improving.

Beginning with our daily forecasts on TV, on radio and online — provided by our Public Weather Service — there's a drive to improve availability and quality, but in tandem, we're developing ever more tailored products and services. From these we generate revenue and the profit from these tailored services is reinvested, limiting our cost to the tax payer; maximising value for money; and funding further development.

Another aspect of our core role is the provision of the National Severe Weather Warning Service which lets people, emergency responders and, when necessary, the emergency command structure know in advance that the weather may take a turn for the worst. Meanwhile, the Met Office Hadley Centre has been recognised as leading the world in climate-change research and services, and makes a significant contribution to the Intergovernmental Panel on Climate Change.

Some of our less well-known services include environmental monitoring. Here the Met Office again works alongside emergency services to give guidance on the spread of volcanic ash, or diseases such as Foot and Mouth and Bluetongue in cattle. We also have staff serving in a military reserve unit of the RAF, stationed abroad in countries in conflict.

We provide services for healthcare, most notably to sufferers of COPD (Chronic Obstructive Pulmonary Disease). By notifying individual patients of the likelihood of the kind of weather which aggravates the condition, this service has been shown to save lives and the cost of hospital admissions.

We also provide forecasts for utilities companies, the construction industry, airlines, shipping, road gritting, sporting events, mining companies, the oil industry, the insurance industry, private pilots, leisure sailors, balloonists… The list goes on. The range of Met Office customers is vast because the weather touches all our lives.

I hope I've been able to provide you with at least one, *"Wow, I didn't know that!"* and an outline of some the important work that goes on at the Met Office.

A GLOBAL CLIMATE SERVICE FOR THE UK

Dr Vicky Pope, Head of Climate Change Advice, Met Office

CLIMATE SCIENCE

Introduction to the basic science with the evidence of climate change

http://www.metoffice.gov.uk/climatechange/science/controversy/facts.html

CLIMATE SERVICES: STATEMENT OF INTENT

The vision:

- To deliver the most trustworthy predictions of how climate may vary and change over the coming weeks and decades.
- To interpret those predictions in terms of the risks of hazardous weather and climate extremes
- To provide products and advice to help society plan for and adapt to climate variability and climate change in a timely fashion

EXAMPLES OF CLIMATE SERVICES

UK Climate Projections 2009

Climate change is affecting our world now and, because of greenhouse gases already released, we are guaranteed further changes in the coming years and decades. While the extent of these changes will be influenced by the emissions we release today and in the future, any level of change will pose many potential threats and some possible opportunities. It is, therefore, essential to understand these issues so we can start adapting right away for the changes to come.

The UK Climate Projections 20091 are a major step forward in addressing this need for the UK. The Met Office Hadley Centre produced an ambitious and comprehensive analysis of regional climate change for UKCP09. The projections provide probabilistic information on how the UK's climate could change in the 21st century based on state-of-the-art climate models, observations and statistical analysis, combined with expert knowledge. The projections are a key part of a programme of decision support tools and measures from the UK Government to both encourage and support action to prepare for the impacts of our changing climate.

THAMES ESTUARY 2100 PROJECT

Key points

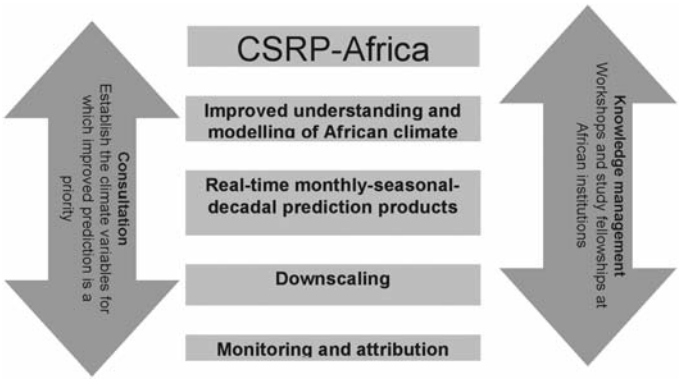
- Advice to Environment Agency
- Simulated flood in the Thames Estuary
- Model projections
- Average sea level - most likely 20-80cm 2m possible
- Intensity and frequency of storm surges up to 0.7m
- Inform future design improvements to the Thames Barrier

Background information

http://www.metoffice.gov.uk/corporate/pressoffice/2008/pr20080923.html

THE DFID-MET OFFICE HADLEY CENTRE AFRICA CLIMATE SCIENCE RESEARCH PARTNERSHIP (CSRP)

- Over next 10 years comprehensive climate services will be developed internationally
- Focus on monthly to decadal timescales of near term adaptation (unavoidable climate change)
- Natural climate variability and man made change both important – extremes focus
- Current climate models indicate some levels of skill for regional predictions but there is much to be done to improve them – process focus.
- Will need strong links to application modelling and risk analysis
- Adaptation is regional – international collaboration and user engagement is critical



CLIMATE SERVICES – A NEW INDUSTRY EMERGES

Dr Matt Huddleston FRMetS,
Principal Consultant,
Climate Change, Met Office

In the communication of weather and climate perils, each side of a debate are apt to rally around any evidence that supports their cause. There have been many examples of this in recent years as the implications of climate science have impinged on political and social debate, with for example low levels of artic sea ice being attributed to the worsening of man-made climate change, and likewise the recovery some glaciers in Greenland being used to show it has stopped.

These variations may be influenced by man-made change to some degree, but are in fact largely natural in origin. As with the old fable of the blind men describing an elephant, seeing too small amount of a problem can lead to wrong assumptions. Some of these *natural variations*, such as the Pacific wide El Nino phenomenon, impact on human endeavours globally, and also in this case act as a modulation on top of any underlying longer trend from either natural or man-made sources. As with any complex system, a narrow view of a short lived event may hide significant underlying trends in the opposite direction.

The revolution in weather and climate science has been driven forward by increasing computational power. The underlying rules which govern the movement of heat, energy and moisture of the earth's environmental system can be encapsulated, coded and tested and so enabling our daily weather forecasts. Forecasts of weather for 3 days ahead are now as good as forecasts of tomorrow 20 years ago, and indeed the Met Office daily global forecasts are world leading in terms of accuracy and relied upon by everyone from our military operations in Afghanistan to disaster management efforts in Africa.

Three factors govern the use of computational resource:

(1) the detail to which one wishes to analyse environmental risk. A case in point is the latest IBM supercomputer at the Met Office has enabled a stunning improvement in the forecasts of impacts of extreme rainfall for flooding events such as those in Morpeth in 2008. Such short-range weather models now resolve down to 1.5km allowing local mountains and coasts to be more fully resolved. The forecasts from the models look astonishingly like satellite images as they resolve more detail than ever before. Application to climate forecasts also allows changes in weather to be captured over decades – which is critical for understanding the actual impact of our changing climate.

(2) the complexity can be increased to match more of the processes observed in the real world. The atmosphere interacts with these and the complex dance of energy, heat and moisture between the systems defines the variations in our climate. To date this has included the addition of the oceans, land surface, land ice, atmospheric gases such as ozone and methane, aerosols such as desert dust, volcanic ash, black carbon and cooling sulphur, sea ice, ocean biology, crops and forestry and even natural fires. King among these for forecasting beyond 2 weeks ahead is the world's oceans. Indeed the top 3m of the ocean holds more heat than the entire atmosphere and yet the average depth of the ocean is more than 3km. As the ocean moves heat around our planet, the atmosphere responds and interacts defining future weather patterns and impacts.

(3) there are uncertainties in science, not just from our understanding but also some inherent but quantifiable uncertainties in the chaotic

weather-climate system itself. This means that individual events such as a hurricane may not be predictable more than 2 weeks ahead, but the likelihood of more hurricanes over the coming June-November Atlantic season can be forecast. This is the difference between a weather and a climate forecast – one relies on knowing the here and now well enough to forecast the near future. The second relies on knowing the boundaries that drive the atmosphere such as the ocean temperature.

One forecast is not enough to quantify risk – the uncertainties need to be sampled and different scenarios explored. This leads to "ensemble" forecasts – meaning that we may need to run a forecast 10, 50 or 100 times to increase certainty to the level at which decisions can be made.

The combination of weather and climate forecasting technologies and these 3 factors, together with understanding of natural climate variations on a 1 month to 10 year timescale thus opens a new chapter in the management of risk in countless human endeavours. These are the timescales on which we can respond and react, and put mitigating responses in place. It is the timescale of the life of a government or a CEO. It is the timescale on which we can adapt to a changing climate.

As such we have a new paradigm – that of the climate service. Many institutions globally are involved, and it is fair to say that the UK has an expertise and lead in the science and it's application to real world decision making. Our goal is:

- To deliver the most trustworthy predictions of how climate may vary and change over the coming weeks to decades;
- To interpret those predictions in terms of the risks of hazardous weather and climate extremes, and of the potential for dangerous climate change;
- To provide products and advice to help society plan for and adapt to climate variability and climate change in a timely fashion;
- To provide ongoing scientific advice on the climate benefits and risks associated with mitigation policies.

Examples of such services are already emerging. In giving an early warning of potential floods in West Africa in 2008, the International Federation of Red Cross and Red Crescent Societies put food reserves and emergency stocks in place such that most countries received needed supplies in a matter of days after flooding occurred compared to an average of 40 days in the past, thus ameliorating human suffering and fostering community recovery.

Tropical storms are devastating no matter where they hit and adaptation mechanisms include the global insurance and re-insurance industry to distribute the costs of devastation. In the Atlantic, a forecast of the number of tropical storms for 2005 using today's technology shows a very high chance of a season that had never occurred. The outcome was indeed a record breaking year with hurricanes such as Katrina and Wilma causing colossal damage and loss. Lloyds reported losses of more than £3bn. Key to note is that this technology is not reliant on past data – it is not an empirical or statistical analysis. It thus allows forecasts of things that have not previously occurred – and as green houses gases continue to accumulate in the atmosphere and the earth system moves into new climatic territories, this will be a critical tool to enable us to adapt.

The costs of natural climate change can also be assessed. For Europe, a study commissioned by the Association of British Insurers showed insured losses from winter wind storms for the UK could rise by 25% to £827 million for slight southward shift in storm track; a scenario in which more storms hit London.

To summarise, the UK now has the world's first climate service. Initially it is two fold focusing on the needs of Africa for DFID and a set of proposals to address core insurance industry needs. It is a nascent science but one of great promise which has largely become possible of the globally unique co-location of weather and climate research at the Met Office, and experience in the daily delivery of science to enable all manner of users make decisions to protect the environment, property and the security of life.

REDUCING BUSINESS RISK FROM CLIMATE CHANGE

Christopher N Bray, Environmental Risk Policy Management, Barclays

Presentation available on the website.

A REINSURANCE MODEL FOR GLOBAL CLIMATE

Matthew Foote, Research Director, Willis Research Network

Britain's public spending on science has doubled in real terms over the past 10 years to more than £6 billion, but the country's future as a leader in scientific research and innovation is by no means secure.

A new report by the Royal Society, which urged the new government to ramp up spending on scientific programmes, showed that, over the past 15 years, public expenditure on research and development as a percentage of GDP has been on a steady decline. According to estimates from the Institute of Fiscal Studies, planned public spending cuts of around 6.4% per year through 2012, if applied to science, would threaten the UK's position at the forefront of global science and risk our long-term economic health. Meanwhile, UK businesses' contribution is not enough to plug the gap. British industry spends around 1% of GDP on scientific research and development – around half that spent by business in the US, Japan and Germany. Without a renewed focus on investment in science, the Royal Society warned, the UK could fall behind other countries – especially emerging economies such as China, India and Brazil, all of which are expanding their funding in scientific research.

The nationwide decline in science-related investments comes at a time when governments and industry from around the world are calling for more sophisticated data to help them prepare for an increasingly volatile climate. This is particularly true of the global reinsurance industry, which, by its very nature, is defined by the impact of extreme events.

Valued at around $213 billion of annual gross written premium in 2009, the industry provides effective financial protection from extreme events to the world's insurance companies, governments and commercial organisations.

The industry is faced with significant challenges – particularly an increasing trend in year-on-year losses, regulation of capital provision, and a steady growth in the worldwide value of insured assets within high-risk areas. Catastrophe losses from extreme weather events continue to rise, and while reinsurance provides insurers and others with the ability to stabilise their loss potential over long periods and deal with the impacts of extreme events, the quantification of that risk is difficult and subject to considerable uncertainty. The problems posed by climate variability and the particular effects on insurance are therefore ultimately ones related to the problems of uncertainty when estimating potential loss.

. . . Catastrophe losses from extreme weather events continue to rise . . .

The impacts of extreme events are measured in terms of a 'probable maximum loss' and expressed as an exceedence probability of a loss over a given period. Reinsurance risk decisions are based upon a combination of loss history, risk appetite and other factors, where possible future losses are estimated using quantitative models that simulate the range of possible extreme events that could affect a given region. These models, known as catastrophe models, form the basis for assessing the impacts of current and future extreme events.

These models combine representations of the range of potential extreme events, the assets being insured, and their likely damages, and translate them into loss probabilities.

Insurers and reinsurers each have key issues that influence their view of extreme 'catastrophic' risk, including:

- How forecasting skill (at varying temporal scales) of event likelihood and severity can be improved through better modelling and data;
- How global teleconnections such as the El Nino Southern Oscillation (ENSO), whose influence is partially evident in available historical datasets, have a physical influence on varying extreme weather distributions, and;
- How the likely frequency, severity and location of extreme events can be represented.

For the public sector, catastrophe models can be invaluable tools to identify which regions and sectors of the economy are most exposed to extreme events.

Conventional methods of modelling extreme weather events to tackle these and other questions rely in large part on available historical datasets. By their nature, however, the recording of extreme events and their impacts are infrequent and inconsistent, and can place a significant limit on the confidence placed in extreme event loss estimation.

The key question of how both natural and anthropogenic climate variability influences the distribution of extreme weather events globally, and how this changes the frequency and severity of extreme event risk, is therefore difficult to assess through the use of historical data alone.

Climate models have, until recently, been limited to broad, global or regional assessment of climate parameters, such as sea surface temperature, making their application to extreme weather catastrophe modelling difficult. Recent advances in climate modelling, used in conjunction with some of the world's largest supercompters, are now enabling scientists to resolve, or 'see', complex weather events, such as tropical cyclones within the global climate models, complementing the information provided by the historical record. More sophisticated modelling techniques are also allowing us to assess the regional impacts we can expect from a dynamic climate. These developments hold profound possibilities for the future, and are particularly crucial as more frequent and severe weather events hasten our need to understand and evaluate atmospheric related hazards.

. . . future losses are estimated using quantitative models that simulate the range of possible extreme events that could affect a given region . . .

As a result, climate modelling is now moving into the front line of both economic and political debate, driven by the ability to generate outputs which include representations of the extreme weather events that ultimately affect people and property. It is the medium and laboratory to assess the current and future risk of environmental change.

UK academic research, particularly that being undertaken by the National Centre for Atmospheric Science, the Met Office, and others, is leading these advances by harnessing the power of these higher resolution climate models and high performance computations. According to the Royal Society, by 2011, the supercomputers employed by the Met Office will deliver close to 1 trillion calculations per second, enabling more detailed global models of extreme weather and improved predictions of regional climate change.

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Such advances, based on climate science programmes funded by the UK, will influence not only the development of the next generation of reinsurance catastrophe models, but long-term policy and financial investment decisions, and will cement the UK's position as a world-class hub for climate science research.

As Dr Robert Kirby-Harris, chief executive at the Institute of Physics recently observed: *"It is important to maintain our investment in both curiosity-driven research and research that addresses the global challenges we face at a time when other countries are doing so much to increase their focus on science and science education. The UK cannot afford to fall behind".*

"AND NOW, THE WEATHER… AND CLIMATE CHANGE"

Peter Gibbs,
Broadcast Meteorologist

For over 150 years, the Met Office has pioneered the science that makes today's advanced weather and climate forecasting possible. The development of supercomputing and, with it, numerical modelling allows us to support the UK in ways far beyond the broadcasts that make us a household name. But when it comes to communicating them to the nation, weather and climate change require very different approaches.

Imagine sitting in BBC Radio 4's *Today* studio, waiting to present the weather forecast. A journalist is being interviewed about some of the worst flooding for half a century. As the interview ends, you look towards John Humphries who asks, "Just before the forecast…tell me. Are these floods due to climate change?" Now try putting a single severe weather event in the context of long-term climate change and presenting the UK forecast in one-and-a-half minutes.

WEATHER

The weather is very complex. While one part of a town may be affected by heavy showers and flash floods, another can stay completely dry. An increase of just 10mph in wind speed in a storm can lead to an exponential increase in damage. These are just some of the everyday challenges weather forecasters face.

Improved models allow us to see in detail the areas at risk. They were behind the Met Office's advance warning of disruptive snowfall last winter, when we accurately predicted that snow was on its way — where it would fall and how long it would last — with a very high accuracy rate. Today, our computer forecasts are fed directly into BBC Weather's graphics system allowing important detail to be presented to the public.

But with increasing forecast accuracy comes another communication challenge: there's a lot more information to cover in a broadcast. While BBC TV and radio are vital in getting clear, accurate and timely information out to the public, particularly when severe weather strikes, other media are increasingly being used. The internet and mobile devices now allow customers to choose how much detail they want, and where and when they want it, adding to the reach and challenge of broadcasting.

And these days, it's not enough to simply forecast the weather. More and more we're being asked to predict its impacts. Last winter, just 5 cm of snow falling during rush hour was enough to cause chaos. A much bigger fall of 30 cm of snow overnight saw many people choosing to stay at home.

Supercomputers also allow us to use ensemble techniques to forecast the weather 3–6 days ahead. Here, the forecast is run many times from slightly different starting conditions and, depending on whether the results converge or deviate, gives us a useful measure of confidence. Where there are uncertainties, percentages can be a helpful way of communicating them to some sectors such as the financial markets. But they're of less benefit to a member of public deciding if they need an umbrella today.

CLIMATE

Despite the sub-zero temperatures that gripped Britain, January 2010 was globally the hottest on record — an announcement that was greeted with derision in parts of the press. While scientists don't have a problem with the global view, someone shivering in the snow is likely to feel highly sceptical. People naturally judge on personal experience, so if the Met Office says it's going to rain tomorrow and they get wet, they believe us next time. With climate change a lot of the information is counter-intuitive, which makes it even more of a challenge to convey.

On this occasion, our cold, snowy January was outweighed by warmer than normal conditions elsewhere. Remember the lack of snow at the Winter Olympics? This really emphasises the difference between weather and climate. Weather is the temperature, precipitation (rain, hail, sleet and snow) and wind, which change hour by hour and day by day. Climate is the average weather and the nature of its variations that we experience over time.

So, while the floods in Cumbria last November — the focus of our fictional *Today* broadcast — cannot be used as the smoking gun for climate change, severe weather is expected to occur more frequently as the climate continues to get warmer.

At the Met Office, we believe it's perfectly reasonable for climate science to be questioned and tested. We continue to do the difficult science that informs the British public, businesses and Government on how the climate may change in the future. We also take great care not to overstate our findings, presenting them clearly so that the facts stand up by themselves.

COMMUNICATING WEATHER & CLIMATE CHANGE – A MEDIA VIEW

Michael McCarthy,
Environment Editor,
The Independent

On Thursday 30 April last year, at 10.30 am in the forenoon, in a small room inside the Royal Institution in Albermarle Street in Central London, the Met Office chief forecaster rose to his feet and told a dozen assembled journalists that it was "odds-on for a barbecue summer" – and at that moment there began a pubic relations disaster.

It was a PR disaster which goes to the heart of the difficulty of communicating both weather and even more, climate change, which is that you are not reporting company results, of a new drug discovery, or anything which has happened, but that in every case, you are making a prediction about the future, which is of course uncertain, and more, you asking ordinary people to take a bet on it.

The barbecue summer affair turned so sour because, in a certain way, the Met Office went further than it ever had done in a forecast, and when that could not be justified, and what was forecast did not happen, everything fell apart. One is reminded of the fact – although of course one would not want to labour the comparison – that we justified going into Iran in 2003 on the basis that Saddam Hussein had weapons of mass destruction, and when none could be found, in many people's eyes, the case for war disintegrated.

But let's look closely at what happened last April 30. The chief forecaster was giving the seasonal forecast for summer 2009, and to be fair to him and the Met Office, when he said it was odds-on for a barbecue summer, he was making an accurate report, and using language precisely.

The odds he was referring to were 65-35. That meant that the Met Office supercomputer had run 50 different simulations of the weather over the coming summer, in what is known as an "ensemble" of forecasts, and 65 per cent of these had indicated it would be warmer and drier than average, while 35 per cent had indicated the opposite.

On one level the forecaster was simply reporting that, and the Met office was indeed saying that there was a 35 per cent chance of rain – which of course is how it turned out.

But in using those figures he was dealing with what is known as a "probabilistic forecast", useful in commercial risk assessment and in the insurance world, but something the public are not really used to, so in 2009 the Met office decided to "put some flesh" on the bones of its dry percentages.

That's where they went further than they ever had before; and the excess – the mistake – was in the use of metaphor. The word "barbecue" did something terribly dangerous: it ignited hope.

. . . The word "barbecue" did something terribly dangerous: it ignited hope. . .

It conjured up a dream of patios and charcoal aromas, which after the washout summers of 2007 and 2008, was the most tremendous piece

. . . To get a perfect forecast you would need an infinite amount of data, but with the few million data points we now have we can get a good picture of the next five or six days. . . .

of good news; the phrase was chosen to make headlines, and indeed it did. It was reported everywhere; in the Daily Express it was the front page lead story. And the chief forecaster went further: he said: "We do not see the London bus syndrome of three wet summers coming in a row. The likelihood of that happening is extremely small.'

That was a hostage to fortune if ever there was one: July turned out to be one of the wettest summer months on record, and by the end of it, the resentment from a public whose hopes had been so firmly raised for hot dry evenings on the patio was so intense, that, amidst a torrent of criticism, the Met Office felt obliged to issue a public apology.

But it didn't end there, and painful though this is to recount, the Met office then proceeded to get the winter seasonal forecast wrong.

