SCIENCE IN PARLIAMENT
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Spring 2009

Food Security

Public Health

Nuclear Waste

Fundamental Research

Protein junctions between intestinal epithelial cells. Each cell is about 20 microns across.

The Journal of the Parliamentary and Scientific Committee

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SCIENCE IN PARLIAMENT

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

The Parliamentary and Scientific Committee

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

Dr Brian Iddon MP
Chairman,
Editorial Board
Science in Parliament

We welcome your comments on the first edition of SiP published in the new format. We have introduced colour on the inside pages to a limited extent, used a new font style and broken up the text by highlighting key phrases from the interesting articles.

Congratulations to the EPSRC on publication of the first edition of its attractive new quarterly magazine PIONEER. One of the headlines that caught my attention was 'New skin' for self heal planes. Aerospace engineers at Bristol University have developed a 'skin' for aeroplanes that mimics the healing processes found in nature should it suffer fatigue or be struck by an object such as a stone.

On 14 January, the Minister of State at DEFRA, the Rt Hon Jane Kennedy MP, made a Statement (*Official Record*, 486, column 14WS) about creation of the Food and Environment Research Agency, a new DEFRA executive agency, vested on 1 April 2009 by merger of the Central Science Laboratory, the Plant Health Division/Plant Health and Seeds Inspectorate and the Plant Variety Rights Office and Seeds Division. We wish it well.

President Barack Obama has appointed one of the world's leading champions of climate change, Harvard physicist Prof John Holdren, to the post of Chief Scientist at the White House Office of Science and Technology. Prof Jane Lubchenco, a respected climatologist, is to head the National Oceanic and Atmospheric Administration (NOAA) and Nobel prizewinner Dr Steven Chu has been appointed to the Department of Energy. These appointments send a clear signal that science will no longer be sidelined in America as it was under George Bush.

Members of the IUSS Select Committee have been receiving reports about the difficulty of winning grants from the EPSRC. I have visited a number of universities to meet the scientists who are complaining; some of them have returned from the USA for the reason given above. Complaints about supporting fundamental research were also made at an Institute of Physics roundtable event held on 28 October last year. My concern is that British educated scientists are threatening to return to the USA now President Obama has been inaugurated.

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SCIENCE AND POLICY

Lord Sutherland of Houndwood
Chairman, House of Lords
Science and Technology
Select Committee

The intersection of science and policy has many faces. It might be the way in which public misperceptions of the risks of MMR now threaten the outbreak of a disease which we thought had been safely contained – measles; it might be how well informed the arguments about the commissioning of a new wave of nuclear power stations are; it might be about whether resources for research in science generally, or in specific areas are adequate; it might be….and so on. The list is long and each example is important.

The House of Lords Select Committee on Science and Technology has proved itself over the years to be able to make significant contributions to these debates. Fortunately, the remit given to it is wide. Essentially, however, its focus is upon developments which require detailed assessment of our national understanding and capability in both science and technology.

This has two main aspects to it: the first is the detailed scrutiny of policy which is dependent upon or is influenced by developments in science and technology – for example we have just embarked upon a study of the impact of the development of various nanotechnologies upon food safety (to be chaired by Lord Krebs). For this, the main focus of the inquiry will be a detailed assessment of relevant technologies both in this country and elsewhere (for example the USA) and their potential benefits and possible risks.

The second is less sharp in outline, but not less precise in outcomes. One example is a report published over two years ago on Science and Ageing. The focus there was the emphasis, or lack of it, on our capacity as a nation to mobilise the various strengths we have in scientific research to prepare for the massive demographic shifts taking place in the UK and elsewhere, in both developed and developing countries. One outcome has been a significant shift in emphasis in setting budgets and priorities in both Research Councils and in relevant charities.

A separate and rather different example of the exercise of influence on Government and other sector awareness of developments in science and technology, was the report chaired by Lord Broers on Personal Internet Security, published in July 2007. The Government response shared one characteristic with the report on Science and Ageing – it was wholly inadequate.

In each case the subsequent debate in the House of Lords illustrated the core of the problem. What is apparent to the members of the Committee, but not always, evidently, to the Government, is that developments in science and technology do not confine themselves within Cabinet and Civil Service demarcations of policy boundaries. The Government response in each case was effectively a scissors and paste job of comments from a variety of Departments each separately and individually evaluating a specific recommendation or comment. The one noticeable feature was lack of (to use an apparently almost deceased phrase) 'joined-up Government'. Thus the loss of personal data from at least three different Departments (Treasury, Defence and Health) within weeks of us being reassured that all was in hand, was not even considered as a possible generic problem. The complacency, as became apparent in the autumn of 2007, was breath-taking.

I am happy to record that since then a further evidence session with two Ministers – Vernon Coker and Baroness Vadera – has moved things on, and that there is now a regular exchange of reporting letters between the Minister now holding overall responsibility and the Committee.

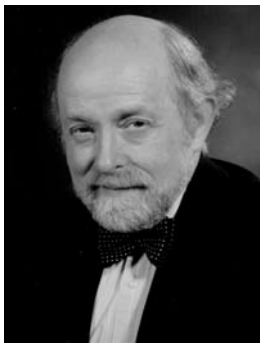
These examples illustrate well the working pattern of the Committee and the context of the interaction between science and policy within which its work takes place. The Committee is not set up to hold and exercise legislative powers, but it does have a variety of means of exercising influence.

Most obviously the Committee prepares and publishes two or three Reports each year. These are detailed evaluations of the significance for policy of particular advances in the understanding and practice of science and technology. We always have the benefit of a specialist in the appropriate field, and scientists, Ministers, civil servants and administrators will attest to the thoroughness of the oral evidence sessions which follow up the prepared and submitted written evidence.

There is debate on the floor of the House on each Report following the Committee's evaluation of the written Government response. This requires an appropriate Minister to respond at the end of the debate. As we find thereafter, those who gave specialist written and oral evidence, as well as at times the media more generally, have a more informed and evidenced based platform to continue with the Committee in informing and critically evaluating the development of Government policy.

. . . developments in science and technology do not confine themselves within Cabinet and Civil Service demarcations of policy boundaries. . . .

A PRAGMATIC ENERGY POLICY FOR THE UK



Ian Fells
Co-author: Candida Whitmill,
Fells Associates

"Energy is the life blood of civilisation; without a secure supply we slide into anarchy and barbarism." Ian Fells

Over the next decade more than one third of our electricity generating capacity will be retired; that is some 23GW of ageing coal, nuclear and oil-fired stations. What will replace them? Not new nuclear stations which cannot be built in time despite the recently rekindled Government enthusiasm for nuclear power. New clean, coal-fired power stations could, but there is a strong environmental lobby opposing their construction; renewable electricity, particularly wind, has been advocated as the solution, but the Government's own figures (BERR 2008) show that we cannot expect more than 14 per cent renewable electricity by 2020, well short of the published targets. The outlook is bleak. The default position is to build more gas-fired power stations, which can be built reasonably quickly but that locks us into an even greater reliance on imported, expensive natural gas for our electricity supply which compromises our energy security.

There are already plans to build 9GW of new gas-fired generation; no doubt more will follow as stalemate occurs with new coal, and yet more procrastination over carbon capture and storage technology (CCS) which could transform the prospect of CO_2-free coal generation, but a demonstration plant will not be available before 2014, if then. Time is running out.

The Government is belatedly realising that a market-led energy policy will neither deliver a secure electricity supply nor protect the environment from climate change. Matters are not helped by those politicians that boast that the UK leads the way in Europe, whereas we are third from the bottom in the renewable energy league table and CO_2 emissions are higher now than when the Labour Party came to power in 1997. Even more worrying and paradoxical is the statement by the Energy Minister, Mike O'Brien on the Today programme (November 12) that despite stark warnings from industry and figures on the Government's own websites, not only will the lights not go out by 2015 but they will shine more brightly. There seems to be a hopeless mismatch between political rhetoric and engineering reality. For informed consumers it is like watching a slow motion train crash.

. . . not only will the lights not go out by 2015 but they will shine more brightly. . .

How can we address first the **short term** problem, the impending energy gap opening up in the middle of the next decade and then develop a **longer term** strategy to meet the 'challenging' target of an 80 per cent reduction in CO_2 emissions, running up to 2050?

We need to commission the equivalent of two new power stations every year through the next vulnerable decade. As an emergency measure the lives of some of the nuclear stations due to be decommissioned over the next few years could be extended but at some considerable cost. In the same way, coal stations due to close by 2015 because they will not meet the new EU emission targets could be kept going, but this will attract large fines from the EU.

New electrical connections to Norway and Germany and a second line to France could give us the added security of being part of the European super-grid and they could be laid relatively quickly, within three years.

Gas storage facilities should be markedly increased as a matter of urgency; we lag far behind our European neighbours and this exposes us to the volatility of the gas market. 'Electricity from waste' incinerators could be built around large conurbations and provide substantial generating capacity (as well as easing the landfill problem). Improved energy efficiency via much tougher building regulation could also play a part. The supply infrastructure must be strengthened to make these actions workable.

These suggestions are not new but need to be part of a strategic plan which must be implemented urgently. It will require Government intervention and real political will.

In the **longer term**, post 2020, nuclear power will come into its own and a mix of renewables, not just wind, (the Severn Barrage for example) will stand alongside gas and coal-fired generation with carbon capture (CCS) in place. It will be expensive and if we are to even approach 80 per cent reduction of CO_2 by 2050, all CO_2-free electricity, including nuclear, should attract a premium to encourage its installation.

Action, not yet more consultation, is required now if we are to implement a workable, pragmatic energy policy. Recovery of our weakened economy depends upon it.

"A Pragmatic Energy Policy for the UK", which includes "A Route Map to Energy Survival in the UK" can be downloaded from www.fellsassociates.com.

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December 2008.

REF MUSTN'T UNDERMINE COLLABORATIVE SCIENCE

Rob Wilson MP
Shadow Minister for
Higher Education

HEFCE Chief Executive David Eastwood was right to boast last month that "The RAE gave the UK much to celebrate and the world much to envy." The 2008 RAE has demonstrated to the world that UK universities are producing a huge amount of internationally leading research. Perhaps the most interesting aspect of the review was that world-class research was evident throughout the UK's diverse set of institutions and not just found in the 'elite' collection of Russell Group Universities. For example, 5% of the University of Winchester's research was assessed as 'world-leading' and yet Winchester was only established as a university in 2005 and the University of Hertfordshire jumped from 93rd in 2001 to 53rd in the RAE league table. Overall, 49 institutions showed some form of world-leading (4*) research, 16 universities had either 4* or 3* work in all their submissions and 118 institutions had at least 50% of their research rated either 3* or 4*.[1]

Research in the UK sector is demonstrably in good shape and HEFCE needs to ensure in March that funding follows the highest quality research wherever it is found. But soon, when the dust has finally settled and funding for research has been announced, the 2008 RAE will fade into a distant memory and universities will start to prepare their strategies for the next assessment in 2014. The newly proposed Research Exercise Framework the Government has announced will be based on a metric system that includes assessing the quantity of citations.

It is of concern however, that many academics have criticised the new assessment model. They believe that if it's not carefully introduced it will do little to encourage collaboration between disciplines and may even prevent the assessment of quality research remaining at the heart of the evaluation process.

This concern has even been confirmed by HEFCE's own advisors. When responding to whether citation analysis provides an objective measure of research quality they said a resounding "No. Bibliometric indicators measure impact rather than quality".[2] Additionally, a report published by researchers at the University of Wolverhampton's School of Computing and Information Technology that studied the citation level between mono- and multi-discipline research found that regardless of quality "the major difference between mono-disciplinary and multi-disciplinary indicates higher citation for mono-disciplinary." This trend was most apparent in many of the sciences, on average the level of citation for mono-disciplinary articles was more than double that for multi-disciplinary articles for health, physical and life science research. But most affected was multi-disciplinary research in astronomy, physics and chemistry. Papers in astronomy and physics received 4.2 times fewer citations than those in single-subject journals and chemistry papers in multi-disciplinary journals received 3.7 times fewer citations. As a result, the report's lead academic, Mike Thelwall, told the Times Higher that the findings should "put a spanner in the works"[3] for the REF.

Interdisciplinary research is vital if human-kind is to rise to the world's foremost problems. Research institutes that focus on strategies to combat 'grand challenges' rather than 'grand disciplines' are at the centre of this. The Walker Institute at my local University, Reading, is a great example because it brings together expertise from a wide range of disciplines in order to produce a better understanding of future climate change. The Wellcome Trust funds the Sanger Institute which brings together sciences to further our knowledge on genomes. Institutes such as these, which place key problem-solving at the centre of research are at the forefront of innovation. It would be a huge shame if our wonderful universities are unable to also contribute to the challenges multi-disciplinary research can solve because the REF unintentionally prevents, or discriminates against this practice taking place at our institutions.

The 2008 RAE proved that our universities are world class research institutions, but if Ministers fail to listen to the concerns of academics the sector's 'world-leading' reputation will, like the RAE, become a fading memory.

1 Times Higher - http://www.timeshighereducation.co.uk/story.asp?sectioncode=26&storycode=404786&c=2

2 HEPI: 2007; *Evaluating and funding research through the proposed Research Excellence Framework*

3 *Times Higher* http://www.timeshighereducation.co.uk/story.asp?sectioncode=26&storycode=403796

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ENGINEERING AND SOCIETY

Norman Haste OBE FREng

'Engineering' and 'engineer' have become the most misused words in the English language. The importance of engineering to society is sadly not understood and not appreciated by many parts of society. The great contribution made by engineering and science to our everyday lives is taken for granted by most, certainly up to the point when something goes wrong and engineers are expected to put things right whether it is dealing with disasters, providing basic infrastructure in a war zone, or dare I say it, repairing the domestic appliances which we have all come to rely on. The challenge for the future is to bring engineers and engineering to the forefront of our strategic planning and policy making, to seek engineering advice at the beginning of these processes and not the end and to recognise that we are now more dependent on engineering to provide and maintain our basic life support systems.

Engineering is the application of science and the healthy interaction between scientists and engineers is a powerful and productive relationship. This interaction has blossomed particularly in the last 50 years and more productively in the last 30 years. The benefits to society are easily identified such as the advances in telecommunications, the growth of the Internet Super Highway, the winning of oil from the depths of the North Sea, the major advances in medical science, and there are many more examples.

We take many day to day things for granted. When we fill our cars up with petrol do we give it a thought or wonder how the processes were engineered from geologists locating the oil field to us getting the refined product to the pumps on the garage forecourt? When we pick up the telephone and listen to a computer generated voice message or talk to someone on the other side of the world with the clarity of the person being in the next room do we have any inkling of how all this is made possible? When we watch 16 cars racing round a track for 2 hours on a Sunday afternoon do we really appreciate that behind an F1 racing team there are 250-300 engineers including materials specialists, fuel technologists, etc all at the cutting edge of their discipline? Do we understand the benefits which spin off to the wider automotive industries? When we hear of people undergoing Keyhole Surgery for what previously would have been major operations requiring long periods of convalescence do we think about the massive strides achieved through the joint developments by engineers and medical practitioners?

The advent of computers to commonplace universal application by the mid-nineties has had the most obvious impact on society and is something recognised by all generations. Young children see the computer as an essential part of daily life and are probably the leading exponents of its power. The worldwide web was the brainchild of an engineer Sir Tim Berners Lee and has developed to a level of usage which would have been hard to comprehend at its inception. It is probably not so well appreciated that computers and software have enabled engineers to design ever more sophisticated structures, model some of the World's greatest grand schemes and develop robotics for many applications. Engineers of all disciplines are able to deliver solutions to increasingly complex problems for the benefit of Society.

Engineers are not however infallible and any perception of engineering being 'a precise science' can be dispelled by an understanding of the vulnerability which comes with continually extending boundaries. Engineers are often dealing with things which they cannot control precisely. A recent simple example is the damage to a major undersea cable which carries internet traffic between Europe and the Indian Sub Continent via the Middle East. Just before Christmas internet usage in the Middle East was severely

When we fill our cars up with petrol do we give it a thought or wonder how the processes were engineered from geologists locating the oil field to us getting the refined product to the pumps on the garage forecourt?

affected by the damaged cable which took several days to locate and repair using a remotely operated vehicle designed by French engineers in the knowledge that such events occur. The cause of the damage was thought to be sub-sea seismic activity – another uncontrolled event which added to the engineers' challenges. The ability to rectify the problem quickly and minimise the impact puts pressure on engineers. This comes from the realisation of the importance of the loss of benefit.

Engineers must be reactive as well as proactive in order to maintain the benefits which they bring to society. In this regard, engineers are realists with a deep understanding of the parameters they work with. Their contribution in all disciplines to society is vast and whilst the engineering profession is often criticised for having too many voices which makes listening difficult for non engineers. We must remember that engineers operate in many disciplines ie structural, civil, mechanical, electrical, aeronautic, space, oil & gas and the list goes on.

The challenges facing engineers in the future will be in several areas. I single out what I call the Life Support Systems ie Energy, Water, Climate Change and Environmental Sustainability and Transport Infrastructure.

It is more than 20 years since the three-year long Public Inquiry into Sizewell B, the last Nuclear Power Station to be built in the UK, ended, and fourteen years since the plant was commissioned. It was the last major power plant to be built in the UK and we have seen a gradual shutdown of ageing Nuclear Stations which have provided 16-20% of the UK's power requirements. There have been numerous papers at Government level with advice sought from engineering bodies which have consumed many months of work and despite the strength of advice to proceed with the building of new Nuclear capacity, we still do not have a well defined way forward. Engineers will be severely stretched in the coming months and years to maintain power supplies to the nation and industry. The need for and the adverse economic impact of Load shedding in South Africa during the last two years are now real possibilities for the UK. This could have been avoided with timeous implementation of a balanced energy policy which of course should incorporate the use of renewables. The need for a strategic Energy Policy which spans the lives of Parliaments and the need for engineering advice to the most senior level of the Civil Service on a continuing basis has never been stronger. There is no doubt that with a growing world population and the poverty experienced in parts of India, Africa and South America, there is insufficient water to go round. The challenge of water supply to the world and the investment needed must be addressed by all developed countries. Engineers are at the forefront of finding solutions and it will be engineers who will be expected to solve the worldwide problem. This challenge needs to be given prominence by all Governments who will need close advice from engineers in the coming years.

The impact of Global warming and Climate Change is a vast and complex challenge which requires all the major factors of energy consumption, investment in renewable sources of energy, waste management and disposal and a lifestyle change for most of us. There is also the need to recognise that if we are to meet a target of 20% of energy consumption from renewable sources by 2020, then it is essential that all stakeholders are brought together to work in a collaborative and cohesive way rather than through disparate ways which are not co-ordinated. There must be a recognition that there is a cost to bear for reaching this target. The Abu Dhabi Government has commissioned the first carbon neutral city called MASDAR which is under construction. It will be a development based on the employment of renewable energy sources and will be car free in order to reduce carbon emissions. This is a bold venture which the whole world will learn from and funded by a Government which can afford it and which has a great vision. Engineers are spearheading this initiative working with the stakeholders and driving a future agenda with total government backing.

If we are to meet the targets for energy consumption, the reduction in carbon emissions and improve the quality of life for everyone, then we have to tackle probably the biggest challenge which engineers face and that is how we move masses of people every day without building more roads and without increasing car ownership. The UK Railways are now very efficient as a result of the investment during the last ten years and moving 6 million people a day into and out of London is testimony to this. On our roads however, we experience increased congestion and a dependency on road transport for widespread distribution of goods, including food. The movement of goods around the world has been made more efficient by containerisation and large ships which together with efficient ports can turn round vessels in hours rather than days. If the population still wishes to be able to get in the motor car at any time and go any place with complete freedom, then it must recognise that there is a price to pay. The subject of road pricing has been with us for several years but in looking forward we will have to bear the cost of that freedom or we shall have to engineer solutions which will make public transport the preferred way of travelling. The extension of high speed rail lines with feeder lines and good localised transport systems eg trams, light rail, etc are not beyond realisation. Engineers have been facing this challenge for a long time but it will take on much greater significance in the coming years.

The most serious challenge for engineers is, however, to attract more young people into the engineering profession. I have tried to bring an awareness through this short paper of the contribution made by engineers to society and to the everyday lives of all of us. I have no doubt that there is a lack of awareness of the role of engineers throughout society and at the highest level of decision making in the UK. I believe that there is a need for Government not only to recognise what engineers contribute through research, collaboration with the wider scientific community and through the application of science, but to value its importance. There should be a much greater involvement of engineers at the 'top table' and for that involvement to be visible to the whole country. I have no doubt that the best young brains will then be inspired to take up a career in engineering because they see it having the same societal perception alongside the other equally important professions.

THE HALDANE PRINCIPLE

Professor Bill Wakeham
Vice-Chancellor,
University of Southampton

Professor Wakeham was Chairman of the recent RCUK Review of UK Physics.

In the Department for Innovation, Universities and Skills, the common rooms of our higher education institutions, in the meeting rooms of the Research Councils and in debates within science policy think-tanks, the term 'Haldane principle' has regularly been heard over the last few years. To a scientist such as myself, this is more than slightly odd, given that this 'principle' has never been formally written down, and derives from a Government report that was published a century ago. So where does the Haldane principle fit into the research policy landscape of the 21st century?

Richard Burdon Haldane, the author of the influential report on the machinery of Government published in 1918, was a liberal politician from a family with strong scientific connections. His brother was the physiologist John Scott Haldane, and he was uncle to the eminent geneticist and evolutionary biologist JBS Haldane. The Haldane report, written against the backdrop of the First World War, is wide ranging and research policy forms only a small part of it. But it is for what Haldane says about research or at least what he is believed to have said, that the report is best remembered. The Haldane principle, as it seems to be understood by most people, states that decisions about the specific research topics to be pursued using public funding should be made by researchers and not by politicians. The report itself paints a rather different picture about the relationship between research and Government. On the one hand Haldane argues that Government departments should commission their own research to inform policy-making in their area of responsibility. On the other hand, the report says that 'general research' should be the responsibility of a specific ministerial department, but there is no recommendation for arms-length bodies within the report. And while Haldane is happy with the existence of bodies such as the Medical Research Committee (the predecessor of the present Medical Research Council), the report does not propose changes to membership of the committee which included 3 politicians at the time. Notwithstanding this difference of interpretation there is now a general, if somewhat loose, understanding of what the Haldane principle means but a debate about its implications.

The present administration's interpretation of the Haldane principle was summarised in April 2008 by John Denham in a speech to the Royal Academy of Engineering. He stated that "three fundamental elements remain entirely valid:

- That researchers are best placed to determine detailed priorities.
- That the government's role is to set the over-arching strategy; and
- That the Research Councils are 'guardians of the independence of science'"

The major policy consequence of the Haldane principle is the very existence of the Research Councils. Government determines what Research Councils should exist and the areas of research they should each cover in quite broad terms. Government also decides the overall level of public spending on research, and what fraction of that should be devoted to the Research Councils as well as the distribution among them. In this process it is guided by advice from its chosen Scientific Advisors. As independent, non-Departmental Public Bodies, each Council then decides which research to fund on the basis of excellence with the help of the research communities themselves through the process of peer review. This ensures that funding is channelled only to research that meets rigorous quality standards; standards that are derived and implemented by the researchers themselves. We should, of course, remember that there are limits to the ability of researchers to make decisions about research funding. This is especially obvious in the comparison of unrelated research areas. For example, it is

. . . it is important to keep in mind the real objective – a vibrant and healthy research base, with it attendant benefits for society and the economy. . . .

hard to see how researchers, however eminent, could make a direct comparison of the quality of, say, projects in particle physics and mediaeval history. But within a single discipline or between closely related ones, researchers are clearly well placed to make these difficult assessments. It is this set of notions which provides legitimacy for the high-level set of strategic governmental decisions supported by detailed quality-based research judgements.

What this illustrates is that, valuable as the Haldane principle is in guiding the development and implementation of research policy, the principle is a means to an end not an end in itself. In considering the role and importance of the Haldane principle it is important to keep in mind the real objective – a vibrant and healthy research base, with its attendant benefits for society and the economy.

In conducting an in-depth review of the health of Physics, the Panel that I chaired examined thoroughly the operation of the Haldane principle, at least in relation to the funding of physics research. Our conclusions are reassuring. We found no evidence that there has been an erosion of the basic principle of independence on which the Research Councils are founded.

However, the real world is not as simple as we might like it to be. In practice the decisions about the expenditure on research are seldom divided neatly into those that are strategic and those based merely upon the quality of what is proposed; instead there is a continuum of types of decision. At one end of the spectrum are decisions about the funding of specific research projects and programmes. These clearly fall on the Research Councils side of the decision making process and my Panel found no evidence of inappropriate Government interference here. At the other end of the spectrum there is the decision on the allocation of funding between the Research Councils. It is hard to see how the Councils themselves could make these decisions, and this is the proper role of Government in deciding the use to which taxpayer's money is put. But between these extremes there is inevitably a grey area. A few examples will serve to illustrate.

I argued above that allocation of funds between the Research Councils is a matter for Government, but what if Government sets conditions on the size of the allocation to one or more Councils, such as requiring them to engage in specific cross-Council research programmes, or to collaborate with specific external partners? There is evidence that both of these happened during the last allocation process, and some would argue that this contravenes Haldane in its strict sense. Another grey area, which exercised my review Panel, is the interface of research and regional economic policy. What criteria should be used to determine the geographic location of large scientific infrastructure, with the related high-value jobs and potential for economic regeneration? Is this a matter for scientific assessment alone, or is there a place for the wider perspective that Government can bring such as where in the country the greatest economic benefit may be gained?

. . . will decision-making based on research-based criteria alone result in the critical mass of investment required to tackle the major issues of our time such as climate change or energy security? . . .

To enter into a debate about which side of some notional Haldane dividing line these decisions lie is, in my opinion, missing the point. Sticking to the Haldane principle, whatever that may mean, should not be our objective. Rather our aim should be to ensure that we have a productive economy and vibrant society for which a healthy research base is a requirement. The experience of the last 100 years supports the idea that application of the Haldane principle – independent Research Councils, and their reliance on peer review – has served the country well in facilitating the development of a research base that is, by some measures, the best in the world. The latest Research Assessment Exercise outcome would certainly support that claim as would our recent review of Physics specifically. But it does not follow that slavish adherence to the Haldane principle will always produce the best outcome. For example, will decision-making based on research-based criteria alone result in the critical mass of investment required to tackle the major issues of our time such as climate change or energy security?

I think not; there must be a place for some strategic direction of the research effort both within the disciplines of a particular Research Council and between the Research Councils. This does most definitely not mean that research should only be conducted to meet short term economic goals, far from it, but rather that there must be a balance between the research areas in which there is a strategic need to conduct novel work and those areas which are driven by curiosity alone. So instead of arguing about the application of a century-old principle perhaps the energies of the research community, the Research Councils and Government would be better spent working together to ensure the best possible decisions on the spending of the limited resources available for research.

FOOD; ADDRESSING THE UK'S GRAND CHALLENGES

Catherine Reynolds
Head of Communications for the Institute of Food Research

The Institute of Food Research is a key player in food security and diet and health issues, particularly healthy ageing.

Alongside climate change, food is at the top of the UK's strategic agenda and central to both the Government and Biotechnology & Biological Sciences Research Council's research priorities. On Norwich Research Park an Institute of the BBSRC delivers crucial research outcomes that assist government and industry in addressing the challenges of food security, diet and health including obesity, and healthy ageing that we face as a nation. The Institute of Food Research (IFR) is the only institute in the UK wholly dedicated to the food science, diet and health agenda.

IFR has had a laboratory in Norwich for 40 years, and a January 2009 analysis confirms it is second only to Tufts University in the USA as the top institution world-wide in agricultural and food sciences, based on the scientific impact of its scientists [1].

Assessing the broader impact of such laboratories is more difficult. But in 2008, DTZ were commissioned to examine IFR's performance, and their data, for example examining some aspects of food safety research, estimate the added value of IFR work supporting UK processed chilled products to be £22.8M pa. Extending the shelf life of products through IFR's work saves UK consumer wastage valued at £24.6M pa. And if ComBase, a predictive microbiology tool pioneered at IFR, saves the EU food sector even 1% of its R&D budget, this is worth £22M pa.

Norwich Research Park (NRP) is a unique constellation of activities that does not exist elsewhere in the UK. NRP partner organisations – the IFR and the University of East Anglia, the John Innes Centre, The Sainsbury Laboratory, and the Norfolk and Norwich University Hospital – are uniquely well-placed to respond to the great global, national and regional challenges of our times. IFR is leading and is the focal point of the NRP's initiative in food science, diet and gastrointestinal tract health. It is also undertaking joint ventures with other BBSRC institutes to enhance the impact of the Research Council's spend.

Through the development of the Norwich Science and Innovation Vision, aiming to deliver the best science in a sustainable way, NRP partners have developed a series of alliances – amongst them the Centre for Preventive Medicine and the Plant and Microbial Natural Products Initiative. Research is leading-edge and cross-cutting, but with a science-to-clinic applicability.

Professor Richard Mithen has, through the BBSRC-supported technology transfer company PBL, extensive patent protection on broccoli lines with enhanced levels of glucosinolates. His fundamental results from a laboratory setting are also being translated into clinical trials in people, as opposed to extrapolating from animal models. In prostate cancer, the most common non-skin cancer for males in western countries, he showed that at-risk men with the GSTM1 gene (around half the population) who ate broccoli had changes in gene expression that may be associated with the reduction in cancer risk.

Professor Vic Morris has shown that a fragment released from pectin, found in all fruits and vegetables, binds to and is believed to inhibit galectin 3, a protein that plays a key role in cancer progression. This first step opens the way to a new and exciting area of research in bioactive carbohydrates. The next is to identify how pectin fragments can be taken up by the body and released so that they can exert their effect on cancer cells, which could result in functional foods with added 'bioactive pectin' as well as providing more conclusive evidence for the importance of eating at least '5-a-day'.

. . . science may be fundamental, but industry recognises not only the need, but also its potential impact. . . .

Allergy is a major health issue in the UK and IFR is an international centre of expertise on both immunological and biophysical aspects of sensitisation to food allergens. Combining expertise in allergy with our interests in GI tract microbiology, in work co-funded by BBSRC and Yakult, Professor Claudio Nicoletti has found, in the first reported human study of its kind, that a probiotic drink containing *Lactobacillus casei* can modify the immune system's response to grass pollen, a common cause of seasonal hayfever. The next stage will be to perform a similar study to see if the immunological changes translate into a real reduction in clinical symptoms and to examine the mechanisms involved.

The prospect of helping people protect their health through active diet choices is on the horizon.

Food safety is a vital aspect of both food security – not only from the point of view of the food supply, but also of food safety in the context of climate change, where the behaviour of food borne pathogens may change, or new species become problematical. The Institute takes a multidisciplinary approach in studying the behaviour of *Campylobacter, Salmonella* and *Clostridium botulinum* to protect the health of consumers.

For example, mathematicians at IFR, in collaboration with the University of Reading, have recently developed a method to measure and quantify the damage that a bacterial cell population suffers during heat treatment. The theory is important in studying the efficiency of heating, for example by microwaves, where the temperature distribution is broad. Their new approach will enable the food industry to optimise the "Use by" dates of, for example, Ready-to-Eat products.

A variety of mechanisms are in place, both internal and BBSRC-sponsored, to foster positive economic benefit. The Institute has a particularly demanding role helping to ensure the long-term competitiveness of the UK agri-food industry – working in collaboration with companies, often funded by Government schemes designed to drive economic impact, but with advances always grounded in academic excellence.

Low fat foods are an essential part of tackling rising levels of obesity, but many lack the appeal of the full-fat product. Dr Peter Wilde's team, part-funded by the Department of the Environment, Food & Rural Affairs through the Food Quality & Innovation LINK scheme, have been working with scientists from Leatherhead Food International to investigate the concept of multiple emulsions; that is, each oil droplet in the emulsion contains many water droplets – Water in Oil in Water (WOW) emulsions. When consumed, the structures that are sensed are still oil droplets (but 40% less fat), but giving a similar sensory response to the full fat emulsion. Formulation is critical, and the next step is to research applications in specific food product areas.

IFR is an internationally-renowned centre for training the next generation of scientists working in food, diet and health. It also has in place and is enhancing innovative biomedical research training programmes for junior academic clinicians (specialist registrars, house officers) that involve public and private health care providers.

Research by PhD student Richard Bailey into a condition called dysbacteriosis, a syndrome of growing importance to animal welfare and industry economics, has recently been recognised with a Scholarship Award by the British Poultry Council. His industry co-sponsor through the CASE Award scheme is poultry breeding company Aviagen Ltd. Complex science addressing the problem is only feasible in a research environment such as that fostered in IFR's gut health programme. The science may be fundamental, but industry recognises not only the need, but also its potential impact.

IFR scientists are encouraged to be entrepreneurial. Part of our strategy is to define a small number of activities that offer good potential for commercial development – 'Exploitation platforms'. An example is the Dynamic Gastric Model developed by Dr Martin Wickham that simulates human digestion for the first time from a true physiological perspective. The device, made from sophisticated plastics and metals, can withstand corrosive gut acids and enzymes, and can be fed real food. Interest in this model from companies world-wide is being managed, again with PBL support.

A trio of activities directly addresses industry needs: commercial subsidiary 'IFR Extra', launched in 2008 to address industry requests for short-term assistance, matches their needs with bench-expertise and leading edge equipment. Through the Food and Health Network, the Institute provides a forum for knowledge transfer and collaboration where science can make a real contribution to industrial effectiveness and sustainability. And, via FHN Direct, a team of staff meet with a company and discuss their research or development needs in total confidence, responding with potential ideas.

The BBSRC is a major funder of organisations and projects within the Norwich Research Park and, as part of its plans to strengthen the sustainability of research in Norwich, has agreed co-funding and joint employment arrangements with the University for senior appointments at IFR. Noted immunologist Professor Simon Carding has joined to lead research on the integrated biology of the GI tract, and the most recent announcement has been that of a successor to IFR's retiring Director, Professor David White. The Vice-Principal for Research and Enterprise at the University of Dundee, Professor David Boxer, joins the campus in Spring 2009; he will have a vital role ensuring the continuing success of food, diet and health research investments in Norwich.

1 Essential Science Indicators Database of Thomson Reuters, scientific journal articles only, period 1998-2008, rankings by citations per paper.

Front Cover Image by Caroline Weight, a BBSRC-funded PhD student at the Institute of Food Research, using the Zeiss meta 510 confocal microscope at the John Innes Centre. Purchase of this highly-specialised kit was funded by BBSRC and JIC. Caroline is investigating tight junction regulation and pathogenic invasion. Only 1 layer of cells separates the gut contents from the body; the cells are held together by tight junctions, which prevent food and pathogens from spilling out of the gut.

MAKING THE CASE FOR FUNDAMENTAL RESEARCH

Beth Taylor
Director of Communications,
Institute of Physics

WHAT IS FUNDAMENTAL RESEARCH?

Some research is undertaken with very direct applications in mind. Recent examples of applied research in the field of physics include the development of high temperature alloys for use in aircraft, or the miniaturisation of computer chips. The case for funding this kind of research is clear. Commercialisation of the application is expected to lead to a healthy return on the resources required, and in most cases the research is likely to be carried out by private industry or to attract funding from private sector investors.