Issued on September 29 last year, the winter seasonal forecast for 2009-10, said that "winter temperatures are likely to be near or above average over much of Europe including the UK. Winter 2009/10 is likely to be milder than last year for the UK, but there is still a one in seven chance of a cold winter".

As it turned out, we have just experienced the coldest winter for 31 years.

Following the barbecue summer affair, this brought down on the Met Office a torrent of extremely unpleasant criticism, ranging from attacks on individual bonuses to the suggestion that its contract to provide weather services for the BBC might not be renewed, and anyone who works with the Met Office and likes and admires its personnel, as I do, cannot but have felt a lot of sympathy.

But beyond sympathy, what are the lessons that can be learned?

The main one is that weather forecasting is still an inexact science.

Of course, it's better than it ever was. Modern weather prediction involves assembling millions of pieces of data from around the world – wind speed, air temperature, air pressure, humidity – and working out on the world's most expensive supercomputers how these phenomena will act on each other, simply according to the laws of physics. To get a perfect forecast you would need an infinite amount of data, but with the few million data points we now have we can get a good picture of the next five or six days.

However, accurately predicting longer than that – to make a seasonal rather than a weekly forecast – is very much harder, as a tiny difference in the data inputted at the beginning of such a program can make, over time, an enormous difference in the outcome. This is the meaning of the often-misquoted "butterfly effect" - the microscopic atmospheric perturbation caused by a butterfly flapping its wings might eventually, in theory, result in a hurricane.

It means that the variability of the weather is infinite, and will always be surprising us. So even though the public craves and will always crave certainty, caution is probably a better option in the medium term, and a badly bruised Met office has clearly now come to this conclusion, and decided to end seasonal forecasting for the general public.

Yet if it's a problem is you're asking people to take a bet on the future, with weather, you're asking them to take an even greater bet on the future with climate change.

Indeed, the principal difficulty with communicating the threat of global warming is that its effects take place in years to come, and on the whole, people are not bothered about that. As Groucho Marx said: why should I care about posterity? What's posterity ever done for me?

Politicians know that ordinary people care most about a certain number of immediate interests: their finances, their health, the education of their children. The future can wait, especially if there is doubt over it, and so, if ordinary people's feelings are the beginnings of political will, it is very hard to construct a widely backed political impetus to tackle climate change. This was evident at last December's UN climate conference at Copenhagen, where it was clear that virtually all the politicians taking part were doing so with very little mandate from an engaged public; they were acting as top-down leaders, out on their own, and perhaps that accounts for some of the conference's failure.

What has carried the movement to deal with global warming for the past 20 years has been what one might call a narrative: a general belief among the public, fostered by senior scientists and bolstered by mounting evidence in the real world that the climate is indeed warming, and that we are responsible for that.

It's important to recognise that in the last three months something has happened to

this; I would venture the view that this narrative has in part imploded.

The reason is a tragic one: the politicisation of the issue.

I think it's fair to say that this polarisation began on the left. With the collapse of socialism, the future of the climate became a substitute issue for young radicals to take up, people who were rebellious in their tenor, did not dress in suits, might eat lentils and came together in climate camps to attack power stations. More seriously, they began to express their conviction as an ideology, and treat those who dissented as heretics. Thus arose the widely-used phrase "climate deniers", which, with its evocations not only of heresy but also of Holocaust denial, seems to me inappropriate; I don't use it. I use the word sceptics.

To this politicisation from the left, there was eventually an instinctive, hostile response from the right. If these long-haired types were supporting the climate change issue, with their unceasing puritan demands that we stop using our cars and cover the countryside in wind turbines, then those on the right were against it. It was a gut feeling as much as anything, but they were strongly backed in their opposition by the fossil fuel industries, who of course have much to lose through anti-climate-change measures, and they were confirmed in their gut feelings by the fact that the warming itself has been on a plateau for the last decade (although the latest forecast from the Met Office suggests that the warming will resume its progress this year).

So with this issue of atmospheric science, which will affect all our futures, it is now broadly the case that, if we leave aside the scientific community, those who think climate change is a mortal threat are on the liberal-left, whereas those who profess it to be all an exaggeration are on the right.

A number of factors have recently combined to give the sceptic side of the argument great impetus: the affair of the University of East Anglia emails, in which climate scientists may be considered to have behaved inappropriately; the sloppiness of some of the science of the UN's Intergovernmental Panel on Climate change; the failure of the Copenhagen conference; and not least, the freezing winter, which instinctively makes people think the idea of global warming is simply a non-starter.

carbon dioxide concentration has risen by 23 per cent since 1958 and is continuing to rise ever more quickly.

For the first time, the climate-sceptic argument has gained a real purchase on public opinion, and the narrative which has been generally accepted for the last two decades, of an acceptance of the reality and menace of the problem, has to some extent disintegrated.

Difficulties with weather prediction and difficulties with climate change prediction are, it may be noted, to some extent being conflated in sceptic circles, such as parts of the Tory party, the Spectator magazine or the Daily Express, where the Met office's troubles with seasonal forecasting are being used to attack its climate expertise; the whole institution is damned as "warmist".

Warmists and deniers – isn't that just a terrible polarisation of a scientific issue?

. . . at Copenhagen, it was clear that virtually all the politicians taking part were doing so with very little mandate from an engaged public . . .

What are we to do about all this?

The first thing is to follow Corporal Jones's advice: don't panic. Climate sceptics are having their moment in the sun. That's all right. Debate is good, But nothing in any of the East Anglian emails, or the mistakes in the IPCC's impact predictions, has remotely altered the basic science, which is that molecules of certain trace gases help retain the sun's heat in the earths atmosphere, and that we are rapidly increasing the second most important of these, carbon dioxide. Its concentration has risen by 23 per cent since 1958 and is continuing to rise ever more quickly. There can be no doubt that this will not be effect-free.

What that effect will be, we will have to wait and see, but eventually we will get our 40 degree summers in the UK and everything that will follow, and people will see that their own immediate interests are indeed threatened, and they will clamour for their politicians to act, sceptics or no sceptics.

Although by then, of course, it will be too late.

A GAP IN THE INNOVATION MARKET

David Dent
Chief Executive Dent Associates Ltd
Vice President, Parliamentary and Scientific Committee

Political rhetoric addressing the nations future economic prospects is always littered with an enthusiastic commitment to the process of scientific innovation. This is because economic growth is dependent on an ongoing ability to innovate, to develop new technologies and services.

Scientific innovation is of course a key component of this process, which should be reflected in the funding and organisation of our research base and supporting infrastructure. Given its significance to our future prosperity, the review and scrutiny of the processes, structures and financing of scientific innovation is essential to ensure we are achieving what we need in the most efficient and cost effective way. With this in mind it was with some excitement that I anticipated in March of this year, the publication of three reports; the Royal Society *The Scientific Century: securing our prosperity*, and Sir James Dyson's *Ingenious Britain: Making the UK the leading high tech exporter in Europe*, and the Council of Science and Technology's report *A Vision for UK Research*, which potentially offered, individually and as a whole, the prospect of a fresh look and appraisal of the UK's process of scientific innovation.

I am constantly amazed that despite the importance of the market in all other aspects of UK politics and economics, how little influence it appears to have in debates about scientific innovation and the organisation of our research base, one of the issues I had hoped to find addressed in the March reports. The market seems to have only a very limited role in our nation's innovation process which is very much science supply-led rather than market demand-led. The market appears to be viewed only as a beneficiary of outputs of a process which may or may not meet particular market opportunities rather than the main driver of demand for specific scientific innovations. Even the terminology we use when we refer to "translational activities" implies that there is no expectation that research has or should be directed towards a specific market opportunity.

The science supply-led model of innovation functions with research priorities determined by scientists according to measures of scientific excellence as opposed to market or business criteria. The subsequent outputs of research, undertaken in universities and national research institutes, is then monitored for commercial potential, if these happen to be identified then intellectual property is usually, but not always, protected prior to scientific publication; commercial and funding partners are sought and innovations then licensed to industry or spin-off companies are created. No one really believes that this complex system is as effective as it needs to be, hence the plethora of initiatives to improve knowledge transfer and so called translational activities to improve the harvesting of the products of research. Most recently with the Research Excellence Framework (REF) the emphasis has been placed on the need for scientists to consider the impact of their work to ensure that the potential commercial and social benefits of their research are not overlooked. This whole process of science supply-led innovation is analogous to building a bridge across a ravine without knowing the required span, its load bearing requirements, necessary materials or the cost of the build – certainly not a bridge on which I would want to be reliant in order to cross any ravine - nor a process on which I would wish

. . . a number of decisions in the last 30 years have made it more difficult than necessary to develop a market-led innovation process . . .

to rely for the future prosperity of a nation.

The science supply-led process of scientific innovation which dominates the UK research base can at best be described as ad hoc, unfocused and an indirect means of developing commercially viable products, technologies and services. We in the UK, have never been good at commercialising our innovations, something recently emphasised by a number of eminent politicians and scientists at the Royal Society of Chemistry's Parliamentary Links Day in June and acknowledged in the March reports. It is my belief, that because of the value we in the UK have always placed on academic "pure", "blue skies research", serendipity and scientific excellence, we have been corralled down a single route into our current process. I have certainly struggled to identify where and when we have actually considered alternative, potentially more effective routes to delivery of scientific innovation whereby the market becomes the driver of demand for specific scientific innovations rather than scientific supply - harvested for commercial purpose.

Also a number of decisions in the last 30 years have made it more difficult than necessary to develop a market-led innovation process; one of which was the political dogma in the 80's that believed publicly funded research should not address "near-market" issues and a second; the more recent emphasis on scientific excellence and publication in high impact journals, mediated through the research assessment exercise (RAE).

The result of the "near market" dogma was that our national "applied" research institutes were effectively robbed of their mandate and we divested ourselves of a research capability and infrastructure that continues to serve other nations very well in deed (e.g. USA, China, Thailand and India) with a near-market research mandate. The subsequent introduction of the RAE across all publicly funded research also meant that the performance of those national "applied" research institutes that remained after the 80's, were and are assessed on the same terms as an academic department - an exercise which continues to facilitate their integration into the university system. And no one seems to question that a research institutes mandate and performance measures might benefit the nation more by being different from those of a university department!

The RAE has assisted many of our universities to justifiably claim their world class status - something which serves us all well as they deliver to their primary purpose of high calibre scientific research adding to the wealth of knowledge and understanding which underpins our whole culture and way of life. Secondarily, and often with the benefit of serendipity, research can also innovate to develop concepts and technologies of potential commercial value. However, it has become increasing apparent in recent years and with the introduction of the REF with its emphasis on impact, that this secondary purpose is becoming more of a priority as we strive to generate greater economic wealth from our research base; a move which may in reality, drive this truly valuable asset away from properly achieving its main purpose.

. . . a change in mandate is a bit like needing a performing aquarium seal to become a circus trapeze artist . . .

Such a change in mandate is a bit like needing a performing aquarium seal to become a circus trapeze artist; a different animal altogether, with different attributes and skill set, performing to a different audience with its own set of standards, encompassing different rewards and levels of risk. Of course there will always be some performing seals who may become trapeze artists, given the right circumstances, but most will not, could not and might even in the attempt, end up destroying the very thing for which they excelled. It might just be better to leave the performing seal to do what it does best, and look to find potential trapeze artists elsewhere and work with them to deliver a focused and singly mesmerizing performance.

. . . Our whole system of science supply-led innovation is based on a number of presumptions . . .

In other words what we have to ask ourselves in relation to scientific innovation for economic and social impact, is whether there is an alternative model which is market-led rather than science supply-led that will better deliver economic and social prosperity for the nation.

Our whole system of science supply-led innovation is based on a number of presumptions which include:

- the emphasis on scientific excellence is the most efficient and cost-effective route to scientific innovation
- science supply is more important for innovation, than market opportunity
- that our best scientific innovators remain within the current system and achieve academic excellence
- that the skill sets and training needs of all types of scientists are essentially the same

. . . in our science supply-led process of innovation, the market has become an after-thought rather than the driver of innovation. . .

- academic culture and organisational structure encourages and supports innovation
- contracts and reward systems meet innovators needs and aspirations
- the Haldane principle prevails for all project proposals
- technologies based on excellent science will eventually find a niche in the market place

We adhere to such presumptions because our whole process of scientific innovation is locked within a paradigm where the same terms, concepts and priorities are reiterated as a given - among which are the need for:

- nurturing a world-class research base
- scientific excellence as an imperative
- an attractive base for international research
- translating research into economic and social benefit

If we refocus these widely used terms towards a more goal oriented approach driven by the market where science becomes the tool of innovation, then an alternative to the above paradigm becomes apparent with the need for:

- nurturing of world class innovation
- excellent innovations based on sound science as an imperative
- an attractive business base for scientific innovation
- translating market opportunity into commercially and socially beneficial scientific innovations

It was this kind of thinking - of realigning our perspective to what is central to the whole concept of innovation, the market, that I had hoped to find, at least in some sense, in one or all of the three reports. The CST report does argue that *"translating into economic or social outcome can arise from any part in the spectrum, from long established or newly discovered basic understanding, from strategic exploration of potential applications, or in response to market driven imperatives"* but the fact of the matter is that in our science supply-led process of innovation, the market has become an after-thought rather than the driver of innovation.

Such an emphasis on science supply-led innovation has to be challenged if only to confirm that the processes selected are the best, most cost effective and the ones most likely to drive growth in our economy. Also putting forward alternative processes does not mean that we transfer the whole research base over to market-led scientific innovation. There is no reason to risk the scientific excellence of our world class institutions by prioritising market oriented activities but rather to build an independent capability to ensure we fully meet commercial business opportunities with appropriate innovation. Refreshingly the CST report did argue for platform technology centres with, it appears, the potential to meet such a requirement.

One of the questions we have to ask ourselves is the one Sir James Dyson continues to ask - are we providing the right training opportunities, infrastructure, career routes, means of assessment and the environment for those scientists and engineers who are motivated, not by scientific excellence and a higher pursuit of knowledge, but by generating solutions of economic and social benefit? Are these people even the same or are we talking about the difference between performing seals and trapeze artists?

Perhaps we need to encourage scientific skill sets that require an entrepreneurial flare, an ability to identify gaps in a market, combined with a commercial solution mind-set, risk taking, a motivation led by business and potential revenues, rather than knowledge generation, scientific excellence, publications and an academic status. Combine this with an infrastructure oriented towards specific market sectors focusing on identifying market gaps and defining the parameters of required innovations, with groups of scientists and engineers whose project proposals are assessed according to business criteria and where they work in a hot-house of entrepreneurship to develop, design and test technologies, products and services that address market need. Then maybe, just maybe, such an approach may provide more immediate and higher financial returns per pound invested for our hard pressed UK economy, than the rather diffuse, ad hoc science supply-led process to which we are currently completely wedded. Even if it doesn't, we have to ask the question and while there were glimmers of hope in this respect in each of the reports provided in March by the Royal Society, Sir James Dyson and the Council of Science and Technology, I did not feel any one of them fundamentally challenged the idea that the future of the UK economy should be dependent on the probability of serendipity delivering the occasional technology to an unsuspecting market rather than the deliberate focused intent of research to develop a technology designed for a specific market opportunity. We have to ask ourselves if we can afford not to consider alternative models of scientific innovation in a country which is, more than ever over the next decade, going to be dependent on innovation and export as a driver of our economy and our nation's prosperity.

HIGH SPEED RAIL

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The case for the building of a high speed rail (HSR) network has been promoted in many quarters. The unquestionable importance of the project to our national economy and, in particular, to the regional economies through which it would travel, inspired a group of us to carry out some research.

Why we are allowing ourselves to blindly fall behind our international competitors in this area is a question of deep concern. Not only against our European counterparts, but also against the developing world, we are lagging behind in the realisation of any manageable or achievable solution. Britain lead the world in the development of rail travel during the last industrial revolution and yet today we seem to have become complacent in our outlook and as we sit, doing up our shoe laces, other less developed countries are continuing to race ahead of us. My concern is rooted, not in patriotic fervour, but in an overriding concern that inaction in this area will result in deterioration of our economic development at large, a fear that in this economic climate is all the more relevant.

In light of the recent budget announcements, previous proposals are financially unfeasible. If we are ever to see HSR come to fruition, we need to apply a fresh, innovative strategy to our approach. What we propose is "HSR Lite" – a low calorie version of what has previously been proposed by HS2. The implementation of HSR is so central to the continued development of our economy that we must initiate a strategy that is fundable within the context of our tightened national purse strings.

Our economic prosperity is reliant on efficient accessibility to the nation's cities; it is clear that the existing UK railway system is untenable. It is already grossly overburdened, with railways now carrying 1.3 billion people a year, more than at any time since 1946. In the harsh light of this figure, it is abundantly clear that the UK railways will be in crisis by 2020 unless measures are taken.

A HSR network would alleviate the problem by increasing capacity through the new lines and releasing capacity on the 'classic' rail network. HSR would drive major economic and social change, transform connectivity between British businesses and their customers, enable faster journey times and liberate work time. It would vastly improve access to European markets, remove pressures on domestic air travel, reduce the damaging environmental impact whilst lessening road traffic.

In the pursuit of all these advantages we lag far behind our global competitors. This can partly be attributed to the cost of procuring railway infrastructure in Britain being estimated at as much as three times higher than comparable projects in continental Europe. A recent estimate of overall cost from Network Rail is a daunting £34bn. To put this figure in perspective, it would finance the 2012 Olympics more than three times over. Reasons for this disparity include the UK's non-standard technical specifications, different operating standards and safety requirements, tortuous planning requirements, complex budgetary and procurement processes. The cost gap between the UK and our European counterparts must be reduced if we are to initiate a successful venture. Financing a venture of this magnitude will only be possible if the government reconsiders the excessively stringent regulations (outlined above), aligning our estimated costs with those in Europe and internationally.

Contrary to other research projects, we concluded that a critical feature of a successful HSR network is that it needs to be national in its scale and dedicated to high speed trains only. European experience suggests HSR procurement, project management and construction operates most efficiently and effectively on stretches of 100 to 200 kilometres. Consequently, we believe that progress towards an overall vision should emulate the development of motorways, conceived as a network but executed little by little over a significant number of years. The HSR programme should be divided into a series of staged and politically, managerially and financially deliverable projects. Our initial aim should be to identify a strategy that delivers the maximum value for that spend and is safe, but simple and direct in design and execution. Decisions made now will have repercussions on domestic travel for generations to come.

The first elements of a new HSR network could provide an effective and efficient link between London, Birmingham and Manchester without venturing into the cities themselves. More than half the cost of the Channel Tunnel Rail Link, and much of the planning effort, arose from the final approach to central London and St Pancras because of the extensive tunnelling and other engineering work involved. Why then, in developing HSR, is it initially essential to build into city centres? Even if traditional appraisal methodologies show that this maximises benefits, a detailed financial analysis will give very different metrics. The last time we addressed the rail network was in the Victorian times, during which accessibility to stations was paramount. However, we no longer rely on horse drawn carriage for transport to and from the station and nor do the majority of commuters live in city centres. It is obvious, with this rationale

> . . . inaction in this area will result in deterioration of our economic development at large. . .

in mind, that the centrality of stations is no longer crucially important. And so the best value for money during the initial development will be achieved by selecting segments with lower costs per kilometre that are outside the cities, which represent the potential for the biggest time savings.

A possible route runs from a London terminus at Old Oak Common on the new Crossrail route, which links Heathrow to the West and Bond Street and Canary Wharf to the East. The Old Oak Common terminus would be convenient for most commuters - only two stops from the West End and seven from the City. Similarly, the northward HSR route would be to Birmingham Airport and then Manchester Airport where linkages with city centres already exist.

The distance involved in this route is about 300km, suitable for letting as two projects in line with the staging principles outlined above. Major construction companies estimate that a reasonable cost for continental rail projects is €20m per kilometre. On this basis, the cost of a route from London to Manchester is less than £6bn, a considerable reduction on previous estimations.

Stations and related facilities should initially be limited in number and designed and built as simply as possible, with essential facilities only. Ancillary development should not be seen as part of the programme but to be added as investors demand.

Finally, it is not essential to integrate the HSR network with the classic network. A High Speed Network can be developed quite separately, reducing cost and facilitating the adoption of more cost-effective technical specifications. These four key principles of staging, selection for maximum VFM, simplicity and separation could transform what feels overwhelmingly challenging as a comprehensive, integrated network into something that looks and is achievable.

The critical point is that a start could be made along the lines proposed, success demonstrated, confidence reinforced and a great platform created for future stages. The economic imperative is clear and the social benefits beckon. Britain must create a high speed rail network.

It is our contention first that high cost, and the appearance of high cost, must be mitigated by cost improvement measures and a critical approach to key assumptions, and secondly that a start should be made as soon as possible, however modest, as the beginning of a staged programme.

The model outlined above is achievable. You can argue that it is un-ambitious; but rather un-ambitious and achievable than overambitious and unfeasible. This prospect is a great deal more positive than the probable alternative if a whole network approach were taken: endless deliberation, indecision, intimidating cost and complexity, overruns and reviews. We have succeeded with the Tunnel Link and mindful of our astonishing, proud railway heritage, we should not hesitate to take the next manageable step. The benefits could be substantial; failure to embrace the HSR challenge could be economically damaging.

THE QUESTION OF FUNDING:

In terms of funding, there is a good deal of information to hand about approaches adopted around the world in developing HSR. What unites them is the major role played in all cases by the state. But this is manifested in different ways. There are basically three potential funding approaches:

The first and the simplest conceptually, is the *public funding* model. Here the public sector acts as both procurer and deliverer, usually working through a state railway company. The taxpayer is both funder and financier.

The second is the project *finance/PPP* model. The public sector acts as facilitator, letting a long term concession to a private sector consortium. The funding consortium raises debt and equity availability fee from government once the infrastructure is complete and operating.

The third is the *rail agency* model under which the public sector usually establishes a dedicated delivery organisation, at arm's length and separate from the state owned railway company – ensuring some independence from government control and protection from political change. Pay back is similar to the PPP model, but the funding is at least partly in the public sector.