Some research is undertaken as part of a major programme directed at an area of national or international concern. The cross-cutting programmes announced in December 2007 by the Department of Innovation, Universities and Skills provide prime examples, addressing the challenges of an ageing population, environmental change, sustainable energy and threats to global security. Government has a clear duty to tackle these issues, and a commendable commitment to supporting the research required.

But some research is undertaken purely and simply to investigate the nature of our world, and to expand the frontiers of our knowledge. Sometimes this kind of research is called 'pure' or 'blue skies' or 'curiosity driven' research, but a better description is 'fundamental research' because this is the work which, throughout the history of science, has provided us with the insight to make sense of our environment, and underpinned the development of the technologies we take for granted in the modern world.

It is sometimes assumed that fundamental research in physics is concentrated in the fields of particle physics and astronomy. It is certainly true that research in these areas is almost solely fundamental in nature, and that they encompass a wide range of significant activities in which the UK has an outstanding reputation. Fundamental physics research, however, is much wider than that. From biological physics through nanotechnology to superconductivity, fundamental research is carried out in all of physics' individual branches.

MAKING THE CASE

Traditionally, the Research Councils have supported fundamental research in the UK. However, there is real concern among the science community that an increasing focus on potential applications, and the prioritisation of funding towards directed programmes, may put support for fundamental research at risk. At the present time in particular, increasing pressures on government funds inevitably increase the threat to continued investment.

In October 2008, the IOP hosted a roundtable discussion bringing together interested MPs, peers and physicists from academia and industry, to review the case for fundamental research. There was general agreement that a purely utilitarian view is wrong – that knowledge has a value over and above any reasonably predictable outcome. But there was also a recognition that significant sums of money are required to maintain current programmes, and that their value needs to be clearly articulated to justify continued government support.

Speaking from their own experience, the researchers illustrated the benefits to society which flow from fundamental research (in addition to the advancement of knowledge). Three clear benefits are the development of new technologies; the excitement and inspiration that attract young people into science; and the

. . . Almost all of the new technologies that we take for granted in modern life are unpredicted – and unpredictable – spin-offs from earlier fundamental research. . .

enhanced capacity of UK researchers to meet new challenges through innovation.

DEVELOPING NEW TECHNOLOGIES

Almost all the new technologies that we take for granted in modern life are unpredicted – and unpredictable – spin-offs from earlier fundamental research.

Examples quoted during the discussion included:

- X-rays, lasers and semiconductors are all technologies which are widely used in every aspect of our lives, and are enormously beneficial to society. They all stem from discoveries made through fundamental research, undertaken without any application in mind, and anything up to 50 years or more before commercialisation;
- The phenomenon of superconductivity was discovered as a result of fundamental research in 1911, but the practical deployment of superconducting magnets was only made possible in the 1960s with the development of alloys able to withstand the high magnetic fields involved. Now superconducting magnets are widely used in MRI scanners in hospitals, in mass spectrometry equipment for chemical analysis, and in magnetic separation processes, as well as in particle accelerators;
- Pioneering work on liquid crystals was undertaken at the Royal Radar Establishment in Malvern in the 1960s. Liquid crystal display technology was made practical by parallel research at Dundee University, 25 years ago, into amorphous silicon. Today, LCD's dominate the market for television and computer screens, and represent a worldwide industry worth hundreds of billions of dollars;
- Quantum Information Technology (QIT) developed from researchers asking fundamental questions, 20 years ago, about the manipulation of data according to quantum laws. QIT is currently at the interface of fundamental and applied research. It offers the potential for a second IT revolution with hugely enhanced manipulation of data and guaranteed secure communications. The UK is well placed to exploit QIT commercially, having been in the field from the very start;
- In atmospheric physics, research into the absorption of different wavelengths of radiation, circulation patterns, the effect of varying combinations of greenhouse gases, and the impact of solar activity is now being applied to modelling the impact of climate change, and has provided input to the work of the Intergovernmental Panel on Climate Change.

These and a myriad of other examples demonstrate how, over a long period, fundamental research has made dramatic technological advances possible, and is still doing so today. Such research may be a bad investment for any private individual – its benefits are unpredictable, may be very long-term, and cannot be exploited exclusively by any one company. But a 1991 report by University of Pennsylvania economist Edwin Mansfield, quoted in the discussion, indicated a 28% return on investment on basic science in the USA. Fundamental research has proved a wonderful investment for society – a classic case of public investment justified by a public good.

PROVIDING INSPIRATION

If the UK is to achieve its ambition of becoming a knowledge-led economy in the 21st century, it needs to attract the brightest and best young people into science. All the evidence suggests that it is the big questions that inspire young physicists – the fundamental building blocks of matter, the nature of black holes, or the origin of the universe.

Viewing figures for programmes like *Horizon,* averaging between 2.5 and 3 million, demonstrate that fundamental physics is popular, and is part of our culture. The continuing popular fascination with astronomy is demonstrated by the presence of an astronomical society in every major town.

There was general agreement at the discussion that another valuable side-effect of fundamental research is its ability to excite, inspire and attract young people into science.

BUILDING UK CAPACITY

Further along the educational pipeline, PhD students and post-doctoral researchers are also attracted into research by the excitement of addressing the big, fundamental questions. Most research funding goes into the salaries of post docs and post grads who go on to work in a wide range of fields including applied research and directed programmes.

Participants in the discussion identified the training of PhD students as the most vital element of knowledge transfer. PhD students were seen as the UK's most important asset – "the only thing we've got to keep us ahead of the rest of the world". As well as developing their own research skills, training research students builds "absorptive capacity", the ability to absorb and exploit the 95% of research done outside the UK.

Young researchers, with prepared minds able to recognise the potential applications of discoveries made through fundamental research, were identified as one of its most valuable byproducts. They will provide the cohort of scientific entrepreneurs who will start the next generation of innovative UK businesses, just as they are the magnet that attracts research-intensive industries to invest in the UK.

CONCLUSION

Physicists undertake fundamental research for one prime reason – to enhance our understanding of the world we live in. But over time their work generates other hugely significant benefits – the development of radical new technologies; the inspiring ideas that draw young people into science; the capacity of our industry to meet new challenges through innovation.

In making the case for fundamental research, IOP is not seeking to penalise applied research, or directed programmes. We believe it is possible to optimise the performance of both basic science **and** UK plc by striking the right balance of funding between applied research, for which private sector investment may be the most appropriate route, and fundamental science, for which public funding is generally the only support available.

Fundamental research is an outstanding investment for society. IOP urges policy makers of whatever party to recognise its value and commit to its long-term support.

THE PROSPECTS FOR BRITISH LIFE SCIENCES AND PHARMACEUTICALS

Dr Richard Barker
Director-General,
Association of the British
Pharmaceutical Industry

Britain is beginning to contemplate its future after the two-headed monster – the unprecedented credit crunch and the deep economic recession – has done its worst.

WHERE WILL THE FUTURE-FACING SKILLS, JOBS, EXPORTS AND PROSPERITY COME FROM?

We have been saying for some time: 'It's the knowledge economy'. The creation and application of intellectual property. The training and attraction to Britain of highly skilled knowledge workers – scientists, technologists, engineers, creative types. High added value brain work to create globally competitive breakthroughs serving global markets.

DOES THIS SOUND LIKE ANY INDUSTRY YOU KNOW?

The life sciences sector, and its most important channel of commercialisation, pharmaceuticals, is already a jewel in our economic crown. 70,000 pharmaceutical company employees support about a quarter of a million others – and similar numbers of public or charity sector researchers are a key part of the effort. The UK has some of the best regarded bioscience universities in the world, working closely with commercial companies to translate the basic bioscience in which we excel into unique therapies. And about one in five of the world's leading medicines were discovered here. But is the sector a secure part of the future?

Businesses periodically conduct SWOT analyses – surveying their strengths, weaknesses, opportunities and threats. Let me do the same for our sector. With the situation we face, it helps no-one to paint an artificially rosy picture, so I'll speak straight from the shoulder.

Our strengths are clear and undisputed. A great track record in basic bioscience, with a disproportionate number of Nobel laureates. And a proven strength in aspects of 'translational medicine' – taking the basic breakthroughs and turning them into so-called molecular 'leads', and turning these into candidates for clinical trial.

As technology has evolved, we have evolved with it. The UK has some of the best biologists looking for new generation medicines among the body's proteins and antibodies. And many of the most important breakthroughs in stem cell biology have been made here.

The NHS is also a strength – but in one main sense only. It is a single system (strictly speaking of course, four systems) with the ability to establish a lifetime relationship with patients and track the course of their treatments and their outcomes as almost no one else can.

Weaknesses, though, are beginning to show. We are no longer attracting more than our fair share of patients for clinical trials. Since 2000, the proportion of UK patients in global trials has dropped from 6% to 2%, which is actually less than our share of the world market (3%). This has happened despite strenuous efforts to build clinical research networks, simplify ethics committees, and 'talk up' the importance of trials for the future. The problem is not far to seek. As for any activity, competitiveness is a function of quality, cost and time. The

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quality of our investigators' work remains high, but – as aggressive competition emerges in Asia and Eastern Europe – our costs are prohibitive and our patient recruitment woefully slow.

We are also no longer a sought-after location for manufacturing. We do not even make the shortlist, when Singapore, Ireland and Bangalore offer tax breaks, regional grants and plenty of highly trained technicians. While some of the sector's manufacturing is routine and low added value, much is the very opposite – sophisticated bioprocessing, cell cultures, sterile handling, etc.

Before depression sets in, let's turn our eyes to the opportunities! Fundamentally, life sciences is still in its infancy. Yes, we have already cracked some of the basic and widespread health problems – most bacterial infections, blood pressure and lipid control, replacing insulin for diabetics. And these have generated large 'blockbuster' markets that have fuelled the industry's growth around the world.

But for the tough targets – targeting cancer cells and eliminating their last traces, turning back the clock on degenerative diseases like Alzheimer's and arthritis – we are still in the foothills. And to crack these problems needs penetrating insights into basic biology – how genes are controlled, how proteins interact, how pathways come together – the kind of stuff we do in Britain as well as anyone.

Now for the threats. Some would say we are lucky. Demand for medicines is one of the more recession-resistant, and the larger pharmaceutical companies are not running out of cash. But the UK pharmaceutical industry is far from immune to the forces of globalisation. In the UK, we face competition from other parts of the world, striving to establish themselves as leaders in bio-science research and investing heavily in their science knowledge base. And a number of these competitors have fast-growing future markets.

Perhaps the biggest threat, however, rests closer to home. It is the risk that the UK Government, distracted by rigours of handling the current downturn, fails to take enough action to boost life sciences. We need to reassure the global leaders of the pharmaceutical industry that the UK offers a long-term, stable environment in which to do business, and ignite uptake of new medicines, in order to repair some of the damage done when the last PPRS deal, which governs the price of medicines sold to the NHS, was renegotiated half-way through its life-cycle.

Let's be blunt. Research and development expenditure in the UK represents nine per cent of the industry's total worldwide expenditure. However the UK represents just three per cent of the total global sales for medicines. So as a nation, the UK is over-represented by a factor of three to one when it comes to the spend on researching medicines against the spend on buying them. This imbalance won't have escaped the attention of global leaders who, in keeping with their counterparts in other industries, are having to make very tough choices about the future direction of their businesses.

So, if we are to have knowledge-based industries on which Britain's future can be anchored well beyond this recession, then the Government needs to pay urgent attention to the research-based pharmaceutical industry for two reasons:

1) The larger company end of the life science spectrum is in the midst of a global restructuring that started well before the recession and will go on long after it. The combination of major patent expiries and falling pipeline productivity is forcing rationalisation of research, scrutiny of trial costs and restructuring of manufacturing facilities.

2) At the smaller company end, things are frankly dire. Small bioscience-based enterprises are struggling to refinance themselves, irrespective of the potential of their research portfolios. These are increasingly important as sources of new products for the whole industry.

So Britain urgently needs to reinvigorate its life science strategy. Yes, we've made progress – greater public investment in research, new clinical networks in the NHS, the PPRS innovation package – but we all know this is not enough to secure our place in the future.

First, we need to carve out a uniquely attractive role for the UK in the new era of open innovation. Most major companies are realising that their partnerships with innovative academics and SMEs will be critically important in new discoveries and in translating them into candidate products. And it is at this end of the innovation pipeline the UK's skills are strongest. We need to build strong clusters of collaboration, through new funding mechanisms, new academic incentives, and new infrastructure initiatives.

Second, we must tackle much more urgently the disconnect between research and practice in the NHS. The recent decision to put research goals into the NHS operating framework is a good start. But we all know that the combination of NICE's focus on keeping out expensive new therapies and the NHS's reluctance to adopt them kills the UK's potential role as a champion of innovation.

Here, a new mindset is needed. NICE needs to be turned around to become innovation-responsive: it is clear to me that the cost per QALY straightjacket is still constraining thinking. We urgently need broader measures of value.

As far as uptake of medicines in the NHS is concerned, following the Darzi Review we have the ingredients of a brighter future. But we and the NHS need to grasp this future with both hands before the likely squeeze on NHS expenditure hits in the next financial planning period.

Finally, jobs. As mentioned above, the industry supports over 300,000 jobs, directly or indirectly, and these are some of the highest added value jobs around. In recent years we have missed out on most of the new wave of process and manufacturing jobs as biological products have mushroomed. We need to put in place the tax arrangements and infrastructure that will attract new bioprocessing investment and jobs to Britain, and so exploit here the intellectual property that is so often created here.

Let me finish with good news. The Government appears to be listening. As I write, we are preparing for a summit meeting with the Prime Minister, attended by global CEOs. Let's hope it leads to meaningful action.

PUBLIC AFFAIRS AT THE ROYAL SOCIETY

Dr Peter Cotgreave
Director of Public Affairs,
The Royal Society

The President of the Society, Martin Rees, said recently: "Science is integral to our culture. It permeates every aspect of our lives and can profoundly alter our understanding of ourselves and of the world we live in". He was being modest in restricting his focus merely to this world. As one of the planet's foremost astronomers, he has made great strides in understanding the wider universe. But his choice of words was not accidental; science is not just about things that are distant in space or abstract in relevance, but it matters to us all in real ways, every day.

So as the national academy of science, the Royal Society's work is important to the public in all sorts of ways, and our definition of public affairs must necessarily encompass a wide array of activities, subjects and audiences. One of the most important audiences is Parliament.

On the vast majority of issues that come before Parliament where there is a significant scientific dimension, there will inevitably be debate and uncertainty among the science and engineering community. Science is a method of plotting a route through that uncertainty, and it is essential that in shaping their debates, MPs, MEPs and peers should be able to take account of it. Pressure groups and interested parties will always emphasise the interpretations that suit their cases, and will tend to make the uncertainties seem irreconcilable. But in the end, politicians quite rightly need 'yes' or 'no' answers. For example, in the height of the BSE affair, ministers had to decide whether to ban offal from the food chain or not; they could not pass legislation that dealt in probabilities, confidence limits and caveats. Parliamentarians need somewhere to turn that provides the best and most up-to-date scientific advice, treating the uncertainties with the respect they deserve, but setting out clear recommendations. Because the Royal Society's work is based in its Fellowship of 1400 of the most outstanding scientists and engineers from around the Commonwealth, it can provide that source of impartial expertise. And because those Fellows cover every scientific and engineering discipline in academia, industry and the public sector, we can maximise the strength of the scientific case by bringing together diverse interdisciplinary working groups that consider every angle before finalising our reports.

An excellent example is biofuels, on which the Society published a major report in 2008. It involved experts from the university sector and industry in this country and overseas, with expertise in environmental issues, chemistry, climate change, plant biology and other subjects. It cut through the pointless arguing that had hitherto characterised debates about biofuels and showed clearly that they could make an immediate contribution to reducing greenhouse gas emissions. But it also demonstrated that whether a particular fuel is 'good' or 'bad' depends on the type of crop, the way it is grown, the way the fuel is produced from the feedstock, how it is transported, and so on. The Royal Society recommended that Government targets should be reworked specifically to promote those biofuels that are based on sustainable crops used in sustainable ways, and that the timeframe for incentives should be extended to give industry the confidence to invest adequately in making it happen. These

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ideas were picked up by the Environmental Audit Committee and went on to influence the Government's policies.

The Royal Society is in the process of strengthening its policy work by creating a Science Policy Centre under the leadership of a new Director, James Wilsdon, currently running ambitious projects on geoengineering, innovation in the services industry, biological approaches to food production, and a comparison of the state of science in nations across the globe. With our colleague Alice Raine, James and I are working on maximising the effectiveness with which the Society engages with Parliamentarians so that we can support you in ways that make a difference. As well as our successful scheme for pairing scientists with MPs, we want to harness the unrivalled expertise of our Fellowship in supporting scientific debate in Parliament.

Equally crucial to the Royal Society's role is creating opportunities for members of the public to appreciate science and to be inspired by cutting-edge research. As well as the work of our Press Office, and of course the Society's website (royalsociety.org) and regular magazine, *Inside Science*, we run a highly successful series of public lectures, given by researchers actively engaged in exciting discoveries. As a single recent example, Professor Eleanor Maguire from UCL enthralled a packed lecture hall with her work on how the brain stores memories. One of the most fascinating parts was the revelation that London taxi drivers have different shaped brains from other people, allowing them to memorise the back street short-cuts that baffle the rest of us.

The highlight of the Society's activities to engage the public is our annual Summer Science Exhibition at which more than 20 scientific research groups from around the UK come to London with eyecatching interactive exhibits that attract everyone from school students to government ministers. Anyone who turns up can interact directly with the scientists who are making the discoveries – the experience is not mediated by a curator, presenter or journalist. My colleague Katherine Jarrett and her team will run the exhibition for longer than ever in 2009, including opening at the weekend to allow as many people as possible to attend. We are proud of the fact that across all of our activities, we strive to make sure participation reflects the community from which participants are drawn; the people who come to the Society are broadly representative of society at large in terms of gender, ethnic mix and so on, and with the help of a number of colleagues, I take responsibility for co-ordinating our programme celebrating equality and diversity within science.

To support the development of the cutting-edge science we want to present to the public, the Royal Society must also promote discussion among the world's research community, so Katherine and her team also run about a dozen international scientific conferences each year, based on the most promising areas of science, with the subjects chosen competitively by an expert committee. In a sense, these Discussion Meetings take us back to the Society's early days, when Robert Hooke would perform experiments showing his colleagues the latest advances in knowledge. These days, experts from around the world showcase their experiments through giving talks and presentations, but the principle is the same – stretching the limits of the latest knowledge, expounded by its discoverers, interpreted and refined in discussion with dedicated experts.

. . . Parliamentarians need somewhere to turn that provides the best and most up-to-date scientific advice, treating the uncertainties with the respect they deserve, but setting out clear recommendations. . . .

The Royal Society does many other things – international relations among the scientific community, directly funding about 600 of the brightest researchers in the country, inspiring schoolchildren through partnerships with research scientists, investing in early stage science-based commercial ventures, running one of the world's premier libraries for the history of science, and a great deal more besides.

This wide and varied remit provides an ideal platform for the Royal Society's plans to commemorate its 350th anniversary with a year-long series of events, exhibitions, publications and associated activities, and we hope this will include a celebration within Parliament itself. These activities are designed not merely as a celebration but as a mechanism for engaging a variety of audiences with science and with the Society's role. This programme will begin later this year on 30 November (known in the Society as Anniversary Day from the date of its founding) and will run until November 2010, 350 years after the Society was formed. It is intended that the programme will have a legacy in terms of ongoing engagement with the expanded audiences developed during the year. As a theme for its anniversary year, the Society has adopted the phrase "See Further," taken from one of its early Presidents, Sir Isaac Newton, who famously wrote: "If I have seen further, it is by standing on the shoulders of giants". For three and half centuries, Fellows of the Royal Society have been seeing further into the intricacies of life and the universe using a way of thinking called science. The theme offers an invitation to the public to 'see further' with us.

To return to the words of our President, "Our 350th anniversary presents us with a challenge: to energise the relationship between science and society throughout 2010 and beyond."

THE ARTS AND HUMANITIES RESEARCH COUNCIL AND INNOVATION

Ben Gibbons
Public Affairs Manager of the Arts and Humanities Research Council

In November last year the Arts and Humanities Research Council (AHRC) and the National Endowment for Science, Technology and the Arts (NESTA) launched their report entitled *Arts and Humanities Research and Innovation*, which offers a new perspective on the roles that arts and humanities research and the AHRC play in the UK innovation system. This contrasts with traditional understandings of innovation, where the emphasis has been on science and technology. The AHRC and NESTA describe innovation in their report as the successful exploitation of new ideas. It is about finding new uses for knowledge, enhancing products and services, and developing new ways of getting things done. The report is part of the growing body of evidence that links arts and humanities research to innovation thinking.[1]

The AHRC supports innovation in the UK by funding post-graduate training and post-doctoral research projects, which often involve large collaborative teams that address crucial, many-sided research questions. Joint strategic initiatives with other Research Councils also offer opportunities for researchers to collaborate on addressing large and complex societal problems. This includes the *Global Uncertainties* initiative, which brings together all seven Research Councils to advance understanding of conflict, crime, environmental degradation, poverty and terrorism.[2]

The Design Against Crime Research Centre, based at Central Saint Martins, University of the Arts London, is an exemplar in the field of innovative, practise led design solutions that respond to pressing issues around crime in society.[3] The Centre generates innovative capacity, via the development and dissemination of new design processes and business models, working with numerous commercial partners and has had some of its work funded by the AHRC. The Centre's projects have developed ways of tackling bag and bike theft via the design of innovative crime prevention products such as *Grippa* and *Bike Off*. Researchers based at the Centre work with the Jill Dando Institute of Crime Science, the UK's Designing out Crime Association and Secured by Design – UK police flagship initiatives supporting the principles of designing out crime in the built environment.

. . . innovation flourishes within a culture of tolerance that embraces novelty and a diversity of ideas. . . .

It doesn't just stop with the design of new crime prevention products, with both the *Grippa* and *Bike Off* projects being used to train the next generation of designers at both undergraduate and postgraduate level, as well as being used on professional training courses for the police. This ensures a contribution towards the development of world-class, transferable skills, which are essential to the UK's future prosperity and security in the global marketplace.

Innovation is also about finding new uses for knowledge, and the AHRC's knowledge transfer activities connect researchers with non-academic sectors for their mutual benefit. The AHRC also has an intermediary role, creating links between other organisations connected to the arts, humanities and related sectors such as the creative and cultural industries. It provides the structure for people and groups to come together who otherwise may not have come into contact with each other; this is a key part of the successful exploitation of new ideas, whether those ideas are for new products, new services or new uses for knowledge. And of course, the projects the AHRC supports are underpinned by the rigorous process of peer-review.

Innovation involving arts and humanities researchers often uses what could be described as 'softer' evidence and approaches to problem solving, with some surprising collaborations. An AHRC Knowledge Transfer Fellowship investigating network theory brought together a medieval historian from the University of Glasgow and Volterra, an economic consultancy. This project compared the similarities between the decentralised structures of heretics, such as the Cathars, and the very loosely connected terrorist organisations of the 21st century. The historian, with expertise in the analysis of networks from his research on medieval heresy and the early Inquisition, also provided bespoke training and actively participated in Volterra's work in providing real solutions to business problems. This has enhanced the social network models built by Volterra in areas such as consumer and financial markets, giving the firm comparative advantage in securing new business. Knowledge transfer is fundamental to the innovation system, and this is reflected in the AHRC's growing support for projects in this area; from less than £200,000 in 2005/06 to over £3.3 million in 2007/08.

The UK's ability to address urgent social issues and to remain competitive in global markets rests on innovation.[4]

Solutions to social problems such as conflict, climate change, public health issues, poverty and crime will require fresh thinking and the combined use of technological, cultural, social and economic expertise. As described in the two examples above, innovation is a shared activity which takes place within a broad setting. This success of this activity requires co-operation between government, universities, third sector organisations, businesses and consumers, because innovation flourishes within a culture of tolerance that embraces novelty and a diversity of ideas.

A well-functioning innovation system is always changing and relies on networks built on trust, repeat engagement and 'social capital'. It is also subject to uncertainty and risk, where the application of new ideas may lead to unintended consequences, but these risks have to be accepted if innovation is to thrive. Researchers also have the critical and analytical skills to challenge assumptions and entrenched ways of working, while providing a sense of the historical context, traditions and culture in which society and the economy function.

Arts and humanities research has a strong affiliation with the creative industries, which arts and humanities research help to fuel. Creative industries, in turn, stimulate and support innovation in the UK. The AHRC is involved in bridging activities between the Department for Innovation, Universities and Skills the Department for Culture, Media and Sport and the Technology Strategy Board, and policymakers increasingly understand how arts and humanities research feeds into the innovation system. The AHRC will build on this understanding by continuing to articulate and demonstrate how public funding for arts and humanities research supports advances in innovation, society and the economy in the UK.

1 http://www.ahrc.ac.uk/News/Events/Documents/AHRI.pdf

2 http://www.ahrc.ac.uk/FundingOpportunities/Pages/GlobalUncertainties.aspx

3 http://www.designagainstcrime.com/index.php?q=taxonomy/term/2

4 Department for Innovation, Universities and Skills (2008) *Innovation Nation.* London: DIUS.

A 'SIN' TO ACHIEVE THE MILLENNIUM DEVELOPMENT GOALS?

In this article Sam Myers briefly highlights contributions which have been made by the Government's global Science & Innovation Network (SIN) towards achieving the Millennium Development Goals, and the potential for a more sustained global partnership.

The Science & Innovation Network (SIN) comprises 90 officers in 39 cities around the world and is a partnership between the Department for Innovation, Universities and Skills, and the Foreign & Commonwealth Office. It works on behalf of a range of internal and external customers including Research Councils and the Department for International Development, and has a unique capability to deliver policy advice and action on the ground.

Sam Myers is the First Secretary (Science & Innovation) at the British High Commission in Singapore, and has responsibility for Southeast Asia.

The Millennium Development Goals (MDGs) were agreed by world leaders in 2000 to improve the quality of life for the 3 billion people living on less than $2.15 a day. To be achieved by 2015, they include:

MDG 1) Eradicate extreme poverty and hunger
MDG 2) Achieve universal primary education
MDG 3) Promote gender equality and empower women
MDG 4) Reduce child mortality
MDG 5) Improve maternal health
MDG 6) Combat HIV and AIDS, malaria and other diseases
MDG 7) Ensure environmental sustainability
MDG 8) Develop a global partnership for development

The House of Commons Science and Technology Committee reported in 2004 that "it is impossible to make sustainable progress towards the Goals without harnessing the potential of science and technology, which as part of a vibrant innovation system can provide a route out of poverty for developing countries." Indeed science, technology and innovation are an intrinsic part of the solution for providing clean water, sustainable food supplies, renewable energy, improved infrastructure and basic healthcare in developing countries. Equally importantly they are generators of economic wealth, and are vital in preparing and responding to natural and man-made disasters.

RECENT EXAMPLES OF SIN'S CONTRIBUTION TO THE MILLENNIUM DEVELOPMENT GOALS:

Case Study 1: Combat Malaria (MDG 6)

Some 3.2 billion people live at risk of malaria transmission and there are between 350-500 million clinical episodes of the disease every year, which leads to a million deaths. The disease kills a child every 30 seconds, and only 1 in 5 malaria deaths was reported in 2006 (WHO).

In 2008 the Science and Innovation Team in Southeast Asia focused on improving UK-regional collaboration and enhancing co-ordination in tackling malaria and infectious diseases. We held five scientific workshops bringing together over 900 experts from the UK, Southeast Asia, China and beyond, to share their latest research and agree joint projects. Two policy roundtables involving the UK and Indonesian Science Ministers, World Health Organization, and public and private researchers identified the need for better detection devices in rural settings and action against antimalarial resistance. As a result, the UK's Medical Research Council and Singapore's Agency for Science, Technology and Research announced a joint £6m fund for collaborative research to be launched by mid 2009. Information exchange networks for scientists, clinicians and policymakers have also been set up.

Case Study 2: Ensure environmental sustainability (MDG 7)
Amazonian rainforest depletion is taking place at double the rate previously estimated; an area 40 times the size of Singapore is being destroyed annually by selective logging which was previously undetected by satellite (Science, 2005).

The Science & Innovation Team in Brazil recently brokered agreement for a British high definition camera to be launched on the Brazilian Earth observation satellite Amazonia-1 in 2010. The camera will monitor deforestation, the management of natural resources, pollution and natural disasters in both the Amazon and Congo River basins. Detailed satellite imagery is crucial in the fight against illegal logging activities which cause the loss of livelihoods for millions of local people. The camera is to be manufactured at the UK's Rutherford Appleton Laboratories with £1m funding from the Department for International Development, and will also assess the impacts of climate change.

FUTURE SINNING

Since 2004, the SIN Team in Southeast Asia has organised a series of 38 scientific workshops enabling some 260 UK experts to share their cutting edge research and generate collaborations with an audience of 7,000 local scientists. To date our work outside Singapore has focused on emerging economies such as Thailand, Indonesia and Malaysia. We have a further opportunity to support scientists in less economically developed countries such as Cambodia, Laos and Vietnam.

In 2009 and beyond, the Science and Innovation Network will continue to work with UK and overseas organisations to strengthen the global partnership between the scientific and development communities. Strengthening the science infrastructure and capacity of developing countries "helps nations to help themselves", and home-grown scientists can offer practical and insightful solutions to the challenges on their doorstep. Whilst long-term vision and investment is needed, the returns provide a sustainable self-reinforcing solution to both scientific problems and international development.

Science is therefore a key contributor to the MDGs and more could and should be done to increase co-ordination and accelerate activities. In this way we will maximise our efforts to improve the lives of the world's poorest people and share the economic and social rewards of science and innovation.

FOOD VERSUS FUEL - IS THERE A VIABLE SOLUTION?

Dr Jeremy Tomkinson, CEO, National Non-Food Crops Centre

The National Non-Food Crops Centre (NNFCC) is the UK's National Centre for renewable materials and technologies, providing independent advice and information to industry, Government and the general public. The NNFCC develop and assess the scientific evidence on renewable materials and help to build supply chains for renewable materials, which could be made from non-food crops, by-products from edible crop production or organic material that would currently be specified as 'waste'. Defining a non-food crop is not necessarily straight forward; a non-food crop can be something perfectly edible, so we define non-food crops more by their application than actual plant species. However, the recent so-called 'food vs fuel' situation has driven the need for a sharper focus on biomass, by-products and renewable wastes streams than ever before. Clarifying this feedstock question will form a major part of our work programme in the coming years.

The NNFCC understands the technologies, markets and feedstocks and how to get them working together. Equally importantly, we understand how to identify the supply chains that will be sustainable both economically and environmentally and how to connect the players in these supply chains to realise the benefits. Our team of 17 based in York come from the relevant industry backgrounds eg petrochemical refining, plastics, high value chemicals, materials,

biology and agriculture, which aligns well with our position at the forefront of the burgeoning bioeconomy.

Information is key to what we do; once we have acquired and analysed data we disseminate the information through business to business activity by our sector experts, or through our website, publications and events. We maintain strong links to a number of Government Departments and manage projects to develop the evidence base on which Government policy is founded. We do this through formal responses to consultation documents and through on-going contacts.

The biofuels and bioenergy sectors are obviously of great importance. We are producing a road map for UK advanced biofuels and a techno-economic evaluation of emerging algal oil technologies. On the waste-to-energy side we are reviewing the potential for gasification of waste and we are examining the co-digestion of biodegradable packaging and food waste by anaerobic digestion. Both reports should be available in early 2009.

Plant-derived renewable materials are extremely important to the development of the sector because, whilst renewable electricity can be generated in diverse ways, fuels, materials and chemicals can only come from petrochemicals or biomass. One good example would be the construction industry, which has many applications for renewables, including hemp-lime mixtures and straw bales for walls, hemp, flax or waste sheep wool for insulation, linoleum flooring and linseed oil for surface coatings. The production of one tonne of cement generates around one tonne of carbon dioxide. Hemp-lime mixtures lock up around 110 kg of carbon dioxide per cubic metre. Emissions resulting from cultivation of hemp are also low because it requires few agricultural inputs. An example is The Adnams distribution centre. Built using hemp and lime, it is estimated to have removed more than 150 tonnes of carbon dioxide from the atmosphere; the construction of an equivalent concrete building would have emitted over 600 tonnes.

Construction-related projects we have recently carried out include life cycle assessments of natural fibre insulation compared with conventional materials, and a manual for hemp-lime construction; all are available on our website. We have recently embarked on an ambitious project to build a family home showcasing a wide range of renewable materials. The house will be launched at the prestigious BRE Insite event on June 1st 2009.

The chemicals sector includes the bulk chemicals used as building blocks by the chemical industry and also polymers, adhesives, solvents, pigments, pharmaceuticals and so on. It has been estimated that the replacement of commodity petrochemicals with plant-derived chemicals could deliver up to 32% energy saving in the chemical industry by 2050. This represents up to 3% non-renewable energy saving for the entire European economy. Our involvement with Government initiatives like IB-IGT (Industrial Biotechnology Innovation and Growth Team) and special interest groups like FROPTOP (From Renewable Platform Chemicals to Added Value Products) means we can help the UK to develop into a true bioeconomy in the years to come.

Bio-energy, renewable fuels and renewable materials are closely inter-related and the potential feedstocks are, in many cases, exactly the same, and hence the policy frameworks need to be closely co-ordinated. The processing, conversion and manufacturing are also closely related and valorising co-products can be extremely lucrative for collaborating industries. We can use our land to produce food, animal feed, energy, fuels and materials. The land to produce these feedstocks is limited and calls have been made to develop increasingly stringent sustainability criteria. The UK is already committed to rigorous environmental standards for biofuels. The Renewable Fuels Agency reports on the progress of the RTFO including environmental criteria. A common misconception is that agricultural inputs from growing biofuel feedstocks are not taken into account, but life cycle assessments (which include fertilisers, pesticides, tractor fuel, etc) indicate that UK biofuels yield definite GHG savings compared to petroleum-based fuels. Using UK grown rape in biodiesel, for example, saves 40% of GHGs compared to diesel. The inclusion of the impact of indirect land use change is also being carefully evaluated by NNFCC.

Clearly challenging times are ahead; our land will have to deliver more, but with fewer inputs. However, challenging times bring opportunity. There is enough land to meet our current National and European targets for biofuels but, as land is a limited resource, to go beyond these targets we will need to use advanced technologies that are not reliant on food crops. Furthermore, we must recognise that we're not a country with millions of tonnes of homogenous feedstock and millions of hectares of agricultural land available for use as is the case in Asia and the Americas. Producing synthetic fuels by thermochemical treatment of biomass is one technology suited to the UK's circumstances. This process firstly uses gasification to convert biomass to synthesis gas (also known as syngas), a mixture of carbon monoxide and hydrogen. The syngas is subsequently converted into a range of fuels and chemical with low carbon footprints. This process is flexible in terms of feedstock so it could use what the UK has available: energy crops, straw, forestry, and even municipal solid waste. Synthetic fuels have much higher yields per hectare of land compared to first generation processes, potentially have greater greenhouse gas savings. This process could also produce heat, power and chemicals.

Concerns about climate change and diminishing resources are not new, so where are the big, innovative projects? The Government can help by giving clear, robust commitments to renewables. The creation of our new Department of Energy and Climate Change (DECC) and legislation such as the Climate Change Act 2008 show that the UK is not afraid to take a world-leading stance and reflect the strength of the UK's commitment to tackling climate change. But we have to follow this with stable policies based on a long-term vision that give investors the evidence and courage they need to support renewables.