The most common model has been the public funding model. For example, both Japan and France embarked on their high speed rail developments on that basis. Both supplemented central state funding with contributions from regional and local government, partly to spread the burden and partly to bind in local support. For the most recent additions to its high speed network, France has switched to the PPP model.

Realistically, given the current complexity of issues surrounding government debt, the public funding model appears unattractive. Even without the recent crisis, the continued centralised approach seems at odds with the expressed wish to open up funding to wider ranges of interests and regional groups. Most importantly, the advantage of working with a strong private sector partnership is that financial discipline and effective cost control are rigorously imposed.

The Project funding/PPP model provides such discipline and transfers the financial risks of construction or maintenance overrun to the private sector, but at a price, and the burden on public finances is mitigated significantly by being spread over time (thirty years or more). The main constraint is the balance sheet capacity of private sector contractors to take on construction risk and the need for detailed ex ante contracts to guarantee returns.

Although the PPP model might be made to work with segmented and phased stages, our view is that the rail agency model probably offers the best chances of delivering a successful programme. It's crucial advantages, arising from risk sharing, are the lower cost of finance and the agency's ability to retain control and flexibility through relatively simple contracting arrangements.

THE VALUE OF SCIENCE

Sir Martin Taylor FRS

Professor of Pure Mathematics at the University of Manchester
Chair of The Scientific Century Advisory Group.

When Cesar Milstein and Georges Kohler received their Nobel Prize in 1984 for their work on the isolation and reproduction of monoclonal antibodies, no one could have predicted that their discovery would create a market for monoclonal antibody drugs which is now worth an estimated US$32 billion.

But there were many hurdles to overcome along the way. At first, monoclonal antibody technology was developed by immunising mice. This produced rodent antibodies which were initially rejected by humans. In 1986, Greg Winter, working alongside Milstein, developed a technique to 'humanise' mouse monoclonal antibodies using genetic engineering. Winter went on to develop another technique which meant that human antibodies could be made using bacteria, bypassing the need to immunize mice or humans.

Winter's pioneering technologies have been licensed to approximately fifty companies and have generated over £300 million in royalties for the Medical Research Council. Winter and Dr David Chiswell also founded Cambridge Antibody Technology, a company acquired by AstraZeneca in 2006 for £702 million. Winter acknowledges that he couldn't have done this without the right kind of support. "I was lucky; the MRC allowed me the freedom to roam with my scientific research over the borders to medicine and industry."

This is just one example of where investment in science has paid dividends, both in terms of the treatments available to us and the financial rewards. But investing in science doesn't just mean advances in technology or economic growth – it also means producing skilled graduates and researchers, enhancing our problem solving capabilities, increasing our knowledge of the world around us and developing networks of collaboration.

The UK currently does very well out of its investment in science. With a total government spend of £6.6 billion on science (equal to 3% of global funding for research), and 1% of the world's population, the UK produces 7.9% of the world's publications, receives 11.8% of citations and 14.4% of citations with the highest impact. But our competitors are accelerating their efforts. Recent announcements by the US of a $21 billion boost for science, a €35 billion investment in the 'knowledge economy' by France and a commitment from the German government to increase their federal budget for education and research by €12 billion by 2013 means that the UK cannot afford to be complacent.

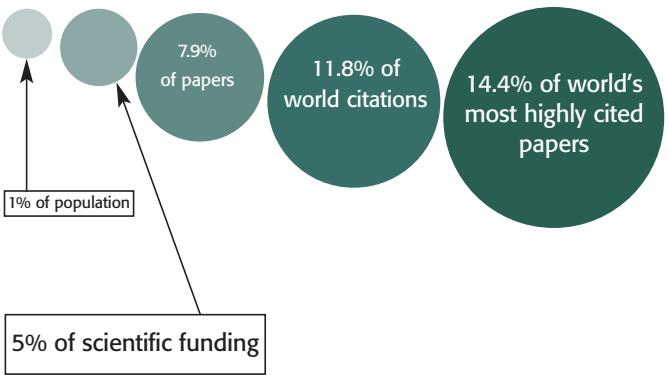
In the current financial climate, no area of public spending is guaranteed. But we believe that cutting the science budget now would be a false economy. Even in these tough times may, the UK needs to invest in the future and concentrate spending where it already has an advantage.

This is why the Royal Society convened an advisory group, which I chaired, and which included two Nobel Laureates, two former ministers of science, and leading figures from two high-tech companies. We wanted to ensure that the next government was fully informed when it came to budgetary decisions, because those decisions could be the most important decisions for a generation.

The group spent a year gathering and analysing evidence and came up with a set of recommendations. Our report – 'The Scientific Century' - recommends that science should be at the heart of any long-term strategy for economic growth. It demonstrates how excellent people are at the core of our prosperity, and why we need to invest in their training and research.

Throughout its 350th anniversary year in 2010, the Royal Society will continue to promote these messages, because it wants to provoke a richer debate about the contribution that science and innovation can make to society now, and to our future prosperity.

THE UK'S SHARE OF GLOBAL SCIENCE



'The Scientific Century: securing our future prosperity' is available to download at royalsociety.org/the-scientific-century

Meeting of the Parliamentary and Scientific Committee on Tuesday, 15th June 2010

VOLCANIC HAZARDS NEAR AND FAR

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Volcanoes grabbed the World's attention when ash from a small eruption of the Eyjafjallajokull volcano in Iceland brought Europe's aviation to a standstill for several days in April 2010. Volcanic eruptions are of course spectacular but they can also be killers and the cause of huge economic losses and societal disruption. At least 500 million people live close enough to active volcanoes to be threatened when they erupt. Managing volcanic risk is thus a worldwide problem. Some of the science issues are generic to many natural hazards and environmental issues. This short article explains some of the key science behind assessing volcanic hazards, discusses the problems of uncertainty and use volcanoes to illustrate the challenges to science of forecasting the future for the benefit of society.

Volcanoes are dangerous and have several ways of causing mayhem and loss of life. Explosions are a major cause of fatalities through the formation of hot flows of volcanic ash and rocks known as pyroclastic flows. These devastating flows can move down the side of a volcano at speeds of 100 to more than 200 kph and it is impossible to survive their direct impact. Pyroclastic flows have been the major cause of death around the world; the entire population of 30,000 people in the city of St Pierre on the Caribbean island of Martinique was wiped ou0t in just a few minutes by a pyroclastic flow in 1902 when Mont Pelée erupted. Another major danger is the volcanic mudflow when large amounts of water are mixed with new volcanic deposits. In 1985 25,000 people lost their lives when the town of Almero, Colombia was buried by a mudflow. Such tragedies can be avoided by careful monitoring of a volcano and timely evacuation.

But volcanic hazards are not just local, as the April Iceland ash crisis demonstrates. Very large eruptions can have regional and global effects. On 15th June 1991 Mount Pinatubo volcano in the Philippines erupted five cubic kilometres (or a billion tonnes) of volcanic ash in a colossal explosion. This was about the biggest eruption of the 20th century. Sulphur dioxide and sulphuric acid pollution spread around the equator within 3 weeks and it took over 2 years for the global atmospheric pollution to dissipate. The pollution was so great that the trend of increasing CO_2 in the atmosphere was momentarily halted, there was global cooling and there was significant reduction in ozone over northern Europe. In 1815 an even bigger eruption (6 billion tons of ash) occurred at Tambora volcano in Indonesia and led to "the year without a summer" in 1816. In1783 a

. . . At least 500 million people live close enough to active volcanoes to be threatened when they erupt. . .

major lava eruption known as Laki occurred in Iceland lasting 6 months. One third of Icelanders died largely through famine due to the environmental catastrophe and there is compelling evidence that there were tens of thousands of deaths in England and France related to the resulting sulphur pollution and crop failures.

Volcanic eruptions are one of many kinds of natural hazards that include earthquakes, floods, tsunamis, hurricanes, wildfires, droughts and magnetic storms. There is also evidence that disasters due to natural events are increasing mostly as a consequence of global populations growth, globalisation and associated environmental stresses which are increasing vulnerability. There is also a plausible view that global warming may be increasing the incidence of extreme weather events as energy in the Earth's atmosphere increases. There are thus some broader lessons and perspectives that can be learnt from volcanic hazards, emergencies and disasters. Society is increasingly asking science to make predictions about what the future holds and this is an unprecedented challenge. In the case of natural phenomena science is being asked to predict so that Society can reduce or avoid losses.

The eruption of the Soufrière Hills volcano, Montserrat began in 1995 and is still going on. Over 15 years the volcano has erupted over 1 cubic kilometre of magma. Montserrat has a special interest to the UK as an Overseas Dependent Territory and the eruption has so far cost 20 lives and likely well over a billion pounds. A hospital built in the late 1980's in the capital Plymouth was destroyed in 1997 and is somewhat symbolic in that a hazards assessment of the island in the early 1990's recognised the possibility of an eruption and recommended that key infrastructure should not be built in the south of the island where Plymouth is located. During the crisis the island has been kept going by dividing the island into an exclusion zone around the volcano and a safe area in the north. One of the great difficulties in all such mitigation policies which in the case of Montserrat required evacuation, is a boundary between safe and unsafe areas has to be drawn. In a crowded island this is bound to cause tensions and disagreements as in practice the risk decreases smoothly away from the volcano and a decision has to be made about the level of risk that is acceptable. However, peoples risk threshold varies greatly, while governments tend to be risk averse, not wishing to be held to account by allowing people to live in dangerous areas. On Montserrat this issue was addressed by using the best knowledge of volcano science to assess how risk varied and then providing this information to the authorities to decide where the boundary should be placed. Inevitably one family house would be on the right side of the line while a neighbour 100 metres away would be on the wrong side of the line and would have to move.

Drawing lines on maps to demark safe from unsafe zones sounds easy in principle but is difficult in practise especially if the threshold that defines the line is itself hard to estimate and the uncertainties in these estimate are large. This problem is very well illustrated in the recent Icelandic ash emergency. Initially the operational guidelines for response of air traffic control involved avoidance so computer models simply had to forecast where ash would go rather than how much ash there was. However, engine manufacturers announced after a few days of almost complete shut down of European air space that engines would not be compromised if the ash was less than 2 milligrams of ash per cubic metre of air. Forecasting where the atmosphere has concentrations of ash higher than this threshold is much more challenging and requires advances in scientific knowledge and modelling methods.

. . . global warming may be increasing the incidence of extreme weather events as energy in the Earth's atmosphere increases. . .

Knowledge about the Earth's volcanoes is still surprisingly meagre. There are some volcanoes like Kilauea, Hawaii and Vesuvius in Italy, which are very well monitored with sophisticated instruments that have a good chance of detecting the telltale tiny earthquakes and ground movements that precede an eruption. However many of the Worlds active volcanoes are located in the developing World where scientific resources and instrumentation are limited or even non-existent. An international project called VOGRIPA being co-ordinated at the University of Bristol is developing a global database on volcanic hazards and eruptions, complementing and partnering the Smithsonian Institution in Washington DC. One of the products of this project is an inventory of the largest explosive eruptions over the last 10,000 years of Earth history. Analysis of these data show that only about 15% of these eruptions are know prior to 2000 years ago. The database can also be analysed to estimate how often extremely large eruptions like Laki in 1783 and Tambora in 1815 occur. Such eruptions are about 100 times larger than the small Icelandic eruptions that caused so much disruption in April. It looks like there is about a 1 in 3 chance of such an eruption in the 21st century. In the modern globalised and interconnected World the economic and societal impacts of such an eruption would be considerable.

We are entering a century of great change and anxiety. Many of the acute problems that humanity faces require the advance and application of science. Natural hazards are one of many examples of the difficulties as the World becomes ever more populated and inter-dependent. There will be many volcanic emergencies in the next few decades and society needs to be better prepared.

GEM - GLOBAL EARTHQUAKE MODEL

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Over half a million people died in the last decade due to earthquakes and tsunamis, most of these in the developing world, where the risk is increasing due to rapid population growth and urbanization. In particular many of the world's megacities of 10 million inhabitants and more, such as Delhi, Bogota, Jakarta and Lima, are situated in highly seismic active areas. A significant proportion of the world's population is therefore at risk from earthquakes.

The 2010 Haiti and Chile earthquakes painfully reminded the world of the destructive impact of seismic events: not only in terms of human casualties, but also in terms of social disruption and economic losses. Some earthquakes have caused losses that are higher than the country's annual GDP.

It may be obvious that there is need to reduce this risk. However in many earthquake-prone regions no risk models exist, and even where models do exist, they are often inaccessible due to their proprietary nature or their complex user-interface. Risk mitigation requires accurate, consensual and uniform risk estimates; reliable earthquake risk information.

Such information should be state-of-the-art and compiled in a transparent manner by the community - everyone should be able to contribute and comment - so that it is owned by the public and hence trusted to be used. It should be accessible to all possible stakeholders, cover the entire globe and not only include hazard and risk information, but extend towards the social and economic impact of earthquakes.

GEM, the Global Earthquake Model initiative, aims to do all that. GEM is an internationally sanctioned programme, initiated by the OECD, working at the establishment of an independent, open standard to calculate and communicate earthquake risk around the world. GEM is structured as a public-private partnership and thereby combines the strengths (and objectives) of both the public and the private sector.

The partnership includes a number of authoritative global institutions, such as the World Bank, the OECD, UNESCO and UN's International Strategy for Disaster Reduction, but also the two largest international professional associations in the field: IASPEI (International Association of Seismology and Physics of the Earth's interior) and IAEE (International Association for Earthquake Engineering). There are six private organisations contributing to GEM and currently nine countries have adhered to GEM and discussions with another 15 are ongoing. GEM's partners have ensured over two-thirds of the 35 Million Euro needed for GEM's first five-year programme.

GEM is building a dynamic, modular, flexible and expandable model, plus accompanying software and tools. Implementation of GEM's working programme is based on a combination of global and regional elements, and integrates developments on the forefronts of scientific and engineering knowledge as well as IT processes and infrastructure. It takes five years to build the first working global earthquake model and its accompanying software and tools. The work started in 2009 and at the end of 2013 the first version of a truly global and comprehensive earthquake model will be presented.

In June 2010 the GEM initiative has been able to deliver a proof-of-concept for hazard and risk calculations on a global scale, mainly as a fruit of the collaborative GEM1 pilot project. GEM1 laid the foundations of

the model, by critically reviewing the current state-of-the-art, by collecting input data and models and building engines for global calculations. It also included a first User Needs Assessment.

International consortia, involving hundreds of professionals and institutions, are working on the creation of necessary standards, databases and methodologies on a global level. These are the global components of the model and are thus developed by the community for the community. The work on Hazard Global Components has started and will be delivered in 2012. The work on Risk Global Components will start in the fall of 2010 and will be delivered in 2012 and 2013 and the work on the Socio-Economic Global Components will take of in early 2011, with the goal to be finalized in 2013.

Programs are being set-up in many regions of the world as independently run, bottom-up projects, and links are established with ongoing regional programs. Both such programs are defined as GEM Regional Programs and involve a great number of local experts who will use GEM software, will generate local data, will validate the data and standards that were created on a global level and will serve as a starting point for technology transfer in the region. Currently three GEM Regional Programs are operational: in the regions of Europe and the Middle East and a collaboration is ongoing in Central America. Programs are being prepared in Africa, South-Asia, South-East Asia and Oceania, Central Asia, South America, the Caribbean, North-East Asia

There are hundreds of institutions, organizations and individuals involved in GEM that contribute expertise, data or software, participate in global and regional programs, or take part in reviews and public assessments. Participation of individuals and institutions worldwide ensures that the model is owned by the global community and reflects its needs and knowledge.

GEM is going through a continual user-needs assessment effort, to ensure that the software and tools that are being developed meet the needs of users. GEM potential users are broad and have different characteristics. GEM's products will therefore be attuned to the needs of expert users and consumers with a basic knowledge of the subject. Partnerships and an active user-community are the ingredients that support the initial use of the tools and subsequent adoption of the information the global earthquake model produces, a necessary first step toward awareness and risk mitigating behaviour.

. . . Participation of individuals and institutions worldwide ensures that the model is owned by the global community and reflects its needs and knowledge. . .

The main output of GEM's first five-year working programme will be the inclusive OpenGEM platform for the calculation and communication of earthquake risk. It will allow basic and expert users to run applications, access seismic risk information on local, national and regional scale, and visualize the latter in maps, curves, tables and export these in compatible formats. Basic users are likely to want to view output produced by the global earthquake model, perhaps that related to the location of their own house. Expert users will be able "plug in" their own data and run their own calculations. Because not everyone will be able to access an internet portal, or would like to run calculations through the internet, a stand-alone OpenGEM software package will be an important derivative.

GEM will however produce more than a platform for risk assessment. Global harmonized databases within the fields of earthquake hazard, vulnerability, exposure and socio-economic impact will be made available, such as a global earthquake consequences database and a global historical seismic catalogue. GEM will also produce best practices and standards related to many aspects of seismic risk assessment, which will help the community to work together under a common framework at a global scale. A community development platform for the computational engine will allow for true open-source and object-oriented development of the GEM risk engine by the community. Programmers and other experts will be able to test, use and further improve GEM's software code. There will be technical reports for the (scientific) community to build upon. Finally technical training programmes /workshops will be held for diffusion of the knowledge on GEM software and use (including application for risk mitigation), especially in less supported and developed areas where risk information is needed most.

. . . GEM's partners have ensured over two-thirds of the 35 Million Euro needed for GEM's first five-year programme. . .

UK EARTHQUAKE ENGINEERING: REDUCING WORLDWIDE DISASTERS

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Recent statistics show that over the last 40 years the number of disasters, as well as economic losses and people affected by disasters, is increasing *(Munich Re. 2009)*. Some of the largest losses derive from earthquake events (or earthquake triggered events such as tsunami). Earthquakes affect both developed and developing countries, although distribution of losses greatly varies in the two cases; economic prevailing in the first case, whilst both human and economic losses being important in the second. For example, the 1995 Kobe Earthquake in Japan (magnitude, Ms=7.0) killed 5,420 people but caused US$ 150 billion economic loss whilst the 1972 Managua Earthquake in Nicaragua (magnitude, Ms 6.1) caused 10,000 deaths and US$ 2 billion economic loss; the latter constituting 40% of the country's GNP.

There is no evidence that the number of earthquake events is increasing, so why are disasters more frequent and more severe? Most economic and life losses in earthquakes occur as a direct or indirect consequence of building and infrastructure collapse. Growing urbanisation with accompanied rapid increase of poorly built housing, uncontrolled use of land, overstretched services and high population densities, has increased our vulnerability to earthquake effects and therefore increased the potential for disasters. Therefore although an earthquake is a natural phenomena, the level of losses are largely dependent on human activity and hence it can be misleading to use the term "natural disaster".

"Surely this is a foreign problem! How are these worldwide earthquakes relevant to us in the UK?" We live in an increasingly globalised world where, as recent events have shown, economic troubles in a country elsewhere can have knock-on effects on the UK economy. Furthermore, the loss of production, manufacture or services in an earthquake affected region can impact UK services, imports and exports. For example, the recent Chile 2010 earthquake caused damage to pulp and paper mills that had a knock on effect on the cost of publishing in the UK. Finally, a country's government is often judged on how well it deals with the aftermath of a disaster, with mismanagement often leading to changes in government or political instability. These instabilities in countries where the UK has interests may or may not be desirable. Understanding earthquake risk and developing engineering knowledge to ensure earthquake-safe construction (earthquake engineering) is also important to the insurance and civil engineering industries in the UK, who have markets and bid for construction projects abroad, respectively.

It is also important to recognise that the UK itself has a low but non-negligible level of seismic hazard, as the 2007 Folkestone (magnitude Ml=4.2) and 2008 Market Rasen (magnitude Ml=5.2) events demonstrate *(see Figure 1)*. Although not relevant to the engineering design of ordinary offices or houses, this seismic activity must be taken into account in the design, building and assessment of important facilities. The UK already operates 24 reactors that provide 1/5th of UK energy, and that this number may increase in the future. All new reactors must be designed to be earthquake resistant and existing facilities assessed at regular intervals for compliance with new safety levels and earthquake building standards.

Given the above, it should therefore not be surprising that there is a large amount of Earthquake Engineering expertise in the UK; particularly in the insurance, nuclear, civil engineering consultancy and academic sectors. Numerous examples of iconic structures abroad that have been seismically designed by UK engineers can be found. For example, ARUP carried out the seismic engineering of the 243m tall China Central Television headquarters *(Figure 2a)*, the Beijing National Stadium ("the bird's nest") and Aquatics Centre ("the fish bowl") in Beijing, China. Atkins also did the structural engineering of the second tallest building in Dubai, the Almas tower, which stands at 360m tall and was completed in 2009 *(Figure 2b)*.

Earthquake engineering expertise in academia helps support the competitiveness of UK industry and was recently recognised to be internationally renowned and a strength of UK Research (EPSRC, 2010). Almost all major engineering faculties in UK universities carry out research in earthquake engineering and structural dynamics, with major research centres present in the Universities of Oxford, Cambridge, Bristol, Imperial, UCL, Bath and Sheffield, amongst others. Large scale

facilities for experimental testing of structures and soils under earthquakes are available at Oxford and Bristol. The UK also offers 5 MSc programmes on earthquake engineering, out of approximately 20 worldwide. Research from UK institutions has been incorporated in the European building code for Seismic Actions (Eurocode 8) and Earthquake Engineering has a presence in both the Institution of Civil Engineers and Institution of Structural Engineers, through the Society of Earthquake and Civil Engineering Dynamics (SECED) and the Earthquake Engineering Field Investigation Team (EEFIT), respectively. One of the activities of the latter is to investigate the reasons for earthquake damage to structures and infrastructure in global earthquakes and report lessons learned back to the UK community *(e.g. Figure 3)*.

So how can the UK help to reduce worldwide earthquake disasters? Firstly, we can continue to support this discipline and this small but active community to maintain its excellence and place in the worldwide academic and industrial arena. Secondly, we can do more to export some of our knowledge and academic courses to developing countries where knowledge of earthquake engineering principles can have a real impact in saving lives. This can be done through international campuses of UK universities or distance learning methods. Thirdly, I believe we can take Earthquake Engineering to a new level of involvement in International Development (pre-disaster) and reconstruction (post-disaster). This requires facilitation of dialogue between engineers, NGO's, development agencies and other actors to promote sustainable and resilient building in seismic areas. The adoption of "best local practice" and of "opportunity-based" land-use can lead to a promotion of existing weaknesses in buildings and infrastructure. There is a need for international funding and development organisations to ensure that experienced hazard specialists and engineers are co-ordinating or implementing construction projects (either by directly employing them or by ensuring that the contracted work will be lead by such people). This specialist (or team of experts, depending on the number of hazards and scale of the project), should set a framework for the design and construction, which may then be executed by other engineers, builders, workers, etc. after appropriate training and with adequate supervision. Disasters are very complex processes, involving communities as well as buildings. Hence successful involvement in international development requires engineers to break with disciplinary barriers and collaborate with other fields such as architecture, social sciences, psychology etc. This should be supported by a base of interdisciplinary education and research in the field of earthquake engineering, which is already being pioneered at the UCL Earthquake and People Interaction Centre (EPICentre, www.epicentreonline.com), but should be embraced by other institutions also.

In summary, earthquakes are a threat to the world but also an opportunity for UK engineering. The UK has a strong base of expertise in the field of earthquake engineering which is internationally recognised and must be maintained and kept competitive. This short article also proposes some ideas for the promotion of collaborations between earthquake engineering and other disciples to better understand earthquakes, their consequences and aid resilient international development efforts.

Figure 1

Damage from the 2007 Folkestone earthquake: (a) Damage to a chimney and (b) structural damage, to Victorian masonry houses in Folkestone.

Figure 2

The China Central Television headquarters in Beijing, China (a) and the Almas Tower, Dubai (b).

Figure 3

Investigation by EEFIT of structural damage due to the 2001 Bhuj India earthquake (a) and 2004 Indian Ocean Tsunami in Thailand (b).

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"EATING FOR BETTER HEALTH"
The Foreword

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This is a book that you will find hard to put down. It is not just fascinating and informative: it is also intensely practical. For many, it may well be a life saver. Indeed, it should probably be compulsory reading for every adult and every household. For the uninitiated, much of its content will be new and inspirational, but even the most experienced doctor and therapist will find something new.

'We are what we eat' has become a cliché, but 'healthy eating' for much of the British population is an oxymoron. It is predicted that in fifteen years time almost half of the adult population will be obese. It is also predicted that our children will die younger than ourselves, simply because of obesity. Yet the UK spends less on its food, in proportion to its gross domestic product, than any other developed country. Diabetes, heart disease, cancer and a whole range of other chronic diseases are, in many cases, the result of a poor diet and, in an equal number, can be remedied by getting our diet right. Yet for the majority it is almost a question of 'we don't care what we eat'. This book illustrates wonderfully why we should care and, more importantly, shows us exactly how we can improve our health and resistance to disease in clear and practical ways.

The problems that this book seeks to solve go beyond the health and wellbeing of each of us as individuals, going to the heart of issues of public health and affordability of the health service. Getting our diet right costs very little when compared with the expense of treatment. The cost of pills, technology and hospital care to overcome the problems of bad diet will soon make every health service unaffordable. If we help ourselves and each other by eating more healthily, exercising more and living more fulfilling lives then we will be able to afford expensive technology for when it is appropriate and necessary. A good diet is not a panacea, but it is something that we can adopt fairly easily with a little bit of determination.

It is always flattering to be asked to write a foreword to a book. The downside too often is that you also have to read it! Not so this book. Once I opened it, I found find it difficult to stop reading. You will find it compulsive reading, and thereafter it will serve as a valuable work of reference, with its clear headings and index.

It is much more than simply a 'good read', however. It is packed with the best evidence that we have on healthy eating. Academics may quibble about the weight of evidence for some of the assertions, but they will be missing the point. The point is that in real life we have to make the best use of the best available evidence, and anyone taking advice from this book will be 90 per cent on the route towards better eating and health. They will also have a far better understanding of food itself and how different foods contribute to different aspects of our health. This may lead to a greater interest and connection with the different foods and how and where they are grown. For too many of us, food is simply a fuel. Fats, carbohydrates and proteins are just the diesel, leaded and unleaded petrol that keep us going. In reality, we should regard our eating habits as a complex and wonderful mixture of art and science. We should appreciate its complexity and also its power to heal and improve health. By being both practical and interesting and with a vast range of recipes to illustrate its lessons, this book should create a new generation of healthy-eating advocates, who will influence and interest those around them and improve their heath and wellbeing.

As a GP, I will be recommending this book to my patients, ensuring that we have several copies in our patients' library, and I shall take a copy home to try and influence those younger members of my family who think that they will live for ever and assume that healthy eating is just for health-conscious adults. So by all means use this book as a practical set of tips and recipes to guide your own path to better health, but do not be afraid to be an evangelist and pass the word on to those who might otherwise suffer. Congratulations to both authors on a courageous, inspiring and brilliant book.

LEADING LIGHTS ANNOUNCED IN STEMNET AWARDS

Individuals and organisations rewarded for inspiring future scientists

The 2010 STEMNET Awards took place on 21st June 2010, highlighting the extraordinary achievements of individuals and organisations in energising learning to captivate the next generation of scientists.

The Awards, run by STEMNET (the Science, Technology, Engineering and Mathematics Network), were presented to winning individuals and organisations by writer, broadcaster and scientist, Vivienne Parry, at a ceremony at the House of Lords, hosted by Lord Oxburgh.

The awards celebrate the work of young people, teachers, Ambassadors and employers involved in STEMNET programmes including STEM Ambassadors and STEM Clubs. STEMNET currently has more than 21,000 STEM Ambassador volunteers across the UK who give their time and enthusiasm free of charge to inspire young people in STEM subjects and careers. Many schools run extra-curricular STEM Clubs to provide their pupils with even more opportunities to get involved with exciting STEM activities and projects, enabling them to develop further their creativity, enquiry and problem-solving skills.

The common factor amongst all STEMNET's award winners is that they demonstrate remarkable inventiveness and dedication in bringing STEM careers and subjects to life for all students. Activities range from developing an Applied Science BTEC which involved demonstrating a product's development from R&D through to commercialisation, to getting pupils to design and build a wind turbine, manufacture a new diabetes meter or even investigate the best structure for a tall jelly to enter into the Tallest Jelly Competition.

THE WINNERS OF THE FOUR AWARDS ARE:

1. **Most Dedicated STEM Ambassador Award:** Sam Whitmarsh, AstraZeneca, Bristol and Bath
2. **Most Dedicated Employer Award:** LifeScan Scotland Ltd
3. **Most Dedicated Teacher Award:** Rebekah Hodson, Blessed Edward Oldcorne Catholic College
4. **Most Dedicated STEM Club Award:** Bungay High School (Suffolk)

Yvonne Baker, STEMNET Chief Executive says: *"Encouraging all young people to achieve their potential in science, maths, technology and engineering is key, both for their future and the future of the UK as a whole. Everyone has a role to play – schools, teachers, parents, volunteers and employers. The STEMNET Awards highlight some of the very best examples of people working together to enthuse young people with the excitement and possibilities to which these subjects, and associated careers, can lead."*

The event was attended by some of the UK's most inspirational and dedicated STEM Ambassadors, teachers and STEM academics, representatives from businesses that are reliant on people with STEM skills, colleges and universities, organisations that represent and work with STEM and Members of Parliament including Andrew Miller, Chair of the Science and Technology Committee.

Yvonne Baker adds: *"The Ambassadors, employers, schools and teachers that we work with make a huge impact on how young people view STEM subjects and careers. Their passion shines through, and that enthusiasm is contagious. We would like to thank everyone who supports young people in these ways – your contribution is enormous."*

Most Dedicated STEM Ambassador

Sam Whitmarsh from AstraZeneca in Bristol and Bath, is an experienced STEM Ambassador having joined the programme in 2008. Since then he has unreservedly given up his time to support local schools. One of his huge undertakings has been to help develop an Applied Science BTEC for Bedminster Down School. He has developed an industrial case study to demonstrate a product's development from R&D through to commercialisation, which the school and pupils can apply to learning through the BTEC. Other activities have included delivering a talk on thermodynamics, sessions on drug development, judging awards and supporting events.

Other finalists included Dr Femke van den Berg from BBSRC, Genoveva Esteban from Queen Mary University of London and Dominic Trueman from Metronet.

Most Dedicated Employer Award

Part of multi-national company, Johnson & Johnson, LifeScan Scotland Ltd has a made a huge commitment to the STEM Ambassadors programme with 55 employees ranging from

Most Dedicated Employer Award: LifeScan Scotland Ltd

apprentices right up to the Executive Director of Quality Assurance acting as STEM Ambassadors. LifeScan Scotland Ltd actively encourages its staff to participate and work with local schools but before they can do so, it is compulsory for them to have gone through the STEM Ambassadors training. Ambassadors are given paid time off to attend the induction and undertake activities with schools. Activities its STEM Ambassadors undertake with local schools may range from designing and building a wind turbine to designing and manufacturing a new diabetes meter. Its work in the local community gives pupils the opportunity to be inspired by real scientists and engineers.

Other finalists in this category include Atkins Ltd, AstraZeneca PLC, BP Chemicals Ltd, Perkins Engineering Company Limited and QinetiQ.

Most Dedicated Teacher Award

Rebekah Hodson, Head of Science at Blessed Edward Oldcorne Catholic College in Worcestershire, and delivers a rich and varied programme of events and opportunities for her pupils. She also goes the extra mile by working collaboratively with other schools to share expertise and to support the development of mainstream curriculum and E&E courses. She seeks out and carefully selects the best activities to create an inspiring programme for each year group, catering for pupils of all abilities, aptitudes and interests. She has made valuable contacts with local businesses, bringing speakers into the school to enhance the teaching of the applied science courses. She also hosts STEM CPD events at the school. She has demonstrated a combination of personal commitment and leadership qualities, which have created a flourishing environment within her department, supporting activities both inside and outside the curriculum.

The other finalists for this award were Sarah Connon, Ashton Community Science College (Ribbleton Campus), Martyn Crawshaw, Millburn Academy, Inverness, and Mike Grocott, Callington Community College.

Most Dedicated STEM Club

The STEM Club at Bungay High School in Suffolk is lead by teacher, Nick Thomas. This club has shown great enthusiasm and commitment since it was set up to involve its students in a wide range of STEM activities and events. It has maintained this passion to become a thriving and ongoing part of school activity. The club has looked for ways to work on a cross-curricular basis with teachers from science, D&T and maths. At the weekly events run over the past two years they have covered a wide range of projects including bridge construction from paper and sellotape, crash test investigations into crumple zones, fingerprinting, DNA extraction, researching and mounting a remote telescope on the school roof, building and launching compressed air rockets and even investigating the best structure for a tall jelly and taking part in the Tallest Jelly Competition! They have also organised and hosted a regional STEM Club Celebration Event involving five secondary schools and activities arranged by leading employers such as EDF Energy, BT Openreach and the Unversity of East Anglia.

The other finalists for this Award were Cottenham Primary School in Cambridgeshire and King Charles I School Kidderminster.

For further information about the awards please email info@stemnet.org.uk or call 020 3206 0450.

The winners of the Most Dedicated STEM Club award from Bungay High School in Suffolk, with the Most Dedicated STEM Teacher Rebekah Hodson, from Blessed Edward Oldcorne Catholic College in Worcestershire, and the Managing Director of Brompton Bicycle Ltd, Will Butler-Adams (back centre) who supported the awards.

WATER & SOLAR POWERED PASSENGER LIFT

Designed by Matthew Lloyd Architects

Created by Matthew Lloyd Architects for the London Festival of Architecture 2010, this water and solar powered lift has been designed to raise public awareness around access and sustainability, firmly placing the key issues of inclusive design and equal access in the spotlight. The design team worked throughout with disability arts groups Architecture Inside Out and Shape to ensure that the scheme is relevant and worthwhile. Matthew Lloyd Architects also enlisted the help of the Royal Engineers in the initial design stage, partly because of their historic links to this part of central London, and partly because of their unsurpassed skill in developing swift-response, site-specific solutions.

The zero-energy lift, capable of carrying more than 350kg, uses water weights to counterbalance the lift cart, with solar panels powering the pump. In using water and solar power, one is freed from the need for a connection to mains electricity. This means the lift can be used anywhere, and can even be moved from one site to another. It also enables the lift to touch the historic steps lightly, with no mechanical fixings to the old stonework. As a Grade I listed site, the Duke of York Steps has the highest level of historic and architectural importance. The architects worked hard to create something of architectural merit, suitably responsive to the surroundings. Whereas most lifts of this nature are hidden away, the water powered wheelchair lift takes centre stage on the site. In addition to the symbolic value, the central siting gives disabled people an equal experience of going up and down the Steps, enjoying the views.

It is also important that the lift be an enjoyable attraction to the general public. This is proving to be the case, with queues forming of tourists and passersby eager to have a ride. All the mechanical innards are visible, allowing users and passersby to decipher how it works. The lift is a prototype, a radical vision of equal access; it is hoped that it will be developed into a fully sustainable lift installation, which would consist of three lifts, one on each landing, offering access to the complete staircase.

The Royal Parks (site owner), and the City of Westminster (the local authority) have kindly supported us in our quest to create this installation.

In collaboration with RIBA, Architecture Inside Out and Shape, the Royal Engineers as concept engineers, and The Royal Parks as land owners.

CONSUMER ENGAGEMENT WITH EMERGING TECHNOLOGIES

Rob Reid
WHICH?

New technologies have the potential to offer consumers many benefits, but can also raise potential risks. Effective management of these risks, particularly when faced with scientific uncertainty is essential if consumers are to take advantage of them without being put at unnecessary risk. Consumers need to be engaged at an early stage in order to ensure that technologies are developed and overseen in a way that promotes and protects their interests. But continuing controversy over genetically modified (GM) foods and limited engagement around the introduction of nanotechnologies shows a need to improve risk communication.

Emerging technologies present government and industry with a challenge when they are often beset by uncertainties. Scientists have identified multiple areas in the field of nanotechnology for example, where more research is needed[1]. Uncertainty means we may not know what the risks of a given science or technological development are, let alone how to remove or reduce them. Under such circumstances it is essential that there is effective communication and debate around how to balance potential risks and benefits and to enable consumers to make informed choices. Communication of risk has to be two way: public concerns must be understood and addressed and consumers need to be effectively informed about what the technology has the potential to offer and issues it raises.

To ensure effective risk communication, risk management and ultimately public confidence in emerging technologies, it is essential that government and industry involve the end users of the technology at the earliest possible stage of development, starting with research priorities. Unfortunately, such a strategy has not been widely adopted to date. In the case of GM foods, for example, the regulatory framework developed in response to public concern, rather than anticipating it. Similarly, there is no clear 'roadmap' for the role of nanotechnologies, despite some initial public engagement activities. The lack of information about the status of developments also makes it difficult to have a meaningful debate about the role that nanotechnologies can play. For example, the UK's voluntary reporting scheme for nano materials attracted only 13 submissions in over 2 years despite the previous government's estimate that there are over 220 companies in the UK using nanotechnologies[2].

. . . consumers need to be effectively informed about what the technology has the potential to offer and issues it raises. . .

Early engagement allows government and industry to gauge market desire for new technologies and ensure that the direction in which they develop tackles key challenges and issues for society. For instance, it has been argued that the public's reluctance to accept GM foods stemmed in part from

consumers failing to see any benefits for themselves and anger at the lack of consultation and information when products were introduced.

Some positive attempts have been made by government and institutions to involve consumer groups and the general public early on in debates over emerging technologies.

Which? was recently invited to sit on the Royal Society's Synthetic Biology Coordination Group and the Research Council's Grand Challenges research calls were also informed by a public dialogue. However, attempts to effectively engage the public on new technologies remain few and far between and there remains scepticism as to whether they have any real input to final policy. It is essential that decision-making is open, transparent and takes account of public attitudes at all stages – from ensuring the transparency of risk assessment, the way that the issues put to risk assessors are framed and how ultimately decisions about how to manage and communicate risks are decided.

Effective engagement with the public should be used to help target broad research priorities and policy development. This is not a call for the public to have direct input into specific research funding decisions or to be the sole driver in policy making, but to allow the broader research and policy agendas to be informed by the public's hopes and fears.

After all, it will be the public who decide what emergent products and services will be successful. Whilst this is not easy, the public will be required to take on complex technical ideas and hypotheses, there are precedents, such as the Engineering and Physical Sciences Research Council's (EPSRC) Grand Challenges' use of public consultations and Town meetings to help focus research calls in nanotechnology[3] and the French government's attempt at a national debate to involve citizens in the future direction of nanotechnologies[4].

. . . positive attempts have been made by government and institutions to involve consumer groups and the general public early on in debates over emerging technologies. . .

. . . Current financial constraints must not come at the expense of effective risk communication and meaningful public engagement activities. . .

Our own experience of public engagement activities around new technologies has been very positive. Our 'nano' panel held in November 2007 introduced consumers to nanotechnology and the debates surrounding its development. It clearly highlighted how people can get to grips with complex issues if they are communicated in a meaningful way.

Public engagement has to be grounded in real examples to be meaningful and transparency from industry is therefore equally important in public engagement. As a result, Which? has been calling for the introduction of a mandatory reporting scheme for companies using nanotechnology and a public database providing information to consumers on nanotechnology. This would provide regulators with a better understanding of what consumers are exposed to and help consumers make more informed decisions.

Early public engagement is therefore essential. Failure to do this would undermine the potential long-term acceptance of new technologies and services. However, if developed in line with the public interest, new technologies have the potential to grow the UK economy significantly whilst also benefiting the UK consumer.

1 *EMERGNANO: A review of completed and near completed environment, health and safety research on nanomaterials and nanotechnology*, Defra project report March 2009

2 *UK Nanotechnologies Strategy, Small Scale, Great Opportunities*, March 2010

3 http://www.epsrc.ac.uk/newsevents/cons/Pages/nano.aspx

4 http://www.debatpublic-nano.org/index.html

ECTON MINE - FROM COPPER-BOTTOMED SHIPS TO A-LEVEL CHEMISTRY

Dr Stephen Henley FGS, FIMMM, CEng

Webmaster for P&SC and for EMET

The outdoor laboratory at the G A Cox field studies centre, Ecton

The student smiled with surprise and pleasure when she lifted an iron nail out of the solution, covered with a pink sheen of newly deposited metallic copper. This morning she had collected the piece of ore from which she herself had extracted this copper. This is a typical scene at the outdoor laboratory of the Ecton Hill field study centre, where courses are provided for students of chemistry, geology, and many other subjects.

Chemistry tutor Bill Whitehead explaining transition-metal chemistry

Ecton Hill, on the Staffordshire/Derbyshire border, at the south-western margin of the Peak District, is the location of a mining enterprise which in its late 18th century heyday provided much of the copper needed by the Royal Navy. Ecton was the major UK source of copper in the 1760s-1780s, and was the deepest mine in Britain.

Today its industrial history is all but forgotten and it lies within one of the most attractive parts of the Peak District National Park. However, there is ample well-preserved surface and underground evidence of Ecton's past, and its mineralogical riches and unique geological setting provide the basis for a very 21st century approach to teaching, from junior school to university level and beyond.

Although the workings below river level are now flooded, those above are still accessible and contain much of geological and archaeological interest (recent research has demonstrated that the ore deposits were worked as long ago as the Bronze Age). On the hilltop there is the building which housed one of the first Boulton and Watt steam engines. This and many of the other surface features across the hill have been designated a Scheduled Monument. The mine workings themselves are also a national Site of Special Scientific Interest (SSSI).

The Ecton Hill mines and the associated field studies centre are owned by the Ecton Mine Educational Trust (EMET), set up in 2005 after the death of Geoff Cox, the previous owner, who had developed them as an educational resource. This charitable company, under the chairmanship of John Bramley, a retired engineer and former mine manager in the Peak District, works closely with the Ecton Hill Field Studies Association (EHFSA) to provide a wide range of courses.

The chemistry A-level course, for example, typically consists of a one-day, 10 am – 4 pm, intensive sequence of activities. Normally two tutors run each day, with a maximum of 30 students with their teachers, usually from two schools or colleges. After an initial briefing at the centre, during which some background to mining at Ecton is introduced, the party set off up Ecton Hill to the engine house. Nearby the party inspects the hole where the main Ecton ore-body originally outcropped at surface, before walking on over the hill to mine dumps which offer a rewarding opportunity to collect mineral specimens. These are taken back to the centre where, in the outdoor laboratory, wet chemical analysis techniques are used to identify the compounds in them. There is a further practical session on mineral separation techniques and the science behind them, and finally, as a climax to the day, an underground tour into Salt's Level in Ecton Mine.

EMET receives no public funding but has had financial support from the Royal Society of Chemistry, the Institute of Materials, Minerals and Mining, the London and Southern Counties Minerals Industries Institute (MinSouth), and the Mineral Industry Education Trust, as well as corporate members Anglo American plc and Rio Tinto plc, and much of the work of EMET is carried out by volunteers. As the Trust is responsible for all of the infrastructure, it has ongoing responsibilities for the safety of the 40 shafts and mine adits around Ecton Hill, as well as for the study centre itself.

The Trust remains vulnerable to any cuts in educational funding for what may be perceived as non-core extramural activities. However, if the UK's future is dependent upon the enthusiasm and achievements of its scientists and engineers, then such courses are absolutely essential in providing a link between textbook learning and the real world.

For more information, visit www.ectonmine.org

OBITUARY

Brian Flowers, one of Imperial's longest-serving and most popular Rectors, whose contributions formed the building blocks of the modern College, has died at the age of 85.

Lord Flowers, a physicist, led Imperial for twelve years from 1973 with the ambition to make a good institution even better. Speaking before the College's centenary in 2007, Flowers said that being Rector of Imperial was the pinnacle of his career, one which spanned the worlds of science, academia, politics and public service. He is survived by his wife, Mary.