THE SCIENCE AND TECHNOLOGY FACILITIES COUNCIL

Dr Andrew Taylor

Long term scientific research cannot be adequately funded on short-term budgets determined by a three-year government spending cycle. Dr Andrew Taylor is responsible for facilities development and operations at the Science and Technology Facilities Council. He says a more sustainable approach to funding the operation of facilities is essential to long-term UK prosperity but requires political commitment and courage during difficult financial times.

The UK research community is celebrating the recent completion of the second target station at the ISIS neutron source, a world-leading research centre operated by the Science and Technology Facilities Council (STFC) in Oxfordshire. For 25 years, scientists and engineers at ISIS have kept the UK at the forefront of neutron research. ISIS has delivered economic and social benefits from a wide range of research. The instruments at the new target station will extend its reach and make new impacts in the life sciences and in the study of soft matter.

ISIS is just one of the many world-class facilities which STFC operates at the Rutherford Appleton Laboratory (RAL) on the Harwell Science and Innovation Campus. It is co-located with the Diamond Light Source, the UK's Central Laser Facility and our Space Science, Technology and Particle Physics departments.

STFC is one of the UK's seven national research councils. Our work ranges from the subatomic world of particle physics to the vastness of space. In addition to ownership and operation of the UK's major science facilities, STFC funds university researchers in astronomy, particle physics, space science and nuclear physics. STFC is the agency through which the UK contributes to international science organisations such as CERN and the European Space Agency.

RETURN ON INVESTMENT

Science offers an excellent long-term return on investment, though this isn't always obvious to those looking for immediate and tangible results to justify spending.

Public-funded scientific research delivers vast benefits, ranging from skills and jobs to economic competitiveness and solutions to society's most pressing problems. It always has, but we've perhaps not always been very good at communicating the outcomes of our activities.

Our national research facilities are the result of a sustained public investment over many years. They provide UK and international researchers with the best equipment in the world. Building and maintaining these facilities is part of government's strategy to maintain UK competitiveness in a changing global economy. This investment stems from a conviction that scientific research is central to our future prospects. It will underpin future economies, help us to deal with global security and environmental threats, and make the UK a better place to live and invest in.

We're not asking politicians and policy makers to make a great leap of faith. We can point to evidence that long-term investment delivers benefits. We recently closed the Synchroton Radiation Source (SRS) at Daresbury after 28 years of highly productive operation. Total investment in SRS was £500m. One company alone (e2v, the principal UK manufacturer of high power RF power sources) has created a business worth £250m from technology developed to build the SRS. The SRS unravelled the structure of the foot and mouth virus with a potential economic impact worth billions, to cite another example of its impact.

However, big science facilities operate on timescales far longer than the life of the average Parliament, or even the average government.

Unlike economic cycles, our facilities have a useful life measured in decades. The £200m second target station at ISIS, the leading neutron research facility of its kind in the world, builds on work from over the past 25 years.

These facilities require sustained investment and teams of specialist scientists, engineers and technicians to maintain them safely and productively so they deliver to their potential.

These are not the sorts of things that can be turned on and off. We began planning the second target station at ISIS in the late 1990s and the commitment to build it was based on a projected 20-year operating life. There is already a consultation under way about the science and business case for the next-generation neutron source.

Those who made the decision to proceed with the

new target station at ISIS had studied the numbers and understood not just the research benefits, but also the long-term impact it would have on the huge medical, environmental and social challenges facing the world.

They knew that the UK would rise to the scientific, engineering and technical challenge, and that it would reap the long-term benefits. Without this long-range planning, and courageous decisions to proceed with projects which may only start operating under a different government, the UK's international scientific reputation would decline.

This decline might not be noticeable for many years. But its ultimate impact would be catastrophic, and by the time anybody took notice we'd have fallen a whole generation behind our competitors.

It is vital that we continue to invest in the UK's world class research base, and if we are to exploit our investment to the maximum, we should move to a position where long-term sustainable funding will allow us to operate our facilities with maximum efficiency without falling prey to funding variations arising from the three year spending review cycle.

We must position ourselves for UK science to get the best advantage for an economic recovery.

CASE STUDIES – THE IMPACT OF STFC SCIENCE

Safer chips for aerospace

STFC's ISIS neutron source is helping leading aerospace companies tackle the challenge of cosmic radiation and its damaging effect on microchips in aircraft. Neutrons in the atmosphere can interfere with the normal operation of electronic equipment. One way of tackling the issue is to test the quality and susceptibility of components under accelerated conditions. ISIS can replicate thousands of hours of flying in a very short time. Its research allows manufacturers to build the appropriate redundancy into their electronic components. This increased confidence in the quality of electronic systems makes both civil and military aircraft safer.

Understanding infant lung structure

STFC scientists are contributing to research that could help save the lives of premature babies. A coating of natural lung surfactant lines the internal surface of our lungs and each breath adjusts the tension to let oxygen into the bloodstream. The absence of this surfactant in premature babies causes Respiratory Distress Syndrome and breathing difficulties. It is currently treated with a surfactant aerosol sprayed directly into the lungs. Researchers at the ISIS neutron source are helping to develop synthetic lung surfactants which can be more precisely targeted at clinical needs and made more accessible in developing countries.

Search and detection

Lite Thru is a company which grew out of RAL's Central Laser Facility. It pioneered a spectroscopy technique which can not only assist the search for illegal drugs and the quality control of legal pharmaceuticals, but has potential as a non-invasive technique for detection of cancer.

STFC FACILITIES AT THE RUTHERFORD APPLETON LABORATORY, OXFORDSHIRE

ISIS

ISIS is a centre for research in the physical and life sciences. It produces beams of neutrons and muons to study materials at the atomic level. The construction of the ISIS second target station was funded with £200m from the Large Facilities Capital Fund — and it was completed on time and on budget. ISIS supports an international community of more than 2,000 scientists who use neutrons and muons for research in physics, chemistry, materials science, geology, engineering and biology.

Diamond Light Source

The Diamond Light Source uses intense beams of synchrotron light to investigate the structure of matter. This exceptionally bright light is around 100 billion times brighter than a hospital X-ray. Diamond represents the largest UK scientific investment for 40 years, again drawing on funding from the Large Facilities Capital Fund, and will ultimately host up to 40 beamlines.

Particle Physics, Space Science and Technology Departments

Sensitive underground detectors and astronomical observations let UK particle physicists and astronomers peer into the fundamental structure of nature in the quest to understand the nature of the universe. Technology developed for these projects to make them such a success – detectors, electronics, data acquisition systems, grid-enabled computer analysis and data curation – is now being used to give other scientific endeavours – ISIS, Diamond and Lasers – a cutting edge advantage.

Central Laser Facility

ULTRA is a new laser facility under development at RAL. It will enable UK scientists to monitor biological processes at a millionth of a millionth of a second using light from the ultraviolet to the infra-red. ULTRA has been funded through a major facility development grant of £1.8m, funded equally by STFC and the Biotechnology and Biological Sciences Research Council. Astra Gemini is another unique international laser facility, and it will help the UK maintain its influence in photon science. The facility opened in January 2008 and has been helping scientists to target at key priorities such as the pursuit of fusion power and oncology treatment techniques.

STFC facilities at the Daresbury Laboratory, Cheshire

ALICE (Accelerators and Lasers In Combined Experiments) is a prototype accelerator which has been designed and built at Daresbury Laboratory.

The Hartree Centre is a new computational sciences institute for the UK bringing together academic, government and industry. The centre will provide a step-change in modelling capabilities for strategic themes in energy, life sciences, the environment and materials.

NUCLEAR WASTE – WHAT TO DO WITH IT ?

Richard Waite, Radioactive Waste Management Directorate, Nuclear Decommissioning Authority

(This talk was delivered by Bruce McKirdy as Mr Waite was unwell)

INTRODUCTION

The Nuclear Decommissioning Authority (NDA) is a non-departmental public body, established under the Energy Act 2004. We are responsible for the decommissioning and clean-up of the UK's civil public sector nuclear sites. The NDA's arrival signalled perhaps the greatest change in the UK nuclear industry since its formation. It is the first time a single organisation has been responsible for managing the decommissioning, clean-up and disposal process across the country.

The NDA's mission is:

to deliver safe, sustainable and publicly acceptable solutions to the challenge of nuclear clean-up and waste management. This means never compromising on safety, or security, taking full account of our social and environmental responsibilities, always seeking value for money for the tax payer, and actively engaging with stakeholders.

. . . it is unacceptable to postpone final disposal to future generations . . .

The Energy Act 2004 gave us specific duties including securing the treatment, storage, transportation and disposal of legacy wastes and development of a strategy for carrying out these functions. In addition the Government's Low Level Waste (LLW) Policy Review (published 2007) made it clear that the NDA was responsible for implementation of the new LLW policy and for the operation and competition of existing LLW facilities.

The Government's Managing Radioactive Waste Safely (MRWS) White Paper was published in June 2008 [1]. It sets out the policy for higher-activity wastes as geological disposal preceded by safe, secure storage, supported by R&D. It also gave responsibility to the NDA for planning and implementation of geological disposal.

RADIOACTIVE WASTE

Radioactive waste is divided into three main categories according to how much radioactivity it contains and the heat that it generates:

- Low Level Waste (LLW)
- Intermediate Level Waste (ILW)
- High Level Waste (HLW)

There are also some radioactive materials that are not currently classified as waste, but that may need to be managed through geological disposal. These include:

- Spent fuel
- Plutonium
- Uranium

We use a hierarchical approach to minimise the amounts of waste requiring disposal. The hierarchy consists of avoiding waste generation where practicable; minimisation of arisings where the creation of waste is unavoidable; recycling and reuse; and only then disposal.

The Government reviewed the LLW Policy in 2007. In this it made it clear that diversified disposal solutions based on a risk-based approach are preferred and that the NDA has responsibilities for its implementation. The review also outlined the international waste transfer rules. It made clear that it is unacceptable to postpone final disposal to future generations and committed the NDA to develop a strategy by the end of 2009.

A 'Baseline Inventory' of higher activity wastes for geological disposal is given in the MRWS White Paper. This includes the total amounts of radioactive wastes and other materials that could require geological disposal in the future. However, these figures are calculated on a number of assumptions and can only be taken as indicative because waste amounts will change over time.

Interim stores can provide safe and secure protection for waste packages for a period of 50-100 years. However, the higher activity wastes are potentially hazardous for hundreds of thousands of years.

Rather than leave these wastes in interim stores, we have a responsibility to deal with them as soon as is practicable. In this way we will remove the burden imposed by our actions on future generations. It also provides an end-point for decommissioning and clean up of existing sites.

MANAGING RADIOACTIVE WASTE SAFELY (MRWS) PROGRAMME

In 2001 the UK Government and devolved administrations initiated the Managing Radioactive Waste Safely (MRWS) programme with the aim of finding a practicable solution for the UK's higher activity wastes that:

- achieved long-term protection of people and the environment
- did this in an open and transparent way that inspired public confidence
- was based on sound science
- ensured the effective use of public monies.

In October 2006 the UK Government and devolved administrations accepted the Committee on Radioactive Waste Management's recommendations that geological disposal, preceded by safe and secure interim storage, was the best available approach for the long-term management of higher activity radioactive wastes.

Following a consultation, Government published in June 2008 the MRWS White Paper: A Framework for Implementing Geological Disposal. This covers:

- Government's framework for managing higher activity radioactive waste through geological disposal
- Indicates how the issues of safe and secure interim storage and R&D are being addressed
- Invites communities to open without commitment discussions with Government about possible future hosting of a geological disposal facility

A number of countries (including Finland and Sweden) are already investigating their preferred sites for a geological disposal facility for spent fuel. Finland and Sweden already have shallow geological facilities for disposal of ILW and LLW. Sweden has been operating the deep geological research facility, testing techniques for disposal of spent fuel, for a number of years. France is investigating a site at Bure with a view to it becoming the final disposal facility and Canada is developing a deep repository for LLW and ILW at Kincardine.

There are a number of key issues that arise from this experience, including:

- All counties who have developed a policy for long term management of radioactive waste are pursuing geological disposal
- Need a voluntarism approach, not adversarial
- Processes must be open and transparent
- Need secure long-term funding
- Need to maintain momentum, but can only work at the speed stakeholders are comfortable with

It will take a number of years before a geological disposal facility is able to accept waste. In the meantime we must continue to have safe and secure interim stores, typically for periods of up to 100 years.

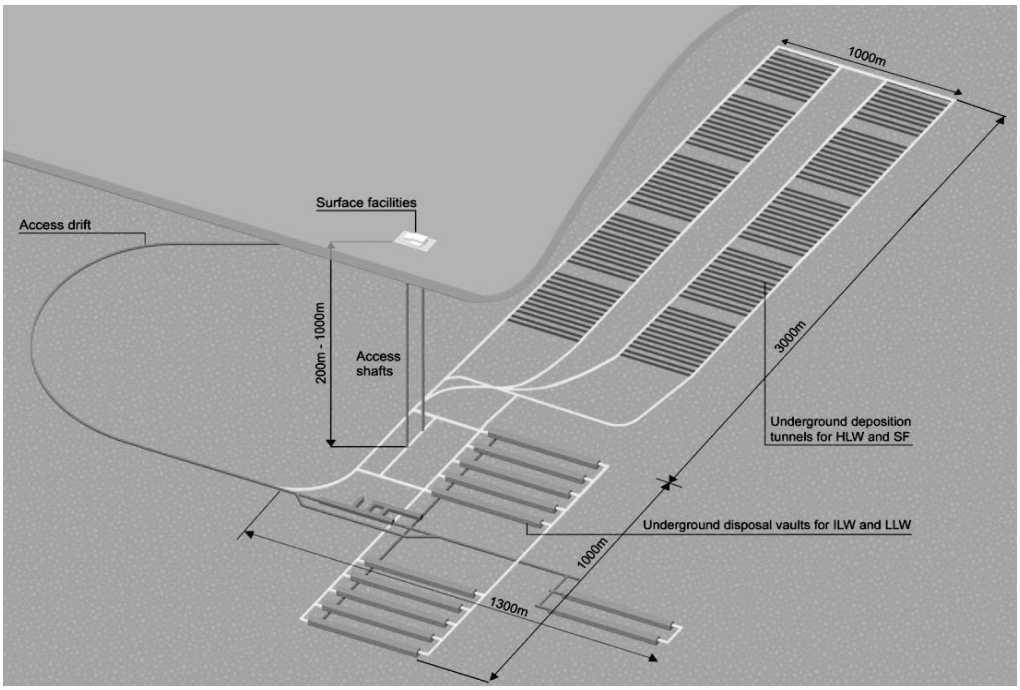
As part of our work we are running a national review of the adequacy of ILW storage. We are also investigating opportunities for rationalising waste storage ie reducing the number of stores that are required.

Geological disposal involves isolating radioactive waste deep inside a suitable rock formation to ensure that no harmful quantities of radioactivity ever reach the surface environment (see diagram below). It is a multi-barrier approach, based on placing wastes deep underground, protected from disruption by man-made or natural events. Geological disposal is internationally recognised as the preferred approach for the long-term management of higher activity radioactive waste.

As noted earlier, the UK Government policy is aligned with countries such as Finland, France, Sweden and the USA who have already made good progress towards implementing geological disposal. The UK is therefore well-placed to benefit from international experience in this field, while using and maintaining domestic capabilities.

The MRWS White Paper sets out the roles and responsibilities for those parties involved in the implementation of geological disposal as follows:

- **Government** is responsible for the policy, will take final decisions and engage with stakeholders to ensure that the objectives of the MRWS programme are met



- **The NDA** is the implementing organisation, responsible for planning and delivering the geological disposal facility and, as part of this process, will engage with communities and other stakeholders.
- **Communities** with a potential interest in hosting a geological disposal facility will have the opportunity to work with the NDA and others in a partnership approach during the process.
- **Local government** will be fully engaged in a partnership approach and will play a part in local decision-making during the site selection process.
- **Independent regulators** will ensure robust, independent regulation in relation to statutory responsibilities for ensuring that national, EU and international safety, security and environmental legislation and standards are met.
- **Committee on Radioactive Waste Management (CoRWM)** will provide independent scrutiny and advice to Government on the plans and programmes for delivering geological disposal including interim storage.

NEXT STEPS

The Government continues with the siting process for a geological disposal facility based on a voluntarism and partnership approach. So far one Borough Council has formally expressed an interest and another is consulting with its community. Additionally a County Council is also consulting with its stakeholders.

We look forward to working in partnership with whichever potential host communities come forward.

We want a range of stakeholder inputs and are consulting on a range of subjects including:

- proposed R&D Strategy for geological disposal
- proposed frameworks for public and stakeholder engagement & Sustainability and Environmental Assessment
- strategic issues e.g. Plutonium

Reference:

1 Managing Radioactive Waste Safely: A framework for implementing geological disposal, June 2008. A White Paper by Defra, BERR and the devolved administrations for Wales and Northern Ireland

NUCLEAR WASTE – WHAT TO DO WITH IT?

NUCLEAR WASTE AND THE NNL

Dr Peter Bleasdale
Managing Director,
National Nuclear Laboratory

Managing nuclear waste in the safest, most effective manner possible is a key challenge for the nuclear industry. Alongside its commitment to clean up the UK's civil nuclear legacy, Government has also given its backing for nuclear to play a key role in helping the UK achieve its energy goals of tackling climate change and securing the UK's future energy needs.

The new National Nuclear Laboratory for the UK is an international centre of excellence in nuclear research and development, playing a vital role in cleaning up the UK's nuclear waste legacy and contributing to nuclear new build. The NNL safeguards the UK's nuclear expertise, facilities and skills.

All industrial processes produce wastes and the NNL has played a key role in the management of waste produced by the nuclear industry. The industry has made a strong effort to build trust as a safe, profitable, technology led business with little impact on the environment. Huge strides have been made since the 1980s in managing wastes.