A passionate supporter of UK universities, serving also as Chairman of the CVCP (now Universities UK), Vice Chancellor of the University of London and Chancellor of the University of Manchester later in his career, Flowers laid the foundations of the modern College during his term as Rector. He set priorities that remain core to its teaching and research today, while recognising that success for the College was in the hands of its staff and students, whom he described as "a very likeable bunch of people, a very clever bunch of people too."

CHARTING A NEW COURSE: INTERDISCIPLINARY RESEARCH AND TEACHING

Lord Oxburgh, who led Imperial from 1993-2000, hailed Brian Flowers as a giant among Rectors, praising his vision for consolidating engineering and physical sciences at the College. Flowers' approach focused on building strong links between subject areas, which led to the establishment and development of interdisciplinary teaching and research activities at Imperial.

Lord Flowers' enthusiasm for the opportunities offered by collaborations across scientific disciplines, fuelled during his time as Chairman of the Science Research Council from 1967-73, led him to found the Centre for Environmental Technology in 1976, which brought together environmental research at the College. The new Centre allowed Imperial to take the lead in providing technological solutions to environmental problems – a path which the College continues along today through the work of the Centre for Environmental Policy, the Energy Futures Lab and the Grantham Institute for Climate Change.

Sir Gordon Conway, who was the first Academic Director of the Centre for Environmental Technology and is now Professor of International Development in the Centre for Environmental Policy, paid tribute to Brian Flowers as a tough, principled and very wise Rector who gave his full backing to plans for the Centre for Environmental Technology when first mooted in 1975.

Describing Lord Flowers' philosophy behind the development, Sir Gordon said: "He faced down those in the silos who disliked cross-disciplinary activities. I remember one comment at a Senate meeting when a professor accused us of peddling 'pap for popinjays.' Brian would have none of that kind of ignorant prejudice. He was convinced from his experience on the Royal Commission on Environmental Pollution that environmental education and research ought to be a central concern of the College. He also rightly insisted that the Centre should focus on postgraduate rather than undergraduate education. He came up with the name of the centre and he and the Pro Rector, John Sutton another sorely missed colleague, devised a fair and sustainable budget formula for us. He even found time to come and give lectures on the course – impeccably crafted and delivered lectures that were clear and well balanced."

Keen to modernise the university culture, Brian Flowers ended the custom of using titles and surnames to address professors and heads of department. He also introduced a democratic approach to appointing heads of department, establishing staff committees that were consulted on the best candidate to lead the department and encouraging all members of the department to write to him in strict confidence with proposals. Physicist Sir Peter Knight, now Deputy Rector (Research) at Imperial, who was recruited to the College by Lord Flowers in 1979 and led his department's non-professorial staff committee when a lecturer, explains: "He wanted to hear a groundswell of opinion from all staff in a department – not just the professors – and was particularly keen to seek the views of the next generation who would shape the department's future."

Attuned to industrial trends, Brian Flowers drove the modernisation of undergraduate courses, recognising the importance of training students for their future careers. Engineering courses were developed to provide students with greater industrial experience and, aware of the increasingly important role of information technology, under Flowers all departments were asked to teach computing skills.

During Flowers' time as Rector the College's research and teaching activities focused on science and engineering, and there were Nobel Prizes for Geoffrey Wilkinson in 1973 and Abdus Salam in 1979, but his vision of a new framework for medical education in London led to one of the most significant developments in Imperial's history – the integration of a number of medical schools with the College. His report, commissioned by the Vice Chancellor of the University of London and published in 1980, proposed the merger of a number of the many free-standing undergraduate medical schools and their amalgamation with multi-faculty colleges.

John Davidson, Personnel Secretary at the College from 1974 to 1989, explains the two strands to Flowers' thinking: "The first was that the medical schools were too small to be viable when funding was being reduced and secondly that it was highly desirable in the latter part of the twentieth century that the London medical schools should have a much closer association with institutions which had basic science departments. Although all of Brian's proposals were not enacted precisely as proposed the present structure of medical education owes a great debt to him."

In 1971 the College conferred upon him its highest honour, the Fellowship of Imperial College.

Lord Flowers often commented that his wife shared his job. Together they sought to catalyse good social relationships with and between students. They were renowned hosts of a twice-termly 'beer and bangers' parties inviting large numbers into their residence at 170 Queen's Gate. Speaking in 2006, Lady Flowers recalled:

"Once we found the sausages were going rather fast and I had to keep on sending down to the kitchen for more. Then I realised that there was a competition afoot as to who could sink the most sausages, and we got wise to that and found the culprits and rationed them!"

In return, Imperial College Union threw its own party for the Flowers at the end of his Rectorship, culminating in a celebratory trip around west London in Bo', a veteran car dating from 1902 owned and cared for by engineering students at Imperial.

"This we carried out to the considerable consternation of the police, who fortunately had a sense of humour and rubbed their eyes in disbelief and waved us on," Lord Flowers later remembered. "That was a great and jolly occasion, and a very nice gesture on the part of the students."

Lynda Davies, who worked as Lord Flowers' PA from 1978-1984, describes his open door policy: "As a young arts graduate I was barely older than most Imperial students, so there was a lighter touch in the office, less stuffiness. We had an 'open door' policy. Anyone could make an appointment to see the Rector. Staff, students, union representatives, parents and alumni – all were treated with the same courtesy and good humour, combined with

common sense. That approach was very novel and much appreciated."

Born in September 1924, Lord Flowers studied physics and electronics at Cambridge, before working as part of an Anglo-Canadian project codenamed Tube Alloys focused on nuclear weapon development during World War II. After the war he continued his research at the Atomic Energy Research Establishment at Harwell, becoming Head of Theoretical Physics in 1952 and pioneering computing methods to solve problems relating to the nuclear structure. He was elected a Fellow of the Royal Society in 1961 at the age of 36.

He went on to hold academic posts in the Universities of Birmingham and Manchester, before taking up the post of Rector at Imperial in 1973 and then Vice Chancellor of the University of London between 1985 and 1990.

While Vice Chancellor of the University of London, he became known for making extensive notes during committee meetings. Sir Peter Knight said: "There was a quite a bit of speculation about why Brian was making so many notes and apparently carefully writing down every word. People thought that maybe he didn't trust the minutes. Later, when his textbook on computer programs came out, it all became clear."

In the preface to his 1995 textbook *An introduction to numerical methods in C++*, Lord Flowers confessed: "It was an enjoyable hobby, and immensely relaxing during interminable committee meetings, to write snippets of programs which could later be tried out at home, and was less visible to one's colleagues than other portable pastimes, such as wood carving or taking snuff".

During his time as Rector, Flowers chaired the Royal Commission on Environmental Pollution, and served as the chairman of the Committee of Vice-Chancellors and Principals, now known as Universities UK, the umbrella body for all UK universities. For six years he was president of the European Science Foundation, and as Rector he also began routine visits to south east Asia and Japan to promote the College overseas, helping to develop the College's international standing significantly. He was made an Officier of the Legion d'Honneur in 1981 – an honour of which he was extremely proud.

In addition to his high profile in science and academia, Lord Flowers is also notable for being one of the founding members of the Social Democratic Party, created in 1981. When first asked by Dame Shirley Williams, one of the "gang of four" that created the party, to leave the independent cross-benches of the House of Lords and join them, he declined. He later recalled that "two days later I rang her up and said 'I've been looking at my face in the mirror and I can't stand the sight of it; do you mind if I change my mind and join?'"

He was knighted in 1969 and made a life peer in 1979, when he became Lord Flowers of Queen's Gate, the London street on which he lived as Rector.

After leaving the University of London he became Chairman of the House of Lords Select Committee on Science and Technology, and was fondly remembered as a parliamentarian by Lord Winston, Professor of Science and Society at Imperial, when he subsequently became chair of that committee himself. Paying tribute, Lord Winston said: "Brian was an extraordinary force, full of trenchantly-held but very sound ideas." He was also a longstanding Member of the Parliamentary and Scientific Committee.

Lord Flowers is remembered as a Rector who nurtured the strengths of staff to build a better College. His approach to leadership gained him respect as John Davidson describes: "Brian was a delight to work with because he was honest and straightforward. He was also a bit puritanical in certain respects. I never remember him asking for any benefits for himself in terms of furnishings and accommodation in 170 Queen's Gate in his 13 years as Rector and one of his earlier acts was to get rid of the Imperial College chauffeur-driven car and acquire a bus pass!"

NEW REPORT REVEALS PUBLIC'S VIEWS ON SYNTHETIC BIOLOGY

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A major new public dialogue activity on the public's views and attitudes on synthetic biology has revealed that most people are supportive of the research but with conditions on how and why it is conducted. Synthetic biology seeks to apply the principles of engineering design to biological systems and processes. Scientists believe that it may lead to new applications, such as novel systems for energy and chemicals production, medical therapies, biological computers and innovative ways to clean up hazardous waste. The findings were published on 14 June at an event in London to launch the report of Synthetic Biology Public Dialogue. The Dialogue process began late last year and included workshops with the public and interviews with interested parties.

HIGHLIGHTS OF THE FINDINGS INCLUDE:

- The public see significant opportunities from the application of synthetic biology and hope that it could help society to address major challenges such as climate change, energy security and serious diseases.
- There is uncertainty about what synthetic biology will lead to and where it is going. There are also concerns that it may be progressing too quickly when the long-term impacts are unknown.
- The public are keen to see effective international regulation and control of synthetic biology, particularly concerning the uncontrolled release of synthetic organisms into the environment.
- The motivation of scientists in this field is important. The public are concerned that curiosity-driven researchers may proceed too quickly and they must consider the wider implications of their work.
- The Research Councils were also seen to have a clear role in developing the capabilities for scientists to think through their responsibilities in this new area of research

The Synthetic Biology Public Dialogue was commissioned and funded by the two UK Research Councils responsible for funding and strategy for synthetic biology - the Biotechnology and Biological Sciences Research Council (BBSRC) and the Engineering and Physical Sciences Research Council (EPSRC) - with support from Sciencewise Expert Resource Centre. The Dialogue report will now be considered by the two Research Councils who will include its findings in their strategic planning on future funding and policy around synthetic biology. As synthetic biology is in its early stages it will be important to ensure scientists have continued dialogue with the public to make sure its development reflects wider public concerns and aspirations.

Professor Douglas Kell, BBSRC Chief Executive, said: "We fund research that has the potential to bring significant benefits to everyone's quality of life. Biological products and processes are at the very heart of our existence, and have been so since ancient times. Synthetic biology is one of many promising areas of modern biology in which research has the potential for massive economic and social benefits. However, we must and shall not lose sight of the wider implications of our science, including in potentially controversial areas such as synthetic biology. Talking to the public about their hopes, concerns and aspirations gives us an opportunity to ensure that our science strategies do not diverge from what society thinks. I hope this dialogue will be the start of an ongoing conversation around synthetic biology"

Professor Dave Delpy, EPSRC Chief Executive, said: "Synthetic biology has made considerable advances in recent years and could offer solutions to some of the big challenges of our time. EPSRC believes that engineering has a crucial role to play in developing synthetic biology for

the benefit of the UK, and has made significant investment in support of this emerging research field. Research cannot and should not exist in a vacuum, oblivious to public perceptions and concern. We recognise the need to understand fully the public's views and attitudes on synthetic biology in order to reflect these in our strategies and policies. We see the need for our researchers to show responsibility for the societal implications of their work and engage with this debate."

The Synthetic Biology Public Dialogue involved members of the public in discussions around synthetic biology and included specialists on the science, governance, application and control of this emerging area of science and technology. The Dialogue was conducted under contract by TNS-BMRB under the supervision of independent oversight and steering committees. Both committees were chaired by the independent consultant Brian Johnson. 160 members of the public were engaged in the process, through three workshops which took place in London, North Wales, Newcastle and Edinburgh. 41 stakeholder interviews were also conducted.

BBSRC is the UK funding agency for research in the life sciences. Sponsored by Government, BBSRC annually invests around £470 million in a wide range of research that makes a significant contribution to the quality of life in the UK and beyond and supports a number of important industrial stakeholders, including the agriculture, food, chemical, healthcare and pharmaceutical sectors. www.bbsrc.ac.uk

EPSRC is the main UK government agency for funding research and training in engineering and the physical sciences, investing more than £850 million a year in a broad range of subjects - from mathematics to materials science, and from information technology to structural engineering. www.epsrc.ac.uk

BBSRC and EPSRC are part of the Research Councils UK partnership (RCUK) www.rcuk.ac.uk

Sciencewise - ERC is a Department for Business, Innovation and Skills funded programme to bring scientists, government and the public together to explore the impact of science and technology in our lives. It helps policy makers in Government departments and agencies commission and use public dialogue to inform decision making in emerging areas of science and technology. Its core aim is to develop the capacity of Government to carry out good dialogue, to gather and disseminate good practice, have successful two-way communications with the public and other stakeholders.

LETTER TO THE EDITOR

The curious way that Parliament works is a mystery to most of the world, especially to incoming members! After a series of recent meetings covering the P&SC, POST, Pitcom, APComms and others I was asked about the history of some of these bodies. That caused me to check with the Library to remind myself of the link between the P&SC and POST.

In 1939 the Parliamentary and Scientific Committee (P&SC) was formed. In 1986 the P&SC determined the need for a new institution and sent a delegation to the then Prime Minister to suggest that some form of resource be established: the idea received a warm reception, but no public funding was forthcoming.

As a result of that dialogue the Parliamentary Office of Science & Technology (POST) commenced operation as an independent entity in April 1989. At that time it received four years' pilot funding from a group of foundations: the Nuffield Foundation, the Gatsby Foundation, the Leverhulme Trust, the Wellcome Trust, the Royal Society, the Fellowship of Engineering, plus some individual Members.

An information Committee report from 4th March 1992 recommended that POST be funded for three years from April 1993 (the point when the pilot funding was to end), and that public funding be reconsidered at that time. According to the House of Commons Commission report of 1995-96, funding was renewed for 5 years in April 1996.

The House of Commons Information Committee (one of the then domestic committees), on which I served in the 1992 and 1997 Parliaments recommended the incorporation of POST into the House services.

As I am the sole surviving link in the Commons to this process I thought I should set out the record before it is all lost in the mists of time!

Andrew Miller MP

Chair, Parliamentary and Scientific Committee.

NEW GOVERNMENT, NEW PARLIAMENT, NEW PEOPLE, SAME ISSUES

Paul Davies
Head of Policy

THE IET

The electorate spoke, the parties discussed, the coalition was formed. A remarkable change has occurred in how the UK is governed. Just as remarkable was the number of new MPs elected to Parliament, with over a third of MPs being replaced. So the UK now has a new type of Government and Parliament is buzzing with newly elected Members. What else has changed?

Unfortunately the problems facing the country haven't changed and the need to solve them in a timely and efficient way has never been so important. Engineering hasn't changed and is still at the heart of raising living standards and solving problems. What has changed is the way in which the profession engages with Government and Parliament. Over the past two years, the profession has taken to heart the criticism it received from the Innovation, Universities, Science and Skills Select Committee that the sheer number of engineering institutions was a barrier to government engagement. The profession has been working actively to form an alliance to offer a single voice and point of contact for Government and Parliament. Running under the banner Engineering the Future (EtF), the alliance is made up of Royal Academy of Engineering, Engineering UK, the Engineering Council, the Institution of Engineering and Technology, the Institution of Mechanical Engineers, the Institution of Civil Engineers, the Institution of Chemical Engineers and the Institute of Physics. The alliance represents a joint membership of over 450,000 professionals.

Engineering the Future seeks to co-ordinate the profession's work with government, for example with joint consultation submissions and interactions with Government departments on specific issues, such as the adaptation of infrastructure to climate change. EtF also engages with Parliament. With such an influx of new blood into Parliament, EtF thought that it would be useful to run a parliamentary event, providing MPs with an opportunity to be briefed on engineering's role in the UK and how EtF can help them.

The briefing took place on the rather warm morning of the 30th June in Westminster Hall. All MPs were invited and around 40 MPs and Peers registered an interest in attending. The briefing was hosted by Prof. Christopher Snowden, President of the IET and Vice-President of the Royal Academy of Engineering, with speeches by Andrew Miller MP and Kate Bellingham, the National STEM Careers Coordinator.

During his opening speech Andrew Miller emphasised the need to include the engineering community in relevant policy discussions. Observing previous examples of policy where engineers were not consulted, such as the development of eco-towns, Mr. Miller said: "Engineering advice is of great relevance to parliamentarians. Expertise must be sought, valued and used by the cabinet." Professor Snowden reiterated the value of involving the engineering community in policy discussions at an early stage, saying: "Engineering advice has historically not been sought early enough in the policy process. Regrettably governments are still learning to take engineering and science expertise on board. We need to develop a stronger dialogue between engineering and Parliament and continue to reinvigorate interest and understanding amongst parliamentarians."

Speaking on a related issue, Kate Bellingham highlighted the need to encourage more young people into engineering to ensure that the country had the right skills for the future. Engineering has long suffered from a poor image, with a subsequent knock on effect on recruitment. It is often seen as a poorly paid, unattractive profession; however the reality is far different. Engineering offers a broad, creative and exciting career and a recent survey revealed that four out of the top ten highest graduate salaries are in engineering subjects. Ms Bellingham noted: "In schools we must reinforce the message that science and maths open doors and reinforce the positive and sometimes hidden messages about engineering. Engineering is vital to the future of the UK." She challenged MPs to promote the positive aspects of a career in engineering to their constituents.

It was good to see that a number of the new MPs attended the briefing and many people commented on how engaged the MPs were on key topics, ranging from local issues such as engineering employment and training to the big national problems such as energy and transport. The problems may be old, but this is the beginning of the engineering profession's fresh engagement with the new Parliament to demonstrate the importance of engineering to the UK.

SCIENCE, INNOVATION AND THE ECONOMY

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

ROYAL INSTITUTION, LONDON
9 JULY 2010

It may not have been a great Summer for football but it has certainly been a great Summer for science. The Royal Society has celebrated its 350th anniversary in great style with a display on the South Bank that showcases pioneering British science. The BBC has been doing a fantastic job, from Martin Rees's Reith Lectures on radio to Michael Mosley's "The Story of Science" and Brian Cox's "Wonders of the Solar System" on television. Exciting and accessible science books are spread out across the tables at Waterstones. And here, at the Royal Institution, you've been highlighting the potential of nanotechnologies – as well as holding lectures on the measurable shortcomings of the England football team.

So to be science minister is an extraordinary privilege for me. Indeed, so much is going on that it's not possible for me to cover every significant issue in science policy in this, my first major science speech. There are areas which we can only really advance once the comprehensive spending review has been concluded. I can assure you of my commitment to the dual support system and the Haldane principle, and I hope to reflect further on both in another speech. I do believe in concentration on excellent research – and excellence is to be found in individual departments. To take this particular debate further we have to be clear about the conditions in which excellence actually thrives and how much research funding we will be able to distribute.

Most importantly, I recognise my deep responsibility to the scientific community in these austere times. Good things were achieved over the past decade and I salute the achievements of David Sainsbury, for example. But the Government was borrowing too much, even before the Crash. It was a debt-driven boom. It never was sustainable but, as so often, it took a recession to reveal the uncomfortable truth. Whichever party won the last election would have had to face difficult decisions. The previous Government left no long-term spending plan – only a commitment to save £600m from the Higher Education, Science and Research budgets by 2012-13, without specifying where these savings came from.

I recognise that countries like the US, Canada and France have reacted to recession by spending more on science. But their public finances are in much better shape than ours. The US government's deficit as a percentage of GDP in 2009 was 10.2 per cent. Canada's was two per cent, France's six per cent, Germany's 1.6 per cent. Ours was 11.1 per cent. And when I meet ministers from other governments at the EU Council on Competitiveness and Research, they are just as preoccupied with saving money as we are. That is why the cost of the ITER programme for nuclear fusion was the top concern of fellow minsters at the last meeting. These are austere times for us all. But this Government wants science to emerge from this period to be strong, sustainable and effective. Vince Cable and George Osborne both understand the key role of science, technology and innovation in rebalancing the economy.

I am an optimist about science's capacity to do this, because the deep forces driving its growth and popularity are as powerful as ever. A very important stimulus for scientific

advance is, quite simply, technology. We talk of scientific discovery enabling technical advance, but the process is much more inter-dependent than that. For example, imaging technology is driven by the demands of astronomers, and then enables those same astronomers to make new discoveries. It's because of this process that we've been able to view this week those awe-inspiring images of the oldest light in the cosmos, gathered by the Planck space telescope. Meanwhile it allows medical imaging to advance along the way, almost as a by-product of our age old desire to look into the heavens.

In my speech at Birmingham University in May, I spoke of links between the academic and the vocational, the conceptual and the physical. We are not always good at this – we have world-class particle physicists at the Large Hadron Collider but sadly not many British engineers helped to build it. But there are other areas where these links between British science and technology are stronger. We not only have distinguished astronomers, but it was scientists and engineers at Cardiff University who produced the Spectral and Photometric Imaging Receiver for Herschel and Planck. This combination of scientific research and technological advance creates extraordinary dynamism, both intellectual and commercial. I see it as one of my tasks to strengthen these links. That is why one of my ambitions is to try to ensure that the exciting intellectual advance of nuclear fusion – we are world leaders at Culham – also drives British technological and industrial development.

This does not just apply to the natural sciences but to social sciences too. Howard Davies is right to remind us of their importance. I'm encouraged by the progress we're making in understanding human behaviour. Understanding social mobility, individual well being, stable families: these are challenges where strong social science can really contribute. My own recent book, *The Pinch*, on fairness between the generations drew on insights from neuroscience, evolutionary biology and game theory. The birth cohort studies of 1958 and 1970, reinvigorated by the millennium cohort study, have fundamentally shaped the debate about social mobility in Britain. Well being is a hot topic in Whitehall at the moment. We just held a valuable seminar in my department, with contributions from health experts, social scientists, psychologists and economists.

. . . I recognise my deep responsibility to the scientific community in these austere times. . .

. . . In the Coalition Agreement, we have undertaken to create a new right for the public to request government-held datasets . . .