Over the years, the NNL has provided support in resolving many of the waste management and disposal challenges presented to the industry. These include wastes currently being produced from reactor operations and reprocessing. The NNL has also worked on the waste legacy produced in the past through civil and military programmes. This includes supporting retrieval of raw wastes, conditioning, packaging and interim storage. Further work will ensure waste products meet disposal requirements in the future.

Government has accepted that deep geological disposal is the most appropriate option for higher activity waste. This means

. . . The cementation technology has been so successful that it has been sold overseas to Japan and the USA. . . .

placing it underground in stable rock structures. The Nuclear Decommissioning Authority (NDA) has the job of finding a suitable site. The NNL will support the NDA by applying science and innovation at the right levels.

Wastes are classified into High, Intermediate and Low level streams. High-level waste (HLW) is very radioactive and generates heat. This waste is what remains when used nuclear fuel has been reprocessed to produce reusable products. Intermediate-level waste (ILW) is far less radioactive and is made up of items such as fuel element cladding, contaminated equipment and sludge produced from treatment processes. Low-level waste (LLW) includes paper towels, clothing and laboratory equipment used in areas where radioactive materials are deployed.

LEGACY WASTE

Nuclear operation in the UK began over five decades ago. Early operations at Sellafield saw large amounts of waste produced and stored in raw form in various silos, storage ponds and other facilities. These wastes include plutonium contaminated materials and high activity liquid wastes that need to be retrieved, conditioned, immobilised, packaged and stored safely.

The ways in which wastes are packaged is very important as products have to be acceptable for long-term future storage and deep geological disposal. The NNL has carried out extensive technical work in support of these operations.

There are many examples where this work has made a significant contribution. For instance, the work carried out by the NNL in supporting sludge tank retrievals at Sellafield. The Sellafield sludge tanks were last used in the 1970s and still contain significant quantities of radioactive sludge. The challenge was to develop long-term storage solutions for the waste in a safe manner using technologies that offer minimum costs to the tax payer.

The accepted route for storing sludge is to mix with cement in a storage drum. This method results in a solid waste form. Fewer drums lead to lower storage costs. The NNL solution adjusted cement chemistry to increase the concentration of waste put in the drum by a factor of two. This means that the number of drums produced is potentially halved from an initial 12,000 to 6,000. The time required to process wastes is also halved. The approved new waste form is being implemented.

Also at Sellafield, there is a quantity of plutonium residues which are not suitable for recycling and need to be managed. The NNL challenge was to find a safe long-term immobilisation and encapsulation technique for the material. The NNL worked with the Australian Nuclear Science and Technology Organisation to modify an existing process for generating a ceramic waste form.

This work has been so successful that it has been named as a preferred waste management technology for these residues. The intention is to incorporate the waste into the ceramic matrix prior to storage and disposal.

WASTE FROM CURRENT OPERATIONS

As operations continue, the NNL provides support in each of the three main waste categories. For low level solid wastes, technology solutions are provided to the LLW repository located a few miles south of Sellafield. The NNL has been carrying out technical support for the operating safety cases, building on work already carried out to produce a post closure safety case for the facility.

Understanding Post Closure scenarios helps underpin the ultimate case for closing the site far into the future. This was the first safety case of its kind in the world produced for a low level waste facility. Other work includes helping to minimise waste production in the first place and improvements in processing methods such as enhanced immobilisation.

The NNL provides technology to assist in the handling of intermediate level wastes, particularly at Sellafield. The Lab supports continued and improved operations in effluent plants. For example, the Enhanced Actinide Removal Plant (EARP) at Sellafield uses ultra filtration to separate out radioactive elements from effluents produced on site. The NNL analyses the operation of the plant in great detail and advises customers on the best way to improve efficiencies and maintenance and make sure EARP continues to play a key role in effluent management at Sellafield.

The ILW encapsulation processes underpin the storage of treated materials at Sellafield. The Magnox Encapsulation Plant (MEP) and Waste Encapsulation Plant (WEP) are the first ever commercial scale cementation plants worldwide for this type of waste. The NNL played a key role in their development and operation and is proud of its contribution to plants that continue to operate efficiently. The cementation technology has been so successful that it has been sold overseas to Japan and the USA. With ILW, stable products are being produced that are suitable for storage and eventual deep disposal. At Sellafield, all ILW produced during operations is processed for storage and disposal as it arises.

High level waste is the most radioactive material stored at Sellafield. NNL has developed processes used to treat HLW and the NNL now supports operators in various ways to manage the waste. HLW is stored in tanks at Sellafield in controlled conditions. Tanks are being progressively emptied and the waste converted into a glass based product using a process called vitrification in a dedicated facility – the Waste Vitrification Plant (WVP).

. . . Tanks are being progressively emptied and the waste converted into a glass based product using a process called vitrification . . .

NNL has worked extensively on the vitrification process to refine and improve performance. WVP is vital to Sellafield as it also deals with new waste being produced as a result of used fuel reprocessing operations. A full-scale replica of the vitrification plant is operated by NNL to make sure WVP remains as efficient as possible. Over the past few years we have improved process throughput by over a third to enable the waste to be treated a number of years earlier than originally planned. The NNL undertakes work to make sure the liquid waste evaporators and storage tanks are functioning at their optimum level.

Eventually, all high level waste stored at Sellafield will be converted into glass product, a very stable waste form readily capable of being stored safely. Now that wastes are being successfully immobilised and packaged into a stable form via processes such as encapsulation and vitrification, the NNL is advancing studies to assess how wastes will behave in a deep geological facility.

DISPOSAL

The Radioactive Waste Management Directorate (RWMD) has been launched by the NDA to develop repository strategy and design. NNL work in support of RWMD is an area where a real and sustained contribution can be made. A number of projects and activities are already under way. A series of trials have been set up to monitor corrosion and expansion of cemented Magnox waste under repository conditions.

NNL has a depth of experience of how these wastes behave in current interim storage above ground and this knowledge is being applied to study waste behaviour in a deep underground facility. NNL will constantly improve understanding of wastes, how to deal with them, make them safe for storage and finally make them good for permanent disposal.

SUMMARY

The NNL is an experienced and capable provider of integrated nuclear solutions and the leading supplier of technology services to the UK nuclear market. It employs the best people and will develop through the application of tailored innovation. NNL strives to become the international centre of excellence in nuclear research and development and play the key role in cleaning up the UK's nuclear waste legacy. The Lab will contribute to nuclear new build and safeguard and grow high-tech nuclear expertise, facilities and skills.

We have been presented with a great opportunity to underpin technical innovation and create a National Nuclear Laboratory that the UK can be proud of.

DURING DISCUSSION THE FOLLOWING POINTS WERE RAISED

How are we reacting to the great loss of skills in the nuclear industry? Universities are now making great efforts to recoup the losses of professional staff with help from the industry. However, young people need to be influenced very early in their choice of career. The industry works with several organisations; one example is the Smallpiece Trust which runs one week courses in vacations for 14-16 year olds. The most recent course attracted 200 applicants for 70 vacancies. We could do more and we also work with 10 year olds in schools where the emphasis is on science. A lifeline plan has been prepared to help develop the skills required by the industry, in schools and universities which will be rolled out on 4 November in Manchester.

There may also be a need, in addition to reprocessing, for direct disposal of nuclear waste from the new generation of nuclear reactors which is addressed in the Nuclear Energy White Paper. If nuclear waste is likely to be required for reprocessing, it would not be disposed of in the first place. However the option for retrievability is maintained within the overall plan for waste management and all the equipment used can be safely recovered. For example the 105t Pu stored at Sellafield is subject to the decision as to whether it is a waste or an asset. There is also a complete mock-up of a MOX facility available at Sellafield should the decision be taken subsequently to reuse the Pu in such a facility to make MOX nuclear fuel rather than dispose of it as waste. The technology is well understood, however the present mechanical design of the facility, which is a sequential process lacking any built-in redundancy, is therefore vulnerable to unplanned plant closure.

Deep geological disposal of High and Intermediate Level Waste had been recommended 40 years earlier and suitable sites were identified as a result of a geotechnical assessment of the UK conducted by the Government. This was presented as a geotechnical solution to the problem at that time, which unfortunately could not be implemented due to a lack of adequate local consultation of the people most likely to be affected, unlike Sweden and Finland where local communities were consulted extensively. The present arrangement for disposal in the UK is based on a non-adversarial procedure involving local communities.

THORP was developed and started work in 1993. It is a flexible facility supported by research R&D undertaken by a skilled workforce. It can be used for re-processing waste from Light Water Reactors and can also accept high burn-up MOX fuel for re-processing. This technology is also of commercial and scientific interest to the US. Sellafield staff are also working with a EU consortium developing new processing technologies. However, a new plant would probably be required to recover Pu for use in MOX fuel from the existing resource of Pu enriched waste due to lack of capacity in existing plant. The recently appointed managing contractor for Sellafield now involves a French component and the NNL is also equipped and prepared to undertake this work should Government decide to recover the Pu rather than dispose of it as waste without further reprocessing.

With regard to EU oversight on nuclear waste disposal, the site selected for deep geological disposal has to be safe enough. It does not have to be the safest site. There are many other criteria involved in the site selection procedure. Waste degradation, including microbial degradation has been recognised and will need to be considered as part of the overall waste disposal strategy. It was suggested that the nuclear industry had previously 'run out of trust'. Are there any aspects of the industry where they currently lack relevant information? If there are any such areas of uncertainty these should be shared with the public. What are the advantages, if any, of disposal in 5km deep boreholes relative to disposal at less than 1km? There are many questions requiring answers. We do not know waste behaviour in the long term, requiring a research programme to be undertaken to identify the waste forms involved. This will help to optimise the waste disposal procedure by excluding any problematic wastes from deep disposal sites. However there are no uncertainties we are aware of with the potential to halt the overall procedure of deep geological disposal. Deep geological disposal in boreholes is conceptually sound but the practical difficulty of drilling holes of adequate diameter and inserting the waste presents problems, however a watching brief is maintained on this aspect. HLW though active and relatively stable is initially heat generating and is currently retained in engineered storage and cooled by air convection heated to 140°C. ILW is less active and less stable and gives off gas.

THE IMPORTANCE OF TECHNOLOGY

Professor Colin Dennis CBE DL
Director-General, Campden BRI

We live in a time of great social, economic and technological change. While close to one billion people suffer from hunger or undernutrition and another 2 billion exist on the borderline of barely acceptable nutrition, the potential for dramatically improving the economic status and food situation of developing countries has never been greater. Our track record of agricultural output has weaned us away from the Malthusian view of limits to growth but, given the finite nature of a planet, has also cautioned us on the necessity to pursue technologies and systems that are sustainable.

Global phenomena such as climate change must be continually monitored as it may benefit some countries while dramatically damaging others with respect to agricultural production and sustainable existence.

The ability of the agricultural and food industries to respond to the substantial increase in demand for food over the coming years will be highly dependent on the increased application of existing technologies as well as exploitation of new and innovative technologies. The increased demand for food will emanate both from the predicted population growth but perhaps even more importantly from the broad based economic development in low income countries and the associated dietary changes which will result. Food demand could be as much as double the current requirement by 2050. The need for technological development and exploitation is further emphasised by the fact that the world's arable land and fresh water are not distributed around the world in the same proportions as is the population and in any case both land and water will be a constraint on future food production.

The drivers for technological development are many and varied, including social, economic, political and environmental aspects as well as the push which will come from the advances in scientific research and development. The nature and intensity of these drivers vary, depending on the country and region.

Consumer attitudes and beliefs are essentially influenced by the degree of availability, accessibility and affordability of foods. These differ markedly between developed economies and that situation which exists in many developing countries. Countries whose economies allow consumers to think beyond the cost of food often incorporate social, ethical and environmental dimensions in their choices.

With the increased demand for food and the competing demands for raw materials (eg fuel versus food) it is estimated that the cost of agricultural commodities in the next decades will be 20-50% above the last 10 year average. This will provide a challenge for economies where food represents a significant share of their import payments.

Feeding the expanding number of urban populations will increasingly rely on the development of organised processed food industries and associated supply chains. This view has been reinforced by Dr Yumkella, the Director-General of United Nations Industrial Development Organization who commented earlier this year *"At UNIDO we are convinced that long term poverty reduction can only be achieved through private wealth creation based on industrial development, particularly manufacturing and agro-industrial processing propelled by vibrant entrepreneurship. This implies diversification into higher value products leading to successful domestic and foreign trade. This is why capacity building is one of our priorities".*

Reduced trading barriers in some countries tend to open the way to much longer

. . . long term poverty reduction can only be achieved through private wealth creation based on industrial development . . .

distribution chains, requiring products that will maintain safe hygienic quality for longer periods and will meet all the sanitary and phytosanitary (SPS) needs of importing countries. The traditional technologies of heat treatment will be supplemented by cold processing methods such as ultra high pressure processing and ionizing radiation both of which are capable of producing products of the highest quality.

The international movement of goods will require significantly greater attention to food safety. Non-invasive technologies and sensors to monitor the quality of foods in- or at-line will increasingly replace current time consuming off-line laboratory techniques. While the SPS and Technical Barriers to Trade Agreements are predicated upon science-based international standards, individual countries may opt for differing levels of protection depending on their parochial requirements. However, because so many goods will be entering the flows of international trade, harmonisation of science based safety standards is likely to take place. This will have a profound impact upon food production and processing policies and practices as well as on the technical and managerial training required to carry them out.

Public policies relating to diet, health and nutrition will also drive the need for technological development.

An understanding of the bioavailability of functional components such as vitamins, antioxidants as influenced by diet, food structure and processing is also fundamental. Our concept of nutrition and the impact of technologies may change as we learn more about the fate of food components after ingestion. Nano- and microtechnologies have the potential for protecting and delivering nutrients with greater efficiency.

The acceptance of the need to preserve natural resources and optimise the use of all kinds of inputs will increasingly focus attention towards sustainability and technologies which can assist in preserving the environment as well as delivering social and economic sustainability.

Issues of sustainability apply along the whole food supply chain from agricultural production through ingredients, product and packaging manufacture to storage and distribution via wholesale, retail or food service outlets. More objective data from relevant life cycle analyses are required to evaluate properly the contribution which different components make to the carbon footprint of food supply chains.

The exciting developments in many scientific disciplines particularly molecular biology, genomics, nutrition and human physiology and psychology, bioinformatics, nanoscience, plant, animal, environmental, material and computer sciences, will continue to provide enabling technologies for the agri-food sector.

There is little doubt that biotechnology will become a major contributor to future production and processing technologies. The technology will not only be focused upon improving quantitative outputs but will also produce crops which are adapted to a wider range of climatic conditions (drought, salinity, acidity and temperature). In addition crops with higher levels of beneficial nutrients such as antioxidants will also be produced.

The range of technologies will span from those that increase the total quantity of food by diminishing losses and avoiding contamination, to those that make food look and taste natural and fresh, reduce some components such as fat, sugar and salt, and minimise the use of additives. The wealth of existing and developing technologies available, for example for separation and transformation of raw materials, and the processing, preservation and packaging of finished product, must be used to deliver ingredients and final products to customers and consumers which are safe, contribute to health and wellbeing and sustainability, while enabling companies and entrepreneurs to operate competitively within agreed national and international regulatory frameworks. The opportunities available will be enhanced by enabling technologies such as biotechnology and nanotechnology while information technologies will continue to be pivotal for business and the public sector in an increasingly interdependent and interconnected world.

Technologies are not applied in isolation. In general it is required that policies provide an enabling environment for entrepreneurs, create fiscal incentives for innovation, supply the necessary infrastructure for entrepreneurship (including the availability of appropriate training and development) and promote the adequate backward (eg financial support to small and medium enterprises, risk capital, and information about future markets) and forward linkages (eg international promotion, 'national' brand).

Developing countries interested in establishing or strengthening a food export business will have to face institutional changes to oversee all activities in the food production chain and not just agricultural production. Public policies also need to ensure a science and technology system that provides support to the local industry and promotes the entrance of new small and medium entrepreneurs into the business. The formation of interconnected technology clusters where suppliers, food processors, Government Agencies, research providers and trade associations come together to facilitate the innovation process must be encouraged.

All of the above have to be supported by regulatory frameworks and enforcement strategies that protect consumers' interests locally and abroad and assure the highest standards of food safety and hygiene.

With regard to the movement of food, technologies and systems with the ability to support extended distribution chains will become increasingly important. Together with the movement of goods and people, there is a distinct possibility of creating pandemics through the parallel movement of infectious diseases. This makes implementation of internationally harmonised high quality standards imperative.

The rapid expansion of information and communication technologies (ICT) has provided the direct access and connections to promote and sell raw materials, ingredients and food products. For the first time, entrepreneurs in developing countries have a very strong potential to access international markets with an unprecedented degree of independence. However, the potential to capitalise on this will largely be contingent upon the economic policies that are in place. Such policies must provide strong support to the country's entrepreneurial base. When properly implemented, these policies will have the

consequent benefit of generating employment, and general economic development from which all will benefit.

Agro-industrial development policy should not add to the risk of entrepreneurs, but encourage the application of sound, proven methods for the production of products. It is important to consider sustainability in context and carefully adjust its significance within the hierarchy of imperatives weighted to achieve rational and successful industrial development. The globalization of the economy has provided entrepreneurs vastly greater markets. In light of these new developments, policies must support entrepreneurial competitiveness in rapidly changing markets.

It is critical that governments send their most qualified people as negotiators to international fora such as the Codex Alimentarius Commission. Although these meetings generally revolve around technical matters such as standards and analysis, consideration must be given to representation by highly trained negotiators and well briefed legal people who understand the long-term significance of standards in trade. The subject of these meetings may be technical, but the consequences are definitely economic.

Thus future food security will be dependent on the more effective adoption of a wide range of existing and new technologies for agricultural production, food processing and storage and distribution supported by developments in ICT. In addition public policies which promote free trade and capacity building in developing economies will be essential.