More broadly, as society becomes more diverse and cultural traditions increasingly fractured, I see the scientific way of thinking – empiricism – becoming more and more important for binding us together. Increasingly, we have to abide by John Rawls's standard for public reason – justifying a particular position by arguments that people from different moral or political backgrounds can accept. And coalition, I believe, is good for government and for science, given the premium now attached to reason and evidence. We have already offered a science induction for new MPs, and ensured that the principles of scientific advice to government are referred to in the new ministerial code. In addition the Government's Chief Scientific Adviser, Sir John Beddington, has updated his guidelines on the use of scientific and engineering advice in policy making.

You might say that science is doing so well in the public sphere that the greatest risks it faces are complacency and arrogance. Crude reductionism puts people off. Scientists can morph from admired public luminaries into public enemies, as debates over nuclear power and GM made clear. And yet I remain optimistic here too. The UK Research Councils had the foresight to hold a public dialogue about ramifications of synthetic biology ahead of Craig Venter developing the first cell controlled by synthetic DNA. This dialogue showed that there is conditional public support for synthetic biology. There is great enthusiasm for the possibilities associated with this field, but also fears about controlling it and the potential for misuse; there are concerns about impacts on health and the environment. We would do well to remember this comment from a participant: "Why do they want to do it? … Is it because they will be the first person to do it? Is it because they just can't wait? What are they going to gain from it? … The fact that you can take something that's natural and produce fuel, great – but what is the bad side of it? What else is it going to do?" Synthetic biology must not go the way of GM. It must retain public trust. That means understanding that fellow citizens have their worries and concerns which cannot just be dismissed.

Transparency is part of the answer. In the Coalition Agreement, we have undertaken to create a new right for the public to request government-held datasets – information which will be published in an open and standardised format for ease of use. The controversy over climate change data at the University of East Anglia has really highlighted the importance of this measure. We must, of course, have due regard to personal privacy, the opportunity

to commercialise research, and national security – but, otherwise, scientific enquiry depends on practitioners being able to test and challenge both methods and results. I have already had some fascinating discussions with Tim Berners-Lee and Nigel Shadbolt about how we might boost data sharing.

This argument for transparency and openness is actually the best protection for science. We cannot, for example, have writers facing libel charges because they offer a scientific critique of other people's claims. This is an issue which I have raised with Ken Clarke, the Lord Chancellor, and which his department recognizes they must address.

So science is an ever stronger voice in the national conversation. For the rest of this speech, I want to focus primarily on the economic case for investment in science and research. In trying to link these grandiose arguments with economic returns, I'm reminded of a rather pompous Oxford don who recommended the study of Greek literature to his Victorian undergraduates, because it "not only elevates above the vulgar herd but leads not infrequently to positions of considerable emolument." And especially when money is tight, emolument matters. Public spending on science, just like everything else, has to stand up to rigorous economic scrutiny. Let's consider some of the most frequently used arguments.

The first relates to the benefits – often unanticipated – which accrue from blue skies research. Few scientists are as sure of their purpose as that man encountered by Gulliver, who was "eight years upon a project for extracting sunbeams out of cucumbers, which were to be put in phials hermetically sealed, and let out to warm the air in raw inclement summers." The man had no doubts about impact. As he told Gulliver, "he did not doubt, that, in eight years more, he should be able to supply the governor's gardens with sunshine, at a reasonable rate", and was desperate for additional funding "as an encouragement to ingenuity, especially since this had been a very dear season for cucumbers."

Margaret Thatcher was more circumspect when she wrong-footed sceptical Cabinet colleagues with her defence of public spending on the Large Hadron Collider. "Yes, but isn't it interesting?" was enough to stifle their objections. And her interest in the work at CERN was rewarded by Tim Berners-Lee establishing the groundwork for the World Wide Web. I've seen the original computer server with a note from Tim attached, instructing fellow scientists not to switch it off. Our lives have truly been revolutionised by his inventiveness.

> . . . Margaret Thatcher's interest in the work at CERN was rewarded by Tim Berners-Lee establishing the groundwork for the World Wide Web. . .

> . . . The surprising paths which serendipity takes us down is a major reason why we need to think harder about impact. . .

The surprising paths which serendipity takes us down is a major reason why we need to think harder about impact. There is no perfect way to assess impact, even looking backwards at what has happened. I appreciate why scientists are wary, which is why I'm announcing today a one-year delay to the implementation of the Research Excellence Framework, to figure out whether there is a method of assessing impact which is sound and which is acceptable to the academic community. This longer timescale will enable HEFCE, its devolved counterparts, and ministers to make full use of the pilot impact assessment exercise which concludes in the Autumn, and then to consider whether it can be refined.

We can also learn from elsewhere. For instance, there are some interesting developments underway in the United States, where the Star Metrics initiative is seeking to track the science dollars pumped into universities through the recovery programme and will then trace their impact on the broader economy. My department and the Research Councils are monitoring progress on this front.

But let's go back to those arguments for science. The previous government appeared to think of innovation as if it were a sausage machine. You're supposed to put money into university-based scientific research, which leads to patents and then spinout companies that secure venture capital backing. The mature business provides tax revenues for the Government, jobs for the local area, a nice profit for the university, perhaps with Porsches in the departmental car park. It sounds very attractive and it does happen – Imperial Innovations has been a great success. But it's too neat and tidy an account of scientific and commercial progress. The world does not work like this as often as you might think. And that is not our failure – it is a gap in that whole picture of innovation. Indeed it may actually have had the perverse effect of an exaggerated focus on IP and spinouts. On average the amount that universities generate from commercialising their IP (through licenses and selling stakes in spinouts) is less then 3 per cent of their total income from business and charities. Two Cambridge firms, ARM Holdings and Autonomy Corporation, are now in the FTSE100, but their route was more via mobility of researchers than via conventional spin outs. There are many other ways of harvesting benefits from

research. But the benefits are real.

For example, I'm a firm believer in clusters – best defined as a low-risk environment for high-risk activity. I think of places like Dundee, where, according to the city council, some 350 computer game and creative industries companies are based around Abertay University. The area around Dundee is now home to about three quarters of all British jobs in computer game development. At the same time, Dundee has made a name for itself in life sciences, where first-rate research has attracted significant investment from multi-national businesses.

But that's not the end of the story. There are other issues as well. Consider the spur of national pride – the pride, so to speak, of planting our flag on Everest first. There are, of course individuals – whether Olympic medallists or Nobel prize winners – whose achievements can be regarded as a vivid reflection of the health of the country that produced them. We all take pride in them. There's certainly nothing wrong with wanting to achieve something for your country. And fame, competition and pride are human motives that we find in every walk of life. But none of this is an economic argument for being the first person to make a scientific discovery. Why does it matter **economically** that we should be first or that something should be discovered by a Brit? What exactly is the **economic** problem if the next scientific discoveries originate overseas, rather than here?

I think that the answer is that we need enough good science so we have the capacity to tackle a new problem, to react effectively to scientific breakthroughs however or wherever they may arise, and to capitalise on those breakthroughs via research programmes and business initiatives of our own. Some 95 per cent of scientific research is conducted outside the UK. We need to be able to apply it here – and, in advanced scientific fields, it is often necessary to conduct leading-edge research in order to understand, assimilate and exploit the leading-edge research of others. It is this absorptive capacity which is crucial. Indeed, Griffiths, Redding and Van Reenen have shown that higher domestic business R&D spend also leads to greater productivity being generated at home from foreign R&D spend as well. And there are powerful feedback mechanisms on top of this – foreign companies cite the quality of the public research base as one of the main reasons for locating their own internationally mobile R&D here.

Now, this is, of course, something that we do already – yet the widespread notion is quite different; that the British invent and then fail to execute. On the contrary, the first model for computer tomography arose in South Africa, but the first CT scanner was made here in the UK. The ozone layer was discovered by French physicists, but UK scientists devised a way of measuring it, while members of the British Antarctic survey found a big hole in it.

. . . The area around Dundee is now home to about three quarters of all British jobs in computer game development. . .

. . . in advanced scientific fields, it is often necessary to conduct leading-edge research in order to understand, assimilate and exploit the leading-edge research of others. . .

Government backing for research does make economic sense. I was particularly interested to read the recent Imperial College Discussion Paper by Jonathan Haskel and Gavin Wallis, *"Public support for Innovation, Intangible investment and Productivity Growth in the UK Market Sector"*. It shows particularly strong spillover benefits from R&D spend on research councils. It shows a positive return from other forms of R&D too, but the spillover benefits seem to be greatest from the research councils. This is interesting evidence that research council spend is doing the job it should be doing – generating wider benefits across the economy as a whole. And the fact that one of the authors is a Treasury official only adds to its value!

These arguments about clusters, about absorptive capacity and the importance of basic research have already led me to a number of conclusions about the role of government in supporting science and innovation. I can't talk about levels of investment – that must await the CSR – but I do want to share my thinking on policy direction.

First, it makes sense for government to back shared facilities – research platforms if you like – which private companies could not develop on their own. So I'm delighted that a state-of-the-art laboratory is opening today at the Harwell Science and Innovation Campus in Oxfordshire. The new £26million lab is next to the Diamond Light Source, the ISIS neutron source and the Central Laser Facility. It will allow researchers to work side-by-side with beam line experts in fields ranging from drug development to novel materials. (They might even find that the most important room on the site is the coffee bar, as at the Hauser forum in Cambridge.) To date, experimentation at Diamond alone has helped firms like Rolls Royce to apply synchrotron techniques for aerospace and energy applications; Pfizer and GlaxoSmithKline on drug discovery and development; Johnson Matthey on improved

. . . Skynet is an example of smart public sector procurement. . .

emissions control catalysts. This is how publicly backed R&D boosts economic performance – one OECD study found that a 1 per cent increase in public R&D increased overall productivity by 0.17 per cent.

I'm similarly keen on pursuing further programmes along the lines of Skynet, the UK's single biggest space project system and the provider of secure satellite tele-communications for Britain's armed forces. With Skynet, the Ministry of Defence purchased a service, and requests further capability as necessary, but does not own the hardware. Instead, Astrium can sell spare bandwidth to other government departments and friendly states, thereby reducing MoD costs. Skynet is an example of smart public sector procurement. Instead of buying a satellite, the MoD bought a service and created a commercial opportunity at the same time. Spending about £220 billion pounds annually, it's vital that the public sector uses that purchasing power effectively. There is a lot more that we can do here both to back SMEs and to back innovation. A purchasing contract can be as effective a way to get money to an innovative small business as a grant or a capital investment: this is particularly important at times when banks are so reluctant to lend.

The economist Daron Acemoglu has shown how demand is sometimes aggregated or mediated through Government, as with defence or (in the UK) healthcare. In these cases the procurement decisions of Government can have important intended or unintended consequences for innovation. ARM Holdings, whom I mentioned earlier, started life as a collaboration between Apple and Acorn, the makers of the BBC micro computer. A BBC contract was crucial in its expansion to become producer of the world's most widely-used 32-bit microprocessor family. We must get better at stimulating businesses through this route so that other small firms can be helped on the road to similar success.

So far I have identified publicly funded research facilities and better public procurement. A third option worth exploring is public competitions for new technologies. Many of you will recall the stir caused by John McCain during the 2008 US presidential race, when he proposed a $300 million prize for battery technology to bring plug-in hybrids & fully electric automobiles into commercial use. It was criticised at the time in the *New Scientist* and elsewhere because it did not reflect the lessons that had been learnt on the best design of such prizes. Economic analysis can teach us a lot here. His idea has impressive antecedents in this country. As we know from Dava Sobel's bestseller *Longitude*, inventors earned more than £100,000 through terms set out in the Longitude Act of 1714, including £14,000 to John Harrison for his work on chronometers over the course of three decades.

In the early twentieth century, teams competing in the Schneider Trophy for seaplane development sometimes received money from the government, as well as RAF pilots on loan. Advances in aerodynamics and low-drag, liquid-cooled engines then contributed to the effectiveness of the Spitfire. A US firm, InnoCentive, runs what has been called an eBay for innovators in which companies set out problems which their network of 200,000 registered experts solve for a fee. One appraisal showed a third of problems which originators could not solve were solved by an outside expert who might be from a different discipline. And separately, the charity, the X Prize Foundation, identifies bigger challenges for which it sets a prize: it has driven innovation in sub-orbital space flight – including with our very own Richard Branson's Virgin Galactic. These sorts of networks are fundamental to a nation's innovative capacity and depend on a wide range of expertise. These prizes, if designed right, can be effective drivers of innovation. And it need not be Government which sets the prize or the challenge – it can happen in marketplaces on the web too.

The challenge we face is to make best use of our science base. Especially in a time of austerity, we inevitably think of the way it can contribute to economic growth. I strongly believe that contribution may come best if we encourage openness and innovation, not if we try to micromanage our universities, direct researchers or count patents. If we get the environment right, the evidence is overwhelmingly that scientific research can contribute to economic growth. A series of excellent recent reports have not just shown this but gone further and identified policy options for doing better in the future. I think of the report from the Council for Science and Technology, *A Vision for UK Research*; The Royal Society report, *The Scientific Century*; Herman Hauser's report on technology innovation centres; Nesta's recent work and, of course, James Dyson's very valuable report for my party, *Ingenious Britain*. There is lot of overlap between them and they provide the intellectual foundations on which we can set to work on the task of rebalancing our economy. The way forward lies in exploiting an evidently outstanding research capability with clear potential, under the right conditions, to drive sustainable economic growth.

. . . If we get the environment right, the evidence is overwhelmingly that scientific research can contribute to economic growth. . .

HOUSE OF COMMONS SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY

SCIENCE AND THE NEW PARLIAMENT

Andrew Miller MP, Chair, Commons Select Committee on Science and Technology

I am delighted to have been elected as Chair of the Science and Technology Committee. Electing the Chairs is a new departure for the House and as time goes on we will discover whether the new Committees are able to exercise more authority as a result of the electoral process. The members of the Committee have been elected or appointed by their own party mechanism and they are:

Gavin Barwell (Con)
Gregg McClymont (Lab)
Stephen Metcalfe (Con)
David Morris (Con)
Stephen Mosley (Con)
Pamela Nash (Lab)
Jonathan Reynolds (Lab)
Alok Sharma (Con)
Graham Stringer (Lab)
Roger Williams (Lib Dem)

We are at the stage of planning our programme of work for the future, but will be having early evidence sessions with the Science Minister, David Willetts as well as the Chief Scientific Advisor, Professor Sir John Beddington

My predecessor, Phil Willis, worked very closely with the scientific community and I pay tribute to the work they did. Not only hard hitting—indeed controversial—reports such as that on homeopathy, but valuable reports such as "Putting Science and Engineering at the Heart of Government Policy", which affect the way Government uses science. Phil also did a terrific job in keeping the Committee's profile at the forefront of science scrutiny. He set a high standard.

Having a parliamentary science committee is extremely valuable and important. It sits at the convergence of strong forces: science, government, politics and ethics. Elected members come to science and technology issues from different angles, bringing values and judgements that differ from academics and industrialists. We await the make-up of the new Committee but it may well follow the pattern of previous Parliaments: a group of members some with a scientific background and expertise and others with a strong interest in science and technology. If the pattern is repeated, I would expect challenging reports to the House of Commons and to government.

I see two major issues on the horizon that may shape the new Committee's future programme.

First, there is the challenge of maintaining the excellent UK science base in the current economic climate. The relationship between science and economic growth is complex but I detect an awareness that investment in science provides the seed corn for future economic growth. That is not to say that both the public and private sector funding of science may face severe constrains in the next few years. I cannot speak for the Committee until it is formed but I would expect that it will take a close interest in spending on science and ensure that UK science is not severely damaged.

Second, one area I am interested in is how we as a society see and use science. On the one hand, as a society we should be excited about science and get full value from the contribution it can make to our social and economic wellbeing. But many of our best ideas are put into production overseas and we do not get the full economic benefit. As a society we should feel confident in the use of science but many do not understand science and actually feel threatened by it. Indeed, it could be characterised as an anti-science culture. It is vitally important and that we have a society that understands and values science and scientists. Science and Society is a subject I would like to the new Committee to examine.

There are numerous, vital challenges facing the new Government. It is my job to ensure that the new Science and Technology Committee continues to make an important contribution to the scrutiny of science and science policy in the new parliament.

HOUSE OF LORDS SCIENCE AND TECHNOLOGY SELECT COMMITTEE

The House of Lords Science and Technology Select Committee was appointed on 22 June 2010. The members of the Committee are: Lord Broers, Lord Crickhowell, Lord Cunningham of Felling, Baroness Hilton of Eggardon, Lord Krebs (Chairman), Lord Methuen, Baroness Neuberger, Lord Patel, Baroness Perry of Southwark, Lord Rees of Ludlow, the Earl of Selborne, Lord Wade of Chorley, Lord Warner and Lord Winston.

BEHAVIOUR CHANGE POLICY INTERVENTIONS

The Select Committee has appointed a Sub-Committee to conduct an inquiry into the use of behaviour change policy interventions in Government, under the Chairmanship of Baroness Neuberger. A call for evidence will be published before the House rises for the summer recess. Further information about the inquiry will be available on the Committee's webpages.

EVIDENCE SESSION WITH THE MINISTER FOR UNIVERSITIES AND SCIENCE, THE RT HON DAVID WILLETTS MP

The Select Committee will be holding a one-off evidence session with the Minister for Universities and Science, the Rt Hon David Willetts MP, on the 13 July. A transcript of evidence will be available on the Committee's webpages.

SETTING PRIORITIES FOR PUBLICLY FUNDED RESEARCH

An inquiry into setting science and technology research funding priorities was launched in July 2009. The inquiry was undertaken by the Select Committee under the chairmanship of Lord Sutherland of Houndwood.

Cuts in overall public spending due to the current economic climate have given rise to some difficult decisions about how to allocate public funds for science and technology research. Effective mechanisms for allocating funds are vital if the United Kingdom science base is to remain healthy, both now and in the future, and is able to continue to meet societal needs. In its inquiry, the Committee investigated a range of issues including how decisions about funding research are made across Government and within Government departments and other public bodies, whether the balance between funding for targeted research and unsolicited response-mode curiosity-driven research is appropriate, and how research is commissioned.

The Committee held a seminar with key experts and relevant stakeholders on 14 October and oral evidence sessions took place between 28 October and 4 February 2010. A wide range of evidence was taken. Witnesses included: Lord Drayson, (then) Minister for Science and Innovation; Professor Sir John Beddington, the Government Chief Scientific Adviser; Professor Adrian Smith, Director General for Science and Research at the Department for Business, Innovation and Skills; Lord Sainsbury of Turville; and representatives from the Research Councils and from other relevant bodies and organisations. The Committee's report was published on 1 April. The Government response is awaited. A debate on the report is likely to take place during the current session of Parliament.

RADIOACTIVE WASTE MANAGEMENT: A FURTHER UPDATE

In January 2010, the Select Committee appointed a Sub-Committee to conduct a short follow-up inquiry into the management of radioactive waste, following the Committee's previous reports on the subject, the last of which was published in session 2006-07.

The inquiry focused on the role and performance of the Committee on Radioactive Waste Management (CoRWM), the body which provides independent scrutiny and advice on the implementation of the Government's Managing Radioactive Waste Safely programme. The Committee held evidence sessions with the following: representatives from CoRWM; Lord Hunt, (then) Minister of State at the Department of Energy and Climate Change (DECC); and representatives from DECC and from the Nuclear Decommissioning Authority and published its report on 25 March 2010. The Government response is awaited. It is anticipated that the report will be debated during the current session of Parliament.

NANOTECHNOLOGIES AND FOOD

In November 2008, the Select Committee appointed a Sub-Committee to investigate

nanotechnologies and food under the chairmanship of Lord Krebs. The inquiry covered food products, additives and supplements, food contact materials, food manufacturing processes, animal feed, pesticides and fertilisers. It included examination of issues relating to the current development of nanotechnologies and their use in the food sector, health and safety, the regulatory framework, and public engagement and consumer information. The Committee's report was published on 8 January 2010. The Government published their response in March and the report will be debated in the House on 13 July.

GENOMIC MEDICINE

During session 2007-08, the Select Committee appointed a Sub-Committee, chaired by Lord Patel, to hold an inquiry into genomic medicine. The Committee's report was published on the 6 July 2009 and the Government response was published in the following December. The report was debated in the House on 9 June 2010.

FURTHER INFORMATION

The written and oral evidence to the Committee's inquiries mentioned above, as well as the Calls for Evidence and other documents can be found on the Committee's website www.parliament.uk/hlscience. Further information about the work of the Committee can be obtained from Christine Salmon Percival, Committee Clerk, salmonc@parliament.uk or 020 7219 6072. The Committee's email address is hlscience@parliament.uk.

HOUSE OF COMMONS LIBRARY SCIENCE AND ENVIRONMENT SECTION

Nothing to Report

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (POST)

WITH DEEP REGRET

Former Board Members and Staff of POST have been deeply saddened by the news of the recent death of Lord Flowers of Queensgate. Brian Flowers was an assiduous member of POST's Board from its earliest days, and also a trustee of the Parliamentary Science and Technology Information Foundation, until ill health forced him to resign a few years ago.

Everyone associated with POST owed him a great debt of gratitude for the forthright way in which he promoted the role of POST as a horizon-scanning organisation – focussing on identifying forthcoming issues before they reach the general policy stage.

RECENT POST PUBLICATIONS

Science in the New Parliament
Special four page briefing, May 2010

At the time of every general election, POST produces a special briefing highlighting what it considers will be some of the main science-based issues that the new Parliament is likely to encounter. Some have already been covered by POST in its series of regular briefings for parliamentarians (POSTnotes) and others will be the subject of future notes. A great deal of material is compressed into POST's usual four page briefing format for this publication, which has received numerous favourable comments.

356 - Addictive Behaviours

Four page POSTnote, May 2010

Behaviours such as gambling and over-eating can become compulsive and are linked to personal and social problems. This note reviews research on the addictive dimensions of gambling, eating, sex, internet use and shopping. It provides an overview of factors contributing to addictive behaviours and their personal and social consequences. It also examines the implications for treatment provision, public health and prevention strategies and industry regulation.