FOOD SECURITY - IS IT ACHIEVABLE?

FOOD SECURITY – IS IT ATTAINABLE?

Professor Chris Lamb FRS, Director, John Innes Centre

The greatest challenges to agriculture over the next 40 years will be to feed the 9.5 billion people that are expected to occupy our planet by 2050. And to find a way to do so that reduces the strain agriculture exerts on the planet.

These challenges seem daunting, but scientists at the John Innes Centre and elsewhere are already addressing them. The UK's plant science institutes are committed to a concerted research effort akin to a wartime effort, co-opting the brightest and the best scientists for a virtual plant breeding institute to drive forward new strategies and technologies to solve major problems.

While the world population is expected to increase by at least 50%, it will require a doubling of grain production to feed, as more people join the middle classes. People in China and other rapidly developing countries are already eating more meat and dairy products and the demand for animal feed is soaring.

WHERE IS THE BREAD BASKET THAT WILL MEET THIS DEMAND?

Prime agricultural land is being lost to erosion, desertification, salinisation and urbanisation. A survey by the Chinese government predicted in November 2008 that harvests could fall by 40 per cent in half a century if soil erosion continues at its current rate.

There is little prospect of any major new cereal producers emerging. Ukraine and Kazakhstan, with their rich dark soil and vast fields of wheat have been the only two to emerge recently onto the world stage.

Purple tomatoes genetically modified to contain high levels of anthocyanin

North West Europe is one of the few politically stable world bread baskets, with some of the highest yielding and best quality crops in the world. Cereals and grasses flourish with cool summers, mild winters and ample rainfall.

Our stability also allows scientific discovery to flourish. The UK could be the global beacon that catalyses how the rest of the world addresses the grand challenge of agriculture's future.

As the director of the John Innes Centre, an international pioneer in understanding plants and microbes, I can see how scientific research might extend the range of what is currently possible and open up possibilities that we have not even yet imagined.

In the 1970s, JIC's work on semi-dwarfing genes contributed to the 'Green Revolution' that saw world wheat yields double. JIC research also led to the first registered 'semi-leafless' pea varieties. Today the entire £38 million annual UK dried pea market consists of these varieties.

There is still much to learn. JIC science now concentrates on three main areas: how plants develop and grow, how they interact with their environment, and how they produce useful products.

HOW PLANTS DEVELOP AND GROW

Stem cells are the source of all growth in both plants and animals. The ultimate source of cells in the root is the 'quiescent centre' – four stem cells that divide infrequently and can produce any type of cell.

From this starting point, plants can make cellulose fibres stronger than steel that enable them to develop their complex architecture. The appealing aesthetic of plants is partly derived from the remarkable uniformity of leaf and flower size that sets each species apart. This uniformity is achieved using a mobile growth signal secreted from cells to reach their allotted size.

Understanding at this kind of atomic level how plants develop and grow will be essential for improving productivity. For example, plants may be rooted to the spot, but we recently discovered that they use long range communication to control flowering. If we could use this knowledge to help breeders develop crops that flower twice, we could immediately halve all the energy use involved in tilling for just one harvest.

Today, wheat provides more nourishment for more people worldwide than any other crop. British farmers grow roughly 16 million tons of wheat every year and export 5-6 million tons making it our biggest crop export. The high fertility of wheat is derived from the stability of its genome and our scientists discovered the stretch of DNA, the *Ph1* locus, that affords this stability.

The stability of the wheat genome has a downside, as it is a barrier to introducing new traits from wild relatives. There are many traits that would be useful for enhancing yields and reducing carbon use, such as tolerances to drought, salinity and disease resistance. Our ultimate goal in studying the *Ph1* locus is to switch off its activity to allow related chromosomes to pair in wheat hybrids, then switch it back on to restore fertility.

Our work should also further enhance the breeding process through breakthroughs on perenniality and hybrid wheat.

HOW PLANTS INTERACT WITH THEIR ENVIRONMENT

The cue that stimulates cell division in the quiescent centre is ethylene. The hormone perceives when environmental conditions are favourable for growth and communicates a signal to stem cells to start dividing.

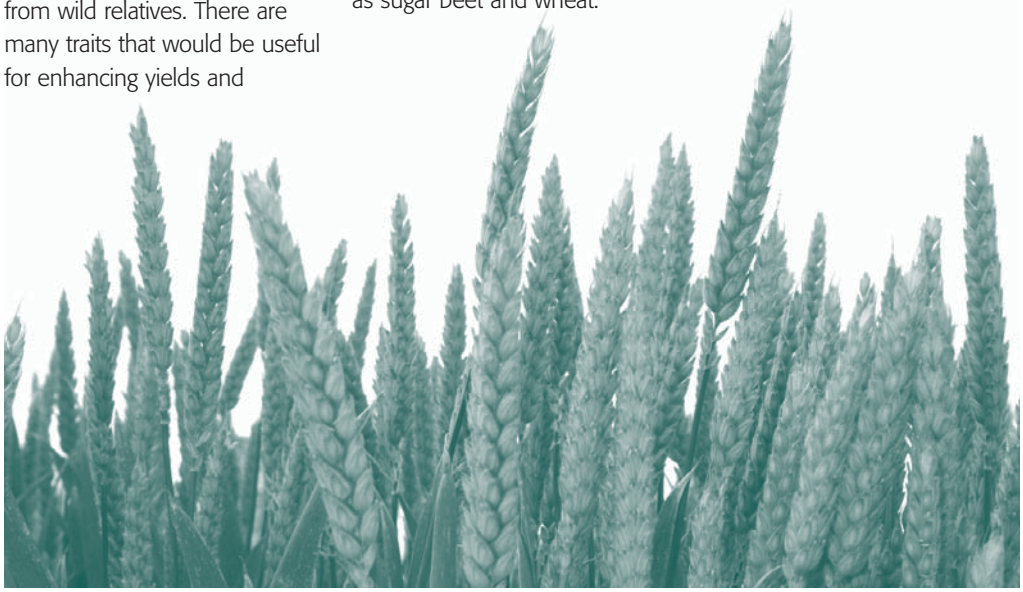
Many plants are dependent on subtle cues from the environment to survive. For example, we discovered that in order to flower at the right time, many plants must experience a period of cold to trigger a process called vernalisation. If it doesn't get cold enough, flowering is delayed or may not happen at all. Some of the plants that need to be vernalised are important food species such as sugar beet and wheat.

Since 1818, the arrival of spring in Geneva has been marked by the first bud that appears on the official chesnut tree in the city's Old Town. In 2005 it burst into unexpected bloom in late October following a balmy autumn. Similar unprecedented events are the manifestation of climate change. By understanding processes such as vernalisation and by using advanced breeding techniques to increase plants' resistance to stress, we can help them adapt to longer growing seasons, changes in temperature and water availability, and the arrival of new pests and diseases.

The cellulose fibres of plants provide a major sink for carbon dioxide, but agriculture is also a major contributor to greenhouse gas emissions. The Haber-Bosch process used to produce nitrogen fertilizers is responsible for about half the fossil fuel usage of modern agriculture.

Nearly 80% of the air around us is nitrogen, but only legumes such as clover and beans can use it. Bacteria living in 'nodules' in their roots take nitrogen from the air and 'fix' it into a form the plants can use.

JIC scientists are currently exploring how to engineer rice



Wheat provides nourishment for more people worldwide than any other crop

to host these helpful bacteria, which might be achievable using genetic modification. Extending the range of crops able to fix nitrogen would revolutionise the potential for global sustainability by massively reducing the carbon footprint of agriculture.

HOW PLANTS PRODUCE USEFUL PRODUCTS

To help reduce our reliance on petrochemicals, plants can be used as green factories, producing starches, oils and lubricants, drugs, plastics and pharmaceuticals. Improvements could also help to enhance the nutrition they provide.

One aspect of food security is ensuring that food provides all the nutrition we need. In the West where food is abundant, many of us are still not eating the recommended five portions of fruit and vegetables a day to help prevent chronic diseases. The annual cost to the NHS of diet-related disease is estimated to be £20 billion and rising.

Plant pigments called anthocyanins, found at high levels in berries such as blackberry, cranberry and chokeberry, offer protection against certain cancers, cardiovascular disease and age-related degenerative diseases. However, berries are a seasonal fruit, can be expensive to buy and are not adequately represented in the diets of many. We conducted experiments to see whether a more common fruit could be engineered to be high in anythocyanins and have the same health benefits.

Two genes that induce the production of anthocyanins were turned on in tomatoes. This produced our now famous purple tomatoes, with levels of anthocyanins higher than anything previously reported for metabolic engineering. To test the benefits of the purple tomatoes, we fed them to cancer susceptible mice. Their lifespan was significantly expanded compared to mice fed a diet supplemented with normal red tomatoes.

This is an early example of a GMO with a trait that offers a potential benefit for all consumers.

To share our excitement and knowledge of what is possible with leading-edge science, we are training the next generation of scientists both in the UK and abroad, and collaborating with breeders and other research organisations globally.

For example, through the Kirkhouse Trust, two of our scientists designed a course in marker assisted selection for plant breeders in Bangalore. Working with farmers who bring their knowledge of crop production and useful traits, the newly trained plant breeders can help make improvements to the local legume crop. In China we are training scientists in reverse genetics to help them identify the functions of rice genes.

The proposed virtual plant breeding institute would move these efforts up a few gears. One of our former incarnations, the Plant Breeding Institute, was the major vehicle for training wheat breeders in the UK. The last generation of PBI trained breeders are due to retire in the next 10 years with no successors emerging. Breeding companies are no longer taking riskier approaches with long term pay-offs.

Wheat, for example, is close to becoming an orphan crop. Major new genetic variation could be brought in by making wide crosses. A UK effort to improve the germplasm of UK crops would be transferable to other settings and to related developing country crops.

This is just a snapshot of the ways in which we are addressing the global threats to food security. The reality is that given the resources we can help plant breeders and farmers feed and fuel the world with a reduced carbon footprint.

DURING DISCUSSION THE FOLLOWING POINTS WERE RAISED

The reason for creating purple tomatoes containing the antioxidant pigment anthocyanin, which is thought to have anti-cancer properties, was to help by inserting it into a vegetable such as tomatoes that are eaten on a regular basis. It is likely to be much more readily accepted in this form than as a powder used as a food additive.

If we are going to be able to provide for a greatly increasing human population it is transparently obvious to some that there will also be a need to reconsider the animal versus vegetable and grain content of the human diet, especially in view of the competition between human beings on the one hand and farm animals on the other for access to basic feedstocks such as soya and grain.

Converting vegetable and grain feedstocks into expensive meat and dairy produce for human consumption is extremely wasteful of both primary food and increasingly scarce water resources. These can better be used directly and much more efficiently as basic primary resources to feed humankind without passing them through another animal species first, which also involves generating unnecessary greenhouse gas emissions in the process. However there is apparently very great reluctance, for what appear to be short-sighted and possibly commercial market-driven reasons, to go down this road. The currently fashionable and actively promoted high cost animal based protein-rich western diet is gaining an increasing hold in Asia, especially in China. It is ironic that the infinitely sustainable and healthy Chinese diet that is now being replaced is based on 5000 years of agricultural refinement incorporating local recycling of waste products without resort to a dairy industry.

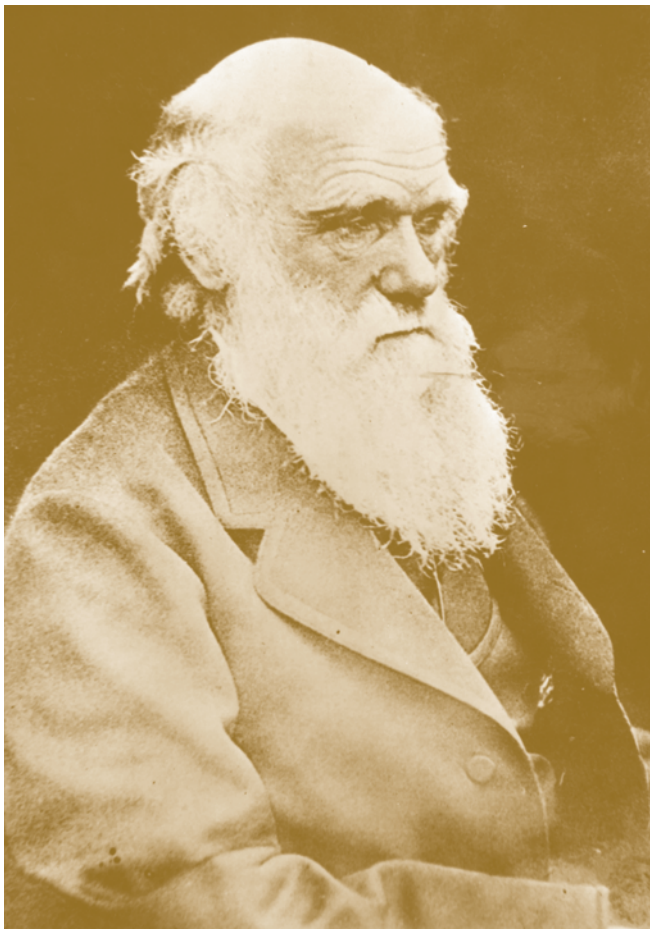
The pressure is on therefore to try to make better use in the future of these increasingly scarce and expensive resources that will be essential for the survival of humanity in the longer term. This will result, for example, in a revolution in Indian agriculture with small family farms disappearing and being replaced by large commercial farming ventures using advanced technology. African farmers are also keen to import new technologies, helped by innovative farmers who act as ambassadors.

Organic agriculture may not be receiving the attention it deserves, possibly as there is currently insufficient organic nitrogen available to feed 9 billion people. Nitrogen fixation by plants would need to be made much more generally available through genetic modification. This will need a new generation of plant breeders to increase global food security using front rank science. However, good applicants are very scarce. A teaching opportunity has been missed to incorporate food and agriculture together with waste management in general education.

The Green Revolution produced crops in Africa that are lower in mineral nutrients resulting in a more restrictive diet which is unrelated to soil condition, and maintaining a healthy diet is very important.

DARWIN

Professor Alan D B Malcolm
Chief Executive, Institute of Biology



If you ask the man on the Clapham Bendy Bus to name the three most important scientists of the last 1000 years, the chances are that Newton, Darwin and Einstein would feature on many lists.

Only a very few would be able to explain what relativity actually is. A few more would have a stab at explaining gravity, but almost all would be able to tell us what evolution means. The impact that Origin of Species had on our understanding of the place of Homo Sapiens in the great scheme of things has been described exhaustively over the past 150 years. There is no suggestion that the clergy got their knickers in a twist over understanding why the moon went round earth, or why the sun's rays were bent as they passed a planet on their way to earth!

The public are believed to regard scientists as elderly males with unruly, and excessive, hair and Einstein and Darwin clearly help to support this hypothesis.

Yet in most other ways the three men display very different characteristics.

Newton seems to have been a rather unpleasant character. He probably maligned and plagiarised his rivals, particularly Robert Hooke. Einstein could not be described as a loyal family-loving character. How remarkably different Darwin was on all these counts.

It is well known that he prevaricated about publishing a complete synthesis of his theory, although much of his thinking was very well known to fellow scientists. This was not just the usual academic self criticism – he had published many papers and monographs previously. It seems likely that a major factor in his delay was that he agonised about the social and religious impact his theory would have, and was particularly sensitive to the beliefs of his wife, Emma.

More particularly, he was troubled by the possible clash over priority with Alfred Russel Wallace. He poured out his concerns to colleagues such as Lyell, but also in letters to Wallace himself. Those who have only seen into the minds of scientists through reading accounts by Jim Watson of the race against Linus Pauling, and stormy relationships with people like Rosalind Franklin, need to read Darwin's correspondence to recognise that scientists can also be warm and generous.

His undoubted dedication to his family was obviously strengthened by his undiagnosed, but intermittently crippling, ailment, which effectively confined him for decades at Down House. His agony at losing his adored daughter Anne, when she was ten (having already lost another offspring) is palpable in his writing.

And yet in addition to his genius, Darwin was also extremely lucky.

Malcolm Gladwell, in his recent book *Outliers*, points out that genius and hard work are necessary, but not sufficient, indicators of success. You have to be born at the right time. Andrew Carnegie was born in 1835, and was therefore just the correct age to take advantage of the growth of railways. John D Rockefeller was conceived at just the right time to exploit the discovery, and use of, petroleum. Bill Gates was born in 1955, and was just the right age to take advantage of the introduction of personal computers. Darwin was born just in time to take advantage of Britain really ruling the waves. The British government was

English Heritage has recently restored the garde
famous 'thinking path', the Sandwalk.

prepared to finance the Beagle as part of its contribution to 'blue skies' research – although it was mainly minerals rather than biology where they hoped to get a return on their investment. Fifty years earlier, and either the French or the American colonists would have got in the way of his travels.

He was born rich – how else could a new Cambridge graduate have managed a five year 'gap year'. (Bill Gates came from a wealthy family, and attended a school with its own computer access).

Darwin dropped out of two careers – medicine after two years in Edinburgh (although he did learn to regard Scotchmen highly – pace Boswell!), and theology/the church after three years in Cambridge. (Bill Gates dropped out of Cambridge, Mass). Such career changes are easier if you have family money to fall back on.

In case this sounds ungenerous, Gates would be out of the house as a teenager between 03.00 and 06.00 to get access to the University computer when no-one else was around. Darwin endured enormous privations (and acute sea sickness) during his time with the Beagle. He even lost his first girl friend, Fanny, to Mr Biddulp, while he was away.

Through a mixture of charm and diligence – he was a prolific letter writer – Darwin deserved the excellent mentors he acquired, as well as many loyal friends and collaborators. But surely the appearance of Huxley as a disciple must be regarded as luck?