357 - EU Fisheries Management

Four page POSTnote, May 2010

The existing Common Fisheries Policy (CFP) has not delivered sustainable fisheries for Europe. In addition to lost fisheries productivity, there have been unwanted impacts on the marine environment and economically inefficient fisheries that are more vulnerable to financial shocks. The recent European Commission (EC) Green Paper on the reform of the CFP reconfirms the need to adopt an ecosystem approach to ensure the CFP supports the Marine Strategy Framework Directive. This POSTnote describes challenges to ecosystem-based fisheries management and how these might be tackled.

358 - Biochar

Four page POSTnote, June 2010

Biochar is carbon rich material made by heating organic matter in low oxygen conditions. It may have the potential to reduce levels of atmospheric carbon dioxide (CO_2), thus helping the UK to meet its greenhouse gas emissions reductions targets. Furthermore, applying biochar to agricultural land could improve soil fertility, although research is far from definitive as results are variable. This POSTnote examines the current status of research into the production and use of biochar, the feasibility of using it to combat climate change, and any unintended consequences that may result.

359 - EU Science & Technology Funding

Four page POSTnote, June 2010

The EU Seventh Framework Programme for Research and Technological Development (FP7) is the world's largest research programme with a total budget of €53.2 billion. Based on past performance, FP7 could be worth over €7billion to the UK; about €1 billion a year. The development process of the next FP, which will replace FP7 in 2014, is under way. This POSTnote explains the FP system and current developments.

360 - Genetically Modified Insects

Four page POSTnote, June 2010

Insects are essential to global ecology and show remarkably varied adaptations to their environment. They are also responsible for economic and social harm worldwide through the transmission of disease to humans and animals, and damage to crops. Their genetic modification has been proposed as a new way of controlling insect pests. However, regulatory guidelines governing the use of such technology have not yet been fully developed.

CURRENT WORK

Biological sciences and health - Assisted Reproduction, Deception Detection Technologies, Drug Pricing, Indoor Air Pollution

Environment and Energy - Future Electricity Transmission, Environmental Limits (long report), Sea Level Rise,

Physical sciences and IT - Digital Preservation, Disruption of the Internet, Space Weather, Solar Technologies, Electric Vehicles, National Infrastructure Resilience

Science, Technology and the Developing World – Biofortification

CONFERENCES AND SEMINARS

On 15th June, POST hosted its special post-election briefing for new MPs, chaired by POST's former Board member, Mr Michael Connarty MP. Participating were David Willetts MP, Minister of State for Science and Universities, Professor Sir John Beddington, Government Chief Scientific Adviser, Lord Willis of Knaresborough, former chair of the House of Commons Science and Technology Committee, and Andrew Miller MP, new chair of the House of Commons Science and Technology Committee.

Also in June, , POST hosted a seminar, chaired by Lord Patel of Dunkeld, to present the results of its June 2010 POSTnote on Genetically Modified Insects, which has attracted a great deal of attention. Presentations were made by Professor Paul Eggleston, Professor of Molecular Entomology, Keele University, Professor Luke Alphey, Chief Scientific Officer, Oxitec Ltd., Dr Jon Knight, Senior Lecturer at the Centre for Environmental Policy, Imperial College London and Dr Ricarda Steinbrecher, Co-Director, EcoNexus.

In July, Lord Selborne hosted a joint seminar organised by POST and the Living with Environmental Change consortium. Environmental change (for example in climate, biodiversity, flooding) presents major challenges to both the natural world and society, and offers opportunities for business and the emerging green economy. The Living with Environmental Change programme of 22 UK public sector research and policy partners is optimising the coherence and effectiveness of UK environmental research. By working in partnership, the programme is ensuring that the UK obtains best value as it mitigates, adapts to and capitalises on environmental change.

The seminar, addressed by Professor Andrew Watkinson, Director of Living with Environmental Change and Colin Drummond, Chief Executive Viridor Ltd & Chair of Living with Environmental Change Business Advisory Board, was an opportunity to learn about how research is feeding into policy effectively.

STAFF, FELLOWS AND INTERNS AT POST

Conventional Fellows

John Bissell, Imperial College London, Engineering and Physical Sciences Research Council Fellowship
Rebecca Caygill, Leeds University, Biotechnology and Biological Sciences Research Council Fellowship
Frederick Cook, John Innes Centre, Norwich, Biotechnology and Biological Sciences Research Council Fellowship
Mandeep Dhillon, Leeds University, Biotechnology and Biological Sciences Research Council Fellowship
Robert Dorrell, Bristol University, Natural Environment Research Council Fellowship
Rosalyn Robison, Cambridge University, Engineering and Physical Sciences Research Council Fellowship
Oliver St John, Oxford University, Biotechnology and Biological Sciences Research Council Fellowship

SELECTED DEBATES AND PARLIAMENTARY QUESTIONS AND ANSWERS

Following is a selection of Debates and Questions and Answers from the House of Commons and House of Lords.

Full digests of all Debates, Questions and Answers on topics of scientific interest from both Houses of Parliament can be found on the website:

www.scienceinparliament.org.uk

Please log in using the members' and subscribers' password (available from the Committee Secretariat) and go to Publications: Digests

SELECTED DEBATES

British Indian Ocean Territory

Debate in Westminster Hall on Wednesday 10 March

Jeremy Corbyn (Islington North): The British Indian Ocean Territory consists of Diego Garcia and an archipelago of islands some distance away from Diego Garcia. Everyone now recognises that the way that the islanders were treated was fundamentally wrong and many, many apologies have been offered to them. The islands were part of the British Indian ocean colonies throughout the 19th century. In the 1960s, the United States was casting around for a base in the Indian ocean, to have a site that its cargo planes, ships and submarines could use as a naval facility in the Indian ocean as part of its Vietnam war effort. The then US President, Lyndon Johnson, and the then British Prime Minister, Harold Wilson, came to an agreement that Diego Garcia could be used as a US base and a lease arrangement was agreed. That was done in a considerable degree of secrecy and additional requirements were made that the outer islands, as well as the island of Diego Garcia itself, should be depopulated. The population was systematically moved away and effectively dumped on the Seychelles and Mauritius.

Laura Moffatt (Crawley): Most of us who have grown up understanding the injustice that has taken place and how islanders were treated like cattle and removed to Mauritius and the Seychelles have a great sense of the wrong that has been done. Those people were subsequently given access to a British passport and turned up in the centre of a town virtually destitute.. The system let them down in many ways. It is very special to realise that the children of that community are doing extremely well at school and that its first students have gone to university.

Keith Simpson, Shadow Minister, Foreign Affairs The UK presence is tiny on Diego Garcia. The issue has been highlighted by accusations of extraordinary rendition, and I do not want to go into the details. The crucial point about the military presence on Diego Garcia, is that by 2014, we must consider proposals for any revisions of the agreement-2016 is the cut-off date-and that is only four years away. My best guess in 2010 is that it is highly unlikely that the United States will want to withdraw completely from Diego Garcia, because of the way in which the world has changed.

Ivan Lewis, Minister of State Foreign and Commonwealth Affairs, Foreign and Commonwealth Office: There can be no doubt about the responsibility and culpability of this country for the decisions that were made in the late '60s and early '70s. Because of that, we owe it to the Chagossian community to ensure that we behave appropriately and in a way that, while remaining consistent with our interests, is also sensitive to our responsibilities. The key issue raised during the debate was the right of return, and in that context it is important to look at the different legal processes that have taken place and explain why the Government felt that they wished to pursue the case legally. We have no choice at this stage but to defend our position in the courts, but we must remember that we are culpable for what happened historically. That moral responsibility will never go away, and we have to find ways, of constantly recognising that, accepting our responsibility and being held to account.

Climate Change: Copenhagen Conference

Debate in the House of Lords on Thursday 14 January

Lord Oxburgh: I had not intended to talk about science today because the science was not seriously questioned at Copenhagen - it was not the issue. On the other hand, it is worth making a comment or two on it. When the former leader of one of the world's important countries, said, as he commonly did, that the science is not certain, that was pretty much a content - free statement. It does not mean anything unless you specify what question the science is supposed to answer. Although scientists, climatologists and so forth disagree about a great many of the details, the general direction of change is not seriously questioned by many. It is very difficult to question the influence of our greenhouse gases in controlling the earth's temperature and

question the fact that during the past 150 years we have significantly increased those by roughly 30 per cent. People who deny that really have to recognise that they have to come up with a whole new theory for temperature distribution in the terrestrial planets, which has stood the test of time for about 100 years, if they want to throw out the concept of greenhouse gas perturbation. When you come to the precise consequences of this - how much ice melts where; whether we are talking about 2 or 3 degrees - there is much more scope for disagreement over modelling and between the different approaches taken. However, there is nearly uniform agreement on the general direction of change.

Turning to the Copenhagen conference, certainly the outcome was a disappointment to many. One cannot avoid the feeling that the approaches to the conference were buoyed up on a somewhat unsubstantiated froth of optimism. There is nothing wrong with that, but that is what I think it was. Certainly, many small and developing countries must have come away with a feeling of deep disappointment because they believe that they are the innocent victims of environmental damage which they had no part in creating.

One of the favourable outcomes of Copenhagen was that there appeared to be a willingness on the part of the developed world to recognise that and to help both with adaptation and mitigation. There is some way to go and a great many details have to be worked out. However, arguably, the most important consequence of the conference was that simply by going to Copenhagen in the numbers they did, world leaders demonstrated the importance that they attached to tackling climate change.

Lord Rees of Ludlow: It is sometimes said fatalistically that the UK's stance on climate change is of marginal import because our emissions are only 1 or 2 per cent of the problem, but we have leverage in two respects. The first is political. Our Government have shown leadership both internationally and through the Climate Change Act. We also have leverage through science and engineering. We have the expertise to spearhead the technologies without which there would be no transition to a low-carbon economy for the world, and it is in our national interest to take a lead. We need to keep our own lights on, but beyond that imperative we should seize the chance to pioneer clean energy to meet the entire world's growing needs.

Lord Browne of Madingley: For many observers, the Copenhagen accord, signed at last month's climate conference, is a failure. Targets for global emissions are conspicuously absent, and while national targets are included, they are set only on a voluntary basis. The failure to acknowledge an ongoing process for converting the accord into a legally binding treaty is disappointing. But despite falling short in these respects, the agreement makes significant progress in others. It commits all major polluters, not just developed countries, to take action on reducing emissions and to submit their plans to international oversight. The agreement enshrines a joint target to limit global warming to 2 degrees centigrade and it promises tens of billions of dollars for developing countries over the next decade, financed through private and public channels.

Lord Hunt of Chesterton: On the Government's achievements, it was important that at Copenhagen there was an acceptance of the need to control global temperature by limiting emissions and preventing deforestation and that there should be help for developing countries. The mere fact that there was this accord at Copenhagen enables the United Nations system and all kinds of international bodies, businesses and industries to continue the general direction of work to reduce emissions, adaptation and work on the effects of climate change. If there had been a total failure, many of these important ongoing activities would have come to a stop. However, there were some bad aspects and outcomes at Copenhagen. One of the features is that it was seen to be too much of a bureaucratic, governmental organisation. Some countries, particularly in the Far East, have realised that dealing with climate change requires visionary, practical, visible, symbolic changes.

Lord Hannay of Chiswick: My Lords, on the spectrum between success and failure, the Copenhagen conference surely has to be placed nearer to the latter. We should have no illusions about that. To delude ourselves that the outcome was really quite good, with clichés about half-full and half-empty glasses, is to underestimate the length and difficulty of the road that the international community still has to travel if it is to handle successfully the challenge of man-made climate change. Such an approach will be likely to programme another more costly failure when the negotiations resume this year. We need to remember, too, that settling for an inadequate outcome on climate change, in contrast with some other multilateral negotiations, such as those on trade or nuclear disarmament, where half a loaf can genuinely be worth more than no bread, is likely to bring in due course a reality check in the form of catastrophic global warming, which it will be too late to mitigate and much more costly to handle.

Lord Stern of Brentford: I was at Copenhagen for the second week of the conference. I was there as an independent, as a professor at the London School of Economics and as chairman of the Grantham Research Institute on Climate Change and the Environment at the London School of Economics, and I was working very closely with Governments from Europe, Africa, the United States, India and others. I pay tribute to the leadership of the UK authorities - the Prime Minister and the Secretary of State - for their very strong input. The outcome was disappointing in many respects and chaotic in others but there was significant progress. At Copenhagen we laid the foundation for future work.

EURO-NEWS

Commentary on science and technology within the European Parliament and the Commission

COPENHAGEN, A MISSED CHANCE?

The IPCC (International Panel on Climate Change) had to wait 17 years before seeing its objectives translated into quantified targets, the famous 2°C temperature increase threshold. Although the IPCC Vice-Chair, the climatologist Jean-Pascal van Ypersele, believes it is a figure that should be regarded with caution, the progress it has represented should not be under-estimated. Today, governments the world over are being urged to act quickly to review targets that are deemed insufficient.

Our dependence on oil – this fossil fuel that we must abandon, and not only because its reserves are depleted – is slowly beginning to end. There is increasing research on other energy sources. Also, after the false start of the first generation agrofuels that proved so costly, biofuels remain full of promise.

But the situation is urgent, that much we do know. Evidence of the impact of global warming on ecosystems is growing all the time. Until recently we were not sure, for example, that carbon dioxide would change sea water composition to the point of threatening marine ecosystems and biodiversity. We now know this to be the case and ocean acidification has been added to the list of worrying environmental problems.

The figures are growing more accurate and the climate models more refined as the projections acquire more precise degrees of probability but grow ever more sombre in the process. Science is advancing, albeit without absolute certainty and thus amid debate. So much the better. Witness these scientists whom we have grouped together as 'climate sceptics' and who continue to doubt the anthropic origin of global warming and/or the sound basis of the measures proposed to combat it.

Recent years have brought demands for greater political commitment and a total review of our consumption practices, but without really achieving the hoped for effects. The agreements reached at the Copenhagen Climate Summit last December are the most recent example. But these injunctions are causing us to leave our fool's paradise in which we knew nothing and wasted everything. We must now reach the other shore.

LASER AND FUSION, THE PERFECT MATCH?

Access to clean and inexhaustible energy is no longer a mirage. This is the message being proclaimed by the supporters of nuclear fusion, delighted to see the prominence being given on the scientific scene to the ambitious HiPER (High Power laser Energy Research facility) project. The inertial confinement fusion developed by HiPER is an equally convincing alternative to the magnetic path advocated by its cousin ITER. There is still a long way to go but recent experimental results are grounds for optimism.

Inexhaustible resources, low waste, low environmental impact, foolproof security and compatibility with existing electricity networks. The benefits of fusion are such that humanity can no longer do without it. The process itself has been known since the '50s: a forced meeting of the nuclei of deuterium and tritium to produce helium, neutrons and an enormous quantity of energy. Simple enough on paper, but complicated to implement, given the conditions of extreme density and temperature at which this reaction is triggered.

Theoretical and experimental studies concur on two possible approaches. The first is to design a torus in which hot plasma is confined by a magnetic field – this is the *ITER* approach. The second, inertial confinement, also known as laser fusion, involves using powerful laser beams to implode pellets of pre-compressed fuel. It is this second approach that *HiPER's* designers have opted for.

"We are pleased that since 2006, *HiPER* is among the scientific facilities supported by ESFRI – European strategy forum on research infrastructures," says Mike Dunne, general coordinator of the project. "Right now, *HiPER* is in its preparatory phase, funded to the tune of three million euros by the 'infrastructure' activity of the Seventh Framework Programme (FP7) and several times that amount by national agencies." The technology demonstration phase will begin in 2011, leading, at the end of the next decade, to the construction of the facility itself, at a cost of around 1 billion euros.

These colossal investments are explained at once by the complexity of the technological innovations themselves and by the applications that are potentially available once the processes are mastered. "Fifty years of experiments have shown that self-sustaining fusion requires a temperature close to 50 million degrees and a density of at least 1 kg/cm^3, 50 times that of gold", Mike Dunne continues. "Moreover, it is a high repetition technology, since we need to align the laser pulses of around one nanosecond each with pellets of one millimetre in diameter, five times a second." To achieve the goal of controlled fusion, scientists are therefore exploring areas of physics that are still poorly understood and which, it is hoped, will open the door to future applications.

"And the list will be long!" Mike Dunne adds. "Mastering high repetition and high energy laser technology together opens the way to activities as diverse as radioisotope production, oncology and even next-generation light sources. On a more fundamental level, we can expect major breakthroughs in extreme materials science and in nuclear and plasma physics."

SCIENCE DIRECTORY

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Eli Lilly and Company Ltd
NESTA

Large-Scale Research Facilities
C-Tech Innovation
The Food and Environment Research Agency
Institute of Physics
London Metropolitan Polymer Centre
National Physical Laboratory
Natural History Museum
STFC

Lasers
Institute of Physics
National Physical Laboratory
STFC

Manufacturing
ABPI
AMSI
EPSRC
Institution of Chemical Engineers
London Metropolitan Polymer Centre
National Physical Laboratory
Semta

Materials
C-Tech Innovation
Institution of Chemical Engineers
London Metropolitan Polymer Centre
National Physical Laboratory
Royal Society of Chemistry
Semta
STFC

Medical and Biomedical Research
ABPI
Academy of Medical Sciences
Biochemical Society
British Pharmacological Society
British Society for Antimicrobial Chemotherapy
CABI
Eli Lilly and Company Ltd
HFEA
Medical Research Council
Merck Sharp & Dohme
Plymouth Marine Sciences Partnership
Royal Institution
Society of Biology
UFAW

Motor Vehicles
London Metropolitan Polymer Centre

Oceanography
AMSI
National Physical Laboratory
Natural Environment Research Council
Plymouth Marine Sciences Partnership

Oil
C-Tech Innovation
Institution of Chemical Engineers
LGC

Particle Physics
Institute of Physics
STFC

Patents
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Pharmaceuticals
ABPI
British Pharmacological Society
British Society for Antimicrobial Chemotherapy
C-Tech Innovation
Eli Lilly and Company Ltd
Institution of Chemical Engineers
LGC
Merck Sharp & Dohme
PHARMAQ Ltd
Royal Society of Chemistry
Semta
Society of Biology

Physical Sciences
Cavendish Laboratory
C-Tech Innovation
EPSRC
Institute of Physics
London Metropolitan Polymer Centre
National Physical Laboratory

Physics
Cavendish Laboratory
C-Tech Innovation
Institute of Physics
National Physical Laboratory
STFC

Pollution and Waste
ABPI
AMSI
C-Tech Innovation
Institution of Chemical Engineers
Institution of Civil Engineers
London Metropolitan Polymer Centre
National Physical Laboratory
Natural Environment Research Council
Plymouth Marine Sciences Partnership

Psychology
British Psychological Society

Public Policy
Biochemical Society
The British Ecological Society
British Nutrition Foundation
British Society for Antimicrobial Chemotherapy
Economic and Social Research Council
Engineering UK
The Food and Environment Research Agency
HFEA
Institution of Civil Engineers
Institution of Chemical Engineers
NESTA
Prospect
Royal Society of Chemistry
Society of Biology

Public Understanding of Science
Academy of Medical Sciences
Biochemical Society
The British Ecological Society British Nutrition Foundation
British Science Association
British Society for Antimicrobial Chemotherapy
Clifton Scientific Trust
EPSRC
Engineering UK
The Food and Environment Research Agency
HFEA
Institute of Physics
Institution of Chemical Engineers
Institution of Engineering and Technology
Medical Research Council
Natural History Museum
NESTA
Plymouth Marine Sciences Partnership
Prospect
Research Councils UK
The Royal Academy of Engineering
Royal Institution
The Royal Society
Royal Society of Chemistry
STFC
Society of Biology

Quality Management
LGC
National Physical Laboratory

Radiation Hazards
Health Protection Agency
LGC

Retail
Marks and Spencer

Science Policy
ABPI
Academy of Medical Sciences
Biochemical Society
The British Ecological Society
British Nutrition Foundation
British Pharmacological Society
British Science Association
CABI
Clifton Scientific Trust
Economic and Social Research Council
Eli Lilly and Company Ltd
EPSRC
Engineering UK
The Food and Environment Research Agency
HFEA
Institute of Physics
Institution of Chemical Engineers
Institution of Civil Engineers
LGC
Medical Research Council
NESTA
National Physical Laboratory
Plymouth Marine Sciences Partnership
Prospect
Research Councils UK
The Royal Academy of Engineering
Royal Institution
The Royal Society
Royal Society of Chemistry
Semta
STFC
Society of Biology
UFAW

Sensors and Transducers
AMSI
C-Tech Innovation
Institute of Measurement and Control
STFC

SSSIs
Kew Gardens
Natural England

Statistics
EPSRC
Engineering UK
Royal Statistical Society

Surface Science
C-Tech Innovation
STFC

Sustainability
The British Ecological Society
CABI
C-Tech Innovation
EPSRC
The Food and Environment Research Agency
Institution of Chemical Engineers
Institution of Civil Engineers
The Linnean Society of London
London Metropolitan Polymer Centre
Natural England
Plymouth Marine Sciences Partnership
Royal Society of Chemistry
Society of Biology

Technology Transfer
AIRTO
CABI
C-Tech Innovation
The Food and Environment Research Agency
Institute of Measurement and Control
LGC
London Metropolitan Polymer Centre
NESTA
National Physical Laboratory
Research Councils UK
Royal Society of Chemistry
STFC

Tropical Medicine
Health Protection Agency
Natural History Museum
Society for General Microbiology
Society for Applied Microbiology

Viruses
ABPI
Health Protection Agency
Society for General Microbiology
Society for Applied Microbiology

Water
AMSI
C-Tech Innovation
Institute of Measurement and Control
Institution of Chemical Engineers
Institution of Civil Engineers
LGC
Plymouth Marine Sciences Partnership
Royal Society of Chemistry
Society for General Microbiology
Society for Applied Microbiology
Society of Biology

Wildlife
The British Ecological Society
The Food and Environment Research Agency
The Linnean Society of London
Natural England
Natural History Museum
Society of Biology
UFAW

Research Councils UK

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Website: www.rcuk.ac.uk

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.

Arts and Humanities Research Council

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Communications Manager
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E-mail: enquiries@ahrc.ac.uk
Website: www.ahrc.ac.uk

Each year the AHRC provides approximately £105 million from the Government to support 700 research awards and around 1,350 postgraduate awards in the arts and humanities, from archaeology and English literature to dance and design. Awards are made after a rigorous peer review process, so that only applications of the highest quality are funded. The quality and range of research supported by this investment of public funds not only provides social and cultural benefits but also contributes to the economic success of the UK.

Biotechnology and Biological Sciences Research Council (BBSRC)

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BBSRC is the UK's principal public funder of research and research training across the biosciences. BBSRC provides institute strategic research grants to eight centres, as well as supporting research and training in universities across the UK. BBSRC's research underpins advances in a wide range of bio-based industries, and contributes knowledge to policy areas which include: food security, climate change, diet and health and healthy ageing.

Economic and Social Research Council

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

EPSRC

Engineering and Physical Sciences Research Council

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Website:www.epsrc.ac.uk

EPSRC is the main UK government agency for funding research and training in engineering and the physical sciences, investing around £850 million a year in a broad range of subjects – from mathematics to materials science, and information technology to structural engineering.

EPSRC's investment in high quality basic, strategic and applied research and training promotes future economic and societal impact in the UK.

Medical Research Council

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Website: www.mrc.ac.uk

For almost 100 years the Medical Research Council (MRC) has improved the health of people in the UK and around the world by supporting the highest quality science.

The MRC is funded by the UK taxpayer. We are independent of Government, but work closely with the Health Departments, the National Health Service and industry to ensure that the research we support takes account of the public's needs as well as being of excellent scientific quality. As a result, MRC-funded research has led to some of the most significant discoveries in medical science and benefited millions of people, both in the UK and worldwide.

Natural Environment Research Council

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Website: www.nerc.ac.uk

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

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

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

Science & Technology Facilities Council

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Website: www.stfc.ac.uk

Formed by Royal Charter in 2007, the Science and Technology Facilities Council is one of Europe's largest multidisciplinary research organisations supporting scientists and engineers world-wide. The Council operates world-class, large-scale research facilities and provides strategic advice to the UK Government on their development. The STFC partners in the UK's two National Science and Innovation Campuses. It also manages international research projects in support of a broad cross-section of the UK research community. The Council directs, co-ordinates and funds research, education and training.

The Academy of Medical Sciences

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Website: www.acmedsci.ac.uk

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

The Association for Science Education

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Chief Executive
Association for Science Education
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Tel: 01707 283000
Fax: 01707 266532
E-mail: info@ase.org.uk
Website: www.ase.org.uk

The Association for Science Education (ASE) is the largest subject association in the UK for teachers, technicians and others interested in science education. Working closely with the science professional bodies, industry and business, ASE provides a UK network bringing together individuals and organisations to share good ideas, tackle challenges in science teaching, develop resources and foster high quality continuing professional development.

Association of the British Pharmaceutical Industry

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Website: www.abpi.org.uk

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

Contact: Professor Richard Brook OBE FREng
AIRTO Ltd: Association of Independent Research & Technology Organisations Limited
c/o Campden BRI, Station Road,
Chipping Campden,
Gloucestershire GL55 6LD.
Tel: 01386 842247
Fax: 01386 842010
E-mail: airto@campden.co.uk
Website: www.airto.co.uk

AIRTO represents the UK's independent research and technology sector - member organisations employ a combined staff of over 20,000 scientists and engineers with a turnover exceeding £2 billion. Work carried out by members includes research, consultancy, training and global information monitoring. AIRTO promotes their work by building closer links between members and industry, academia, UK government agencies and the European Union.

Association of Marine Scientific Industries

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Association of Marine Scientific Industries
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Website: www.maritimeindustries.org

The Association of Marine Scientific Industries (AMSI) is a constituent association of the Society of Maritime Industries (SMI) representing companies in the marine science and technology sector, otherwise known as the oceanology sector.

The marine science sector has an increasingly important role to play both in the UK and globally, particularly in relation to the environment, security and defence, resource exploitation, and leisure. AMSI represents manufacturers, researchers, and system suppliers providing a co-ordinated voice and enabling members to project their views and capabilities to a wide audience.

Biochemical Society

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CEO
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Fax: 020 7685 2470

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

British Science Association

Contact: Sir Roland Jackson Bt,
Chief Executive
British Science Association,
Wellcome Wolfson Building, 165 Queen's Gate,
London SW7 5HD.
E-mail:
Roland.Jackson@britishscienceassociation.org
Website: www.britishscienceassociation.org

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

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

The British Ecological Society

The British Ecological Society
Contact: Ceri Margerison, Policy Officer
British Ecological Society
Charles Darwin House, 12 Roger Street,
London, WC1N 2JU
Tel: 020 7685 2500 Fax : 020 7685 2501
Website: www.BritishEcologicalSociety.org
Ecology into Policy Blog
http://britishecologicalsociety.org/blog/

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

British Nutrition Foundation

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Director General
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Tel: 020 7404 6504
Fax: 020 7404 6747
Email: postbox@nutrition.org.uk

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

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

BRITISH PHARMACOLOGICAL SOCIETY

Today's science, tomorrow's medicines

Contact: Kate Baillie
Chief Executive
British Pharmacological Society
16 Angel Gate, City Road
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Tel: 020 7417 0113
Fax: 020 7417 0114
Email: kb@bps.ac.uk
Website: www.bps.ac.uk

The British Pharmacological Society has now been supporting pharmacology and pharmacologists for over 75 years. Our 2,000+ members, from academia, industry and clinical practice, are trained to study drug action from the laboratory bench to the patient's bedside. Our aim is to improve the quality of life by developing new medicines to treat and prevent the diseases and conditions that affect millions of people and animals. Inquiries about drugs and how they work are welcome.

The British Psychological Society

Contact: Dr Ana Padilla
Parliamentary Officer
The British Psychological Society
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Website: www.bps.org.uk

The British Psychological Society is an organisation of over 45,000 members governed by Royal Charter. It maintains the Register of Chartered Psychologists, publishes books, 10 primary science Journals and organises conferences. Requests for information about psychology and psychologists from parliamentarians are welcome.

British Society for Antimicrobial Chemotherapy

Mrs Tracey Guise
Executive Director
British Society for Antimicrobial Chemotherapy
Griffin House
53 Regent Place
Birmingham B1 3NJ
T: 0121 236 1988
W: www.bsac.org.uk

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

CABI

www.cabi.org

Contact: Dr Joan Kelley, Executive Director, Global Operations, CABI
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Tel: 01491 829306 Fax: 01491 829100
Email: t.davis@cabi.org
Website: www.cabi.org

CABI is an international not for profit organization, specialising in scientific publishing, research and communication. Our mission is to improve peoples' lives worldwide by finding sustainable solutions to agricultural and environmental issues. Activities range from assisting national policy makers and informing worldwide research to supporting income poor farmers. We also house and manage the UK's National Collection of Fungus Cultures which we are exploring for potential new drugs, enzymes and nutraceuticals.

Cavendish Laboratory

UNIVERSITY OF CAMBRIDGE

The Administrative Secretary, The Cavendish Laboratory,
J J Thomson Avenue, Cambridge CB3 0HE, UK.
E-mail: dhp24@cam.ac.uk
http://www.phy.cam.ac.uk

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

Its world-class research is focused in a number of experimental and theoretical diverse fields.

Astrophysics: Millimetre astronomy, optical interferometry observations & instrumentation. Astrophysics, geometric algebra, maximum entropy, neutral networks.

High Energy Physics: LHC experiments. Detector development. Particle physics theory.

Condensed Matter Physics: Semiconductor physics, quantum effect devices, nanolithography. Superconductivity, magnetic thin films. Optoelectronics, conducting polymers. Biological Soft Systems. Polymers and Colloids. Surface physics, fracture, wear & erosion. Amorphous solids. Electron microscopy. Electronic structure theory & computation. Structural phase transitions, fractals, quantum Monte Carlo calculations Biological Physics. Quantum optics.

Chartered Institute of Patent Attorneys

Contact: Michael Ralph -
Secretary & Registrar
The Chartered Institute of Patent Attorneys
95 Chancery Lane, London WC2A 1DT
Tel: 020 7405 9450
Fax: 020 7430 0471
E-mail: michael.ralph@cipa.org.uk
Website: www.cipa.org.uk

CIPA's members practise in intellectual property, especially patents, trade marks, designs, and copyright, either in private partnerships or industrial companies. Through its new 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

CLIFTON SCIENTIFIC Trust

Contact: Dr Eric Albone
Clifton Scientific Trust
49 Northumberland Road, Bristol BS6 7BA
Tel: 0117 924 7664 Fax: 0117 924 7664
E-mail: eric.albone@clifton-scientific.org
Website: www.clifton-scientific.org

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

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

- 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)

Clifton Scientific Trust Ltd is registered charity 1086933

C-Tech Innovation Limited

C-Tech Innovation
...advantage through technology

Contact: Paul Radage
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Capenhurst, Chester, Cheshire CH1 6EH
Tel: +44 (0) 151 347 2900
Fax: +44 (0) 151 347 2901
E-mail: paul.radage@ctechinnovation.com
Website: www.ctechinnovation.com

Innovation Management and Technology Development organisation offering an end-to-end innovation management service, able to assist at every step of the innovation journey. We work with SMEs, Blue Chips, Central, Regional and Local Government. Our activities include research and development, engineering design as well as a wide ranging innovation, business and technology consultancy. See www.ctechinnovation.com for more details.

Eli Lilly and Company Ltd

Lilly
Answers That Matter.

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Fax: 01256 775858
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Email. thorpth@lilly.com
Website: www.lilly.co.uk

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

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

EngineeringUK

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Fax: 020 3206 0401
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EngineeringUK is an independent organisation that promotes the vital role of engineers, engineering and technology in our society. EngineeringUK partners business and industry, Government and the wider science and technology community: producing evidence on the state of engineering; sharing knowledge within engineering, and inspiring young people to choose a career in engineering, matching employers' demand for skills.

The Food and Environment Research Agency

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Website: www.defra.gov.uk/fera

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.

Health Protection Agency

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Web: www.hpa.org.uk

The Health Protection Agency is an independent UK organisation that protects the public from threats to their health from infectious diseases and environmental hazards.

The HPA identifies and responds to health hazards and emergencies caused by infectious disease, hazardous chemicals, poisons or radiation.

It gives advice to the public, provides data and information to government, and advises people working in healthcare. It also makes sure the nation is ready for future threats to health that could happen naturally, accidentally or deliberately.

Human Fertilisation and Embryology Authority

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Website: www.hfea.gov.uk

The HFEA is a non-departmental Government body that regulates and inspects all UK clinics providing IVF, donor insemination or the storage of eggs, sperm or embryos. The HFEA also licenses and monitors all human embryo research being conducted in the UK.

The Institute of Measurement and Control

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Website: www.instmc.org.uk
Reg Charity number: 269815

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 scientific charity devoted to increasing the practice, understanding and application of physics. It has a worldwide membership of more than 36,000 and is a leading communicator of physics-related science to all audiences, from specialists through to government and the general public. Its publishing company, IOP Publishing, is a world leader in scientific publishing and the electronic dissemination of physics.

IPEM Institute of Physics and Engineering in Medicine

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Website: www.ipem.ac.uk

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 and by the Engineering Council (UK) to award CEng, IEng and EngTech.

IChemE

Institution of Chemical Engineers

IChemE is the hub for chemical, biochemical and process engineering professionals worldwide. We are the heart of the process community, promoting competence and a commitment to sustainable development, advancing the discipline for the benefit of society and supporting the professional development of over 30,000 members.

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Institution of Civil Engineers

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

Institution of Engineering 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 from 1871, the IET has 150,000 members in 127 countries with offices in Europe, North America and Asia-Pacific.

KEW GARDENS

The mission of Kew is to inspire and deliver science-based plant conservation worldwide, enhancing the quality of life. Kew is developing its breathing planet programme with seven key strategies:

- creating global access to essential information
- identifying species and regions most at risk
- helping implement global conservation programmes
- extending the Millennium Seed Bank's global partnership
- establishing a global network for restoration ecology
- identifying and growing locally appropriate species in a changing climate
- using botanic gardens as shop-front opportunities to inform and inspire

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Website: www.kew.org

Two stunning gardens-devoted to building and sharing knowledge

LGC

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Website: www.lgc.co.uk

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 28 laboratories and centres across Europe and at sites in China, India and the US.

The Linnean Society of London

The Linnean Society of London
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London W1J 0BF

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Website: www.linnean.org

The Linnean Society of London is the world's oldest active biological society. Founded in 1788, the Society takes its name from the Swedish naturalist Carl Linnaeus whose botanical, zoological and library collections have been in its keeping since 1829. The Society continues to play a central role in the documentation of the world's flora and fauna, recognising the continuing importance of such work to many scientific issues.

London Metropolitan Polymer Centre

Sir John Cass Department of Art, Media & Design

Contact: Alison Green,
London Metropolitan University
166-220 Holloway Road, London N7 8DB
Tel: 020 7133 2189
E-mail: alison@polymers.org.uk
Website: www.polymers.org.uk

The London Metropolitan Polymer Centre provides training, consultancy and applied research to the UK polymer (plastics & rubber) industry. Recently, LMPC has merged with the Sir John Cass Department of Art, Media & Design (JCAMD) to provide a broad perspective of materials science and technology for the manufacturing and creative industries. JCAMD contains Met Works, a unique new Digital Manufacturing Centre, providing new technology for rapid prototyping and manufacture. The new department will offer short courses in polymer innovation, print technology and silversmithing & jewellery.

Marks & Spencer Plc

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Main Business Activities
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Merck Sharp & Dohme Limited (MSD) is the UK subsidiary of Merck & Co., Inc., of Whitehouse Station, New Jersey, USA, a leading research-based pharmaceutical company that discovers, develops, manufactures and markets a wide range of innovative pharmaceutical products to improve human health. Our mission is to provide society with superior products and services by developing innovations and solutions that improve the quality of life.

The National Endowment for Science, Technology and the Arts

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

National Physical Laboratory

National Physical Laboratory
Hampton Road, Teddington
Middlesex TW11 0LW
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Website: www.npl.co.uk

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 England

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Natural England has the responsibility to enhance biodiversity, landscape and wildlife in rural, urban, coastal and marine areas; promote access, recreation and public well-being, and contribute to the way natural resources are managed so that they can be enjoyed now and by future generations. In delivering these responsibilities, we work with a range of partners to continue to develop the broad evidence base we need to underpin both our operational decisions and our advice to government and others.

Natural History Museum

The Science of Nature

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The Natural History Museum is the UK's premier institute for knowledge on the diversity of the natural world, conducting scientific research of global impact and renown. We maintain and develop the collections we care for and use them to promote the discovery, understanding, responsible use and enjoyment of the world around us.

The Nutrition Society

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

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

Principal activities include:

1. Publishing internationally renowned scientific learned journals
2. Promoting the education and training of nutritionists
3. Promoting the highest standards of professional competence and practice in nutrition
4. Disseminating scientific information through its publications and programme of scientific meetings

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Plymouth Marine Sciences Partnership

Contact: Rosie Carr
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The Plymouth Marine Sciences Partnership comprises seven leading marine science and technology institutions, representing one of the largest regional clusters of expertise in marine sciences, education, engineering and technology in Europe. The mission of PMSP is to deliver world-class marine research and teaching, to advance knowledge, technology and understanding of the seas. PMSP research addresses the fundamental understanding of marine ecosystems and processes that must be applied in support and development of policy, marine and maritime industry and marine biotechnology.

Prospect

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Prospect is an independent, thriving and forward-looking trade union with 122,000 members across the private and public sectors and a diverse range of occupations. We represent scientists, technologists and other professions in the civil service, research councils and private sector.

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

The Royal Academy of Engineering

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

The Royal Institution

The Royal Institution of Great Britain

Contact: Dr Gail Cardew
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21 Albemarle Street, London W1S 4BS
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www.rigb.org

The core activities of the Royal Institution centre around four main themes: science research, education, communication and heritage. It has a major Public Events Programme designed to connect people to the world of science, as well as a UK-wide Young People's Programme of science and mathematics enrichment activities. Internationally recognised research programmes in bio- and nanomagnetism take place in the Davy Faraday Research Laboratory. The building has recently undergone a £22 million refurbishment, and now features an extended museum, new social spaces and upgraded facilities in the historic lecture theatre.

The Royal Society

THE ROYAL SOCIETY
CELEBRATING 350 YEARS

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The Royal Society is the UK academy of science comprising 1400 outstanding individuals representing the sciences, engineering and medicine. As we celebrate our 350th anniversary in 2010,our strategic priorities for our work at national and international levels are to:

- Invest in future scientific leaders and in innovation
- Influence policymaking with the best scientific advice
- Invigorate science and mathematics education
- Increase access to the best science internationally
- Inspire an interest in the joy, wonder and excitement of scientific discovery.

The Royal Society of Chemistry

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Parliamentary Affairs
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Website: http://www.rsc.org
http://www.chemsoc.org

The Royal Society of Chemistry is a learned, professional and scientific body of over 46,000 members with a duty under its Royal Charter "to serve the public interest". It is active in the areas of education and qualifications, science policy, publishing, Europe, information and internet services, media relations, public understanding of science, advice and assistance to Parliament and Government.

The Royal Statistical Society

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Website: www.rss.org.uk

The Royal Statistical Society is a leading source of independent advice, comment and discussion on statistical issues. It promotes public understanding of statistics and acts as an advocate for the interests of statisticians and users of statistics. The Society actively contributes to government consultations, Royal Commissions, parliamentary select committee inquiries, and to the legislative process. In 2009, the RSS celebrated 175 years since its foundation in 1834.

Semta

the Sector Skills Council for Science, Engineering and Manufacturing Technologies

Contact: Customer Services
14 Upton Road
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Tel: 0845 643 9001
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E-mail: customerservices@semta.org.uk
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Society for Applied Microbiology

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Society for Applied Microbiology
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Website: www.sfam.org.uk

*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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Website: www.sgm.ac.uk

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

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

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

Society of Biology

Contact: Dr Mark Downs, Chief Executive
9, Red Lion Court,
London EC4A 3EF
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Website www.societyofbiology.org

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

Society of Cosmetic Scientists

Contact: Lorna Weston,
Secretary General
Society of Cosmetic Scientists
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Website: www.scs.org.uk

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.

Universities Federation for Animal Welfare

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Tel: 01582 831818. Fax: 01582 831414.
Email: ufaw@ufaw.org.uk
Website: www.ufaw.org.uk
Registered in England Charity No: 207996

UFAW is an internationally-recognized independent scientific and educational animal welfare charity. It works to improve animal lives by:

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

SCIENCE DIARY

THE PARLIAMENTARY AND SCIENTIFIC COMMITTEE

Contact: Secretariat
020 7222 7085:
parliamentaryandscientificcommittee@hotmail.co.uk
www.scienceinparliament.org.uk

Tuesday 19 October 17.30
Discussion meeting
Topic and speakers to be confirmed

Wednesday 27 October
Annual Lunch
David Willetts MP Guest Speaker

Tuesday 16th November 17.30
Discussion meeting
Topic and speakers to be confirmed

Tuesday 7th December 17.30
Discussion meeting
Topic and speakers to be confirmed

THE ROYAL INSTITUTION

The Royal Institution has now re-opened following its £22 million refurbishment, including the new Time & Space restaurant, bar and café. All events take place at the Royal Institution unless otherwise stated. See www.rigb.org or telephone 020 7409 2992 for full details and to book tickets. For additional details of these and other events visit www.rigb.org

THE ROYAL SOCIETY

Throughout 2010 the Royal Society is celebrating its 350th anniversary in a yearlong celebration of the impact that science has had, and continues to have, on our lives.
The Royal Society hosts a series of free events, both evening lectures and two-day discussion meetings, covering the whole breadth of science, engineering and technology. In addition for its 350th celebrations the Society is teaming up with major cultural institutions in London as part of its Capital Science programme. Events, exhibitions and conferences are also being held in over 70 museums and galleries around the UK as part of the Royal Society's Local Heroes programme. For further details, please visit http://royalsociety.org/events/

THE ROYAL ACADEMY OF ENGINEERING

3 Carlton House Terrace, London SW1Y 5DG
www.raeng.org.uk/events or
events@raeng.org.uk
020 7766 0600

THE ROYAL SOCIETY OF CHEMISTRY

For details please contact Dr Stephen Benn
benns@rsc.org or phone 0207 440 3381

ROYAL SOCIETY OF EDINBURGH

22-26 George Street, Edinburgh EH2 2PQ.
Tel: 0131 240 5000 Fax: 0131 240 5024
events@royalsoced.org.uk
www.royalsoced.org.uk

BRITISH SCIENCE ASSOCIATION

Please visit
www.britishscienceassociation.org for events programme.

ROYAL PHARMACEUTICAL SOCIETY OF GREAT BRITAIN

Contact: events@rpsgb.org
www.rpsgb.org/events

THE LINNEAN SOCIETY OF LONDON

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Unless otherwise stated events are held at the Linnean Society of London

SCIENCE IN PARLIAMENT sip
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BIVDA

MAKING BRITAIN HEALTHY: UNLOCKING THE POTENTIAL OF IN VITRO DIAGNOSTICS IN THE NHS

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

However, to fully realise these patient benefits and cost efficiencies we need the Government to:

- Encourage increased access to point of care diagnostics in the community - allowing more rapid treatment of patients in a setting convenient for their daily lives
- Address the way money flows within the NHS to reduce perverse incentives which block the use of new tests *or* better use of existing tests
- Ensure that the DH supports NHS organisations in embedding recommendations and guidance for diagnostics from NICE

About BIVDA

BIVDA is the national trade association for the manufacturers and distributors of IVD products in the UK. We currently represent more than 95% of the industry and over a hundred organizations ranging from British start-up companies to UK subsidiaries of multinational corporations. BIVDA members employ over 8,000 people in this country including in manufacturing and R&D, with a total industry turnover of approximately £900 million of direct sales.

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

British In Vitro Diagnostics Association · 1 Queen Anne's Gate, London SW1H 9BT
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