From time to time, the powers that be organise competitions to find the greatest Briton that ever was. Without getting bogged down in semantics, let us recognise that it will never be won by a scientist, because we are like a number 14 bus. Miss one and another will soon be along. Had Darwin never existed, the theory of evolution would have been held up for only a few more years. It would not have been so elegantly nor comprehensively expounded by Wallace et al. But Mendel and co would have won through anyway. Sadly for us scientists, we have to recognise that if Shakespeare had not existed, no-one else would have given us all those clichés!

But in this, his bicentennial year, let us rejoice that he was a wonderful role model for scientists in his treatment of his fellow humans, whether relations (including Wedgwood in laws), friends or even rivals.

The actual birthday (12th February) saw Richard Dawkins (in the red corner) discussing with Richard Harries (in the blue corner) Darwin's legacy. And the venue? Why the Natural History Museum in Oxford, where Huxley first bit the ankle of the Bishop of Oxford.

A superb exhibition with many of the original letters and specimens runs at the Natural History Museum in South Kensington until April.

ens – Darwin's 'Outdoor Laboratory' – to their appearance during his time at Down House. Visitors can walk along his

SAFEGUARDING OUR NATURAL CAPITAL

Catherine Martin, Institute of Biology

We all have an intrinsic understanding that an economic value can be put on the environment. A flat in Brighton with a sea view will be more expensive than one three streets back. A house with a view of the beech woods in Bucks will command a higher price than one overlooking a gravel pit. We often identify the cost of mopping up the environmental damage perpetrated by an oil spillage on our coast, but does the Government keep a tally in its asset register of the value of the ecosystem for which it is responsible? What steps do we take to ensure that this increases year on year rather than being eroded? A recent WWF report states that the world's wetlands are worth US$70 billion annually because they are important for controlling flooding, filtering water and as recreation amenities. Yet the UK has lost half of its wetlands[1]. We are now beginning to see the value of creating a viable market for carbon to help reduce emissions and tackle climate change. It is time we do so for those services our natural environment provides for which no market value exists, before it is too late.

Demands on our ecosystems and the services they provide are rocketing. With a growing population to sustain and increasing demand for water, food and energy, today's world is facing problems of an unprecedented scale. The world has been rocked by the scale of the current financial crisis – the ecological crisis posed by depletion of our natural capital will have more far-reaching and devastating consequences. To highlight this issue the Natural Capital Initiative (NCI) – a partnership of the Institute of Biology, the Centre of Ecology and Hydrology, the British Ecological Society and the Science Council – has been created.

Natural capital is vital to our social and economic well-being. Human well-being depends on healthy, functioning ecosystems because of the range of services they provide: food, fresh water, timber, clean air, soil formation, climate regulation, as well as the cultural and aesthetic enjoyment we derive from nature. Over time, human activity has changed ecosystems to derive social and economic benefit. However, this has not always been sustainable or for the benefit of all mankind, and there have been unintended consequences on ecosystem health. The NCI proposes that to ensure the health and prosperity of future generations, we must reconsider how to feed and sustain a growing population whilst safe-guarding ecosystems and the services they provide.

The Millennium Ecosystem Assessment recently reported on the consequences of ecosystem change on human well-being. The report urges a more sustainable approach to human social and economic development, and promotes the use of an 'ecosystem approach' as a guiding framework to achieve this. The 'ecosystem approach' is defined as a holistic strategy for the integrated management of land, water and biodiversity to promote conservation and sustainable, equitable development practices. This approach inextricably links human well-being with the health of ecosystems ensuring that development today does not compromise the needs of future generations. There is growing support for this as a framework for sustainable development from many quarters including the Department for Environment, Food and Rural Affairs (Defra); the Convention on Biological Diversity; the World Resources Institute, and the International Union for Conservation of Nature.

An important question we face today is how to make the ecosystem approach operational? NCI will work to achieve this through identifying gaps in current research, policy and its implementation. By engaging with policy-makers, industry, and different research disciplines (including environment, economics, humanities, health and psychology), the initiative will help link research and policy to develop further understanding around the management and valuation of ecosystem services. The initiative will also create opportunities for constructive debate on the benefits and trade-offs in implementing the ecosystem approach that will be broadened to include public and private sectors.

The aims of NCI fit well with a number of government objectives, most notably the recent cross-government priority (laid out in the Comprehensive Spending Review 2007) to "Secure a healthy natural environment for today and the future". NCI activities and outputs will also feed into a new ten year programme – Living with Environmental Change (LWEC). The LWEC programme is run by a partnership of government departments and related agencies and Research Councils UK. It will provide the evidence required by decision-makers to manage effectively and protect vital ecosystem services to mitigate the economic impact of environmental change.

The first major activity of NCI is a three-day multi-stakeholder symposium from 29 April to 1 May 2009 in London. This will explore mechanisms for assigning value to the services provided by ecosystems to inform decision-making in the face of often conflicting economic and social demands on our natural capital. The first day will set out the challenges involved in implementing the ecosystem approach to achieve this. This will be followed by two days of focused workshops where delegates will identify gaps in science and policy and start to provide potential solutions. A report highlighting the findings of the symposium with details of how NCI plans to progress them will be published. In order to bring the importance of sustainable development and the ecosystem approach to a wider audience, a campaign will be developed with the Science Media Centre ahead of the symposium. There are currently places available. Further details can be obtained by making contact below.

During the next three years NCI will continue to promote the importance of valuing our natural capital by creating a central web-based information resource and organising further workshops and events to build on outputs generated from the symposium.

Contact c.martin@iob.org

1. http://www.wwf.org.uk/article_search_results.cfm?uNewsID=991

MEASURING THE WORTH OF MEDICAL RESEARCH

Dr Ian Viney
Head of Evaluation,
Medical Research Council

A new study, commissioned by the Medical Research Council (MRC), the Wellcome Trust and Academy of Medical Sciences, shows that every pound that the tax payer or charity donor invests in medical research yields a wider chain of benefits equivalent to earning 39 pence each year, forever. The report's findings provide some extraordinary insights into the wider benefits of medical research to both the health and wealth of the UK.

The contribution of medical research to health is clear. For example, research conducted by the MRC in the 1950s established a link between smoking and lung cancer which has since saved millions of lives. But the wider health and economic benefits of medical research can sometimes be overlooked.

The year-long study, commissioned in 2007, was carried out by a consortium involving Brunel University, RAND Europe and the Office of Health Economics. It based its analysis on the returns from investment in research in cardiovascular disease and mental health over 17 years between 1975 and 1992. The consortium chose cardiovascular disease because much is known about how therapies and diagnostics affect health and lifespan, and conversely mental health because there is less understanding of such effects.

Developing methodology to work out the health and gross domestic product gains from investing in these two areas, the researchers aimed to address a raft of questions. These included: what proportion of global cardiovascular disease/mental health research can be attributed to the UK? What is the time-lag between research expenditure and its impact on health? And what were the key treatments and interventions over this period and how many people used them?

Data were gathered from UK research funders, including the MRC, Department of Health, and the Wellcome Trust, to work out total investment in the two chosen disease areas. Evidence-based clinical guidelines were used to estimate the UK's research contribution to interventions in this field including those from NICE (the National Institute for Health and Clinical Excellence). Evidence on 46 different combinations of cardiovascular diseases and interventions to treat or prevent them was analysed, for example aspirin, beta blockers and smoking cessation, while the study for mental health used evidence on six such combinations. Quality Adjusted Life Years (QALY), estimated by NICE to be worth £25,000 each, were used to measure the quantity and quality of life gained from a health intervention.

The results were impressive. The researchers estimated that the health and gross domestic product gains from UK public and charitable investments in cardiovascular disease research over the studied period were equivalent to an annual rate of return of around 39 per cent for cardiovascular disease, and 37 per cent for mental health research. Overall, around 30 per cent of the gains consisted of benefits to the UK economy, and the remainder was derived from health gains from new treatments or preventive measures.

The findings also showed that public and charitable funding of medical research encouraged greater investment from the pharmaceutical industry, a so-called 'spill-over' effect. One example of this is that public investment in universities generates skilled graduates, new ideas, networking opportunities and high-quality libraries. The report points out that it is no coincidence that high-tech firms choose to base themselves near top-quality universities. Each £1 of extra public/charitable investment in UK medical research was shown to yield £2.20 to £5.10 of extra pharmaceutical company investment, which taken together earned an extra £1.10 to £2.50 GDP per year for the UK economy.

Professor Martin Buxton from the Health Economics Research Group at Brunel University, who led the study, said: "Estimating the returns on investment in medical research is notoriously difficult. This is partly due to the time it takes for research to filter into measurable health benefits. We looked at the value of health gains once the cost of healthcare had been taken into account and gains to the UK's national income (GDP) from medical research."

He added: "Our aim was to generate realistic estimates of the economic impacts of medical research. The methodology we came up with should help to assess the returns for different disease areas. However, this was never intended as a one-off exercise, and we hope our results will stimulate more work in this important but neglected area of research."

The study also showed that there is a time-lag between research expenditure and eventual health benefits of around 17 years. This raises further questions, such as whether the measured returns on investment are specific to the time frame studied. Do returns differ depending on the

. . . public investment in universities generates skilled graduates, new ideas, networking opportunities and high-quality libraries. . .

area of research funded? These uncertainties also apply to the time-lag between investment and benefit in different disease areas. More research is clearly needed to answer these questions and expand upon the insights gained from the study.

As the researchers point out, the study was not intended to be viewed as a one-off exercise, but rather as an opening into a new research field which will lead to even more robust studies in future. However, the results do provide the first real quantitative estimates of the economic benefits of UK public and charitable investment in medical research. Although the work focused on just two disease areas, the results indicate that total health and GDP gains arising from medical research across all areas could be even greater.

Sir Leszek Borysiewicz, Chief Executive of the MRC, said: "The report provides a fascinating insight into the substantial benefits of medical research. A key message we can take from the findings – particularly during the current economic downturn – is that supporting a wide portfolio of research is very important for future patient and wider economic benefit. It can be hard to see the full potential of research at the outset, but this study shows that investment at an early stage can pay very healthy dividends further down the line."

Download the full study at www.wellcome.ac.uk/economicbenefits

RSC BILL BRYSON SCIENCE PRIZE AWARDED IN THE ATTLEE SUITE

Bill Bryson (centre) is seen here with Dr Brian Iddon MP, Thomas Williams (winner of the secondary school category), Helen Southworth MP and Professor David Garner, President of the Royal Society of Chemistry at the prizegiving reception in the Attlee Suite, Portcullis House, on 14 October 2008. The reception was organised by the Royal Society of Chemistry, sponsored by Dr Brian Iddon MP and Mr Mark Lancaster TD MP.

An explanation of the aims and origins of the competition can be found on page 53.

The 2008 Winners are:

Emily Bullman of Walthamstow Hall, Kent who won the overall prize with her book *Science and Sport in Action*

Thomas Williams of St Gregory's Catholic High School, Warrington who won the secondary school category with his leaflet on *Drugs in Sport*

Kate Marks and Sophie Jarvis of St Joseph's School, Cornwall won the primary school category with their PowerPoint presentation *Getting ready for your first Marathon*

FROM DRAINS TO HEALTH GAINS: A BRIEF HISTORY OF PUBLIC HEALTH

Dr Rosalind Stanwell-Smith
MB BCh MSC FRCOG FFPH
Honorary senior lecturer, London School of Hygiene and Tropical Medicine, scientific advisor to the Royal Society for Public Health and Secretary to the John Snow Society.

"The history of public health provokes a big yawn since it conjures up an image of investigating toilets, drains and political statutes through the ages" *Dorothy Porter, 1999.*

Public health, as we know it today, is a wide ranging subject defined as the 'science and art of preventing disease, prolonging life and promoting health through organised efforts of society' (Acheson, 1988). One could easily span the alphabet in listing its many concerns, but the term was coined in the 19th century applying chiefly to the improvement of sanitary conditions in towns and 'populace places' in England and Wales. One word, *drains*, sums up what was meant by sanitary conditions: the first Public Health Act, 1848, was driven by the threat of 'King Cholera': cholera epidemics swept England from the 1830s and the best means of control appeared to be better sanitation, partly because infectious disease was thought to be caused by smells and dirty conditions. Plans for improved sewers were delayed due to cost until the Great Stink of 1858, when the stench from the sewage-laden Thames disrupted the work of Parliament: legislation to allow the Metropolitan Board of Works to install London's new sewage system was introduced and passed in just 18 days. It was the most advanced system of its kind in the world and the growing evidence of the importance of clean water and efficient sewerage, linked to the development of microbiology and engineering, set public health firmly in the field of sanitation and hygiene. Public health officers were often nicknamed 'drains doctors' and their activities focused on cleaning up the public and their living conditions. In the first half of the 20th century, the history of public health was often portrayed as a triumphant progress from Hippocrates and Roman drains to Joseph Bazalgette's sewers and the undoubted success of water treatment in controlling diseases such as cholera and typhoid fever.

. . . tension between individual freedoms, choice and the role of the state in improving health is still a challenge . . .

A reaction to this view of public health was inevitable: practitioners pointed to other origins of collective action to improve health, such as vaccination and the emerging notions of human rights to health in the 18th century; also to other societal trends predating the drains concern, such as the disquiet about health, particularly that of children, in the new industrial towns and cities. The British predilection for counting and measuring disease, starting at least three hundred years before the 'sanitary revolution', led to the science of epidemiology and analytical studies comparing population groups with and without particular diseases. Efforts to understand mental health, prison and factory reform and improved nutrition and food safety were also in progress before being overtaken by the sanitary definition of public health. Twentieth century advances in clinical medicine further eroded the status of the 'Medical Officer of Health' as someone dealing with the more sordid and mundane matters of delousing and drain swabs to detect typhoid carriers. Infectious diseases and drains were relegated to a secondary place in the post-WWII public health practice, with the specialty changing its name from social or community medicine to public health medicine and then just to public health, a multi-disciplinary, multi-focus subject claimed by politicians and just about everyone else. Meanwhile, re-organisation of the NHS from 1974 onwards took public health doctors away from their local authority origins and into the field of measuring or auditing clinical practice, planning and managing services.

Educating the public about healthy practices thus shifted from drains and disinfectants to 'health promotion' regarding smoking, obesity, alcohol, drugs, accidents and sexual behaviour. Themes of controlling a disorderly and disobedient population, arising in the 18th and early 19th centuries, re-emerged in the late 20th century as the need for all the public to be involved in looking after their health. It is notable that health campaigns have

often needed the nudge of legislation to increase the effect on behaviour, as in tobacco controls. The tension between individual freedoms, choice and the role of the state in improving health is still a challenge for public health, for example the right not to be vaccinated against the 'nanny state' that knows infections cannot be controlled without widespread acceptance of vaccines and other measures. Rights to confidentiality also sit uneasily with rights to health, where large studies requiring personal data are needed to investigate causes and appropriate treatments. In all the contemporary and perhaps too thinly spread efforts of public health, the key role of 'drains' in allowing its development has been sidelined. Before the 19th century Public Health Acts there was little expenditure on population health and no overall organisation or standardisation of activities. The gradual acceptance of the need for trained personnel, budgets and associated taxes, allowing the range of public health to develop, all stemmed from the sanitary concerns of pioneers such as Edwin Chadwick, William Farr and Dr John Snow. This is more than a historical footnote, acknowledging the importance of sanitation in the emergence of modern public health: the reaction against the 'drains doctors' image had the unfortunate consequence of infection, water and sanitation being seen as dealt with, needing only a maintenance regime. The last major legislative overhaul of public health was the Public Health Act of 1936 and it seems that since then, it has been very hard to find Parliamentary time for these matters. Perhaps we are simply waiting for a dire emergency to occur, since "most changes have occurred because of a failure in the systems or as a response to a crisis" (Kenneth Calman 1998).

At the time of this meeting, at the close of the WHO Year of Sanitation, an epidemic of cholera was raging in Zimbabwe, following the breakdown of water and sanitation services. Worldwide, 2.6 billion people lack sanitation and the targets to address this are "badly off track" (WHO Director General, 2008). Apart from the now re-established concern with new or re-emerged infections, resistance to antibiotics and antiviral drugs, floods, chemical contamination, wars and civil disruption are constant threats to water and sanitation. Is the toilet "the barometer of civilisation", as a recent author (George 2008) suggested? If so, the meandering and uneven progress towards safe sanitary standards in this country, the comparative lack of emphasis on water and sanitation in international aid and the decline of public lavatories at a time when more people need them for health and wellbeing, all suggest that we need to re-examine that barometer. While the history of water and the drains may make some yawn, it remains one of the surest cornerstones of public health and an essential concern when disaster strikes.

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WHY DOES PUBLIC HEALTH MATTER?

THE ETHICS OF PUBLIC HEALTH

Lord Krebs Kt FRS FMedSci

Principal, Jesus College, University of Oxford and Chair of the Nuffield Council on Bioethics Working Party on public health

Public health is news. Barely a day goes by without comment in the media or Parliament about issues such as obesity, smoking, alcohol consumption, vaccination and preparation for the predicted flu pandemic. In the early days of public health policy, in the 19th century, the emphasis was on providing clean drinking water and proper sewage collection, now considered basic necessities of life in this country. Today, much of the emphasis of public health policy in the UK is on so called 'lifestyle diseases' that have become the major preventable causes of premature death.

THE NUFFIELD COUNCIL ON BIOETHICS REPORT

A year ago, the Nuffield Council on Bioethics published a report that lays out an ethical framework for public health policy. The report does not provide a set of rules, but rather a set of guidelines for policy makers. The central question in the report is how to balance individual liberty, responsibility and consent, with the obligations of the state and others to promote the well-being of society as a whole. The Nuffield Council's proposal is that the state has a 'stewardship role'. By this we mean that whilst a premium should be placed on individual responsibility and lack of coercion, there are justifiable

circumstances in which the state might intervene to protect and promote public health. These include preventing people from harming others, protecting vulnerable groups such as children, reducing inequalities, providing education and information, as well as medical and other services.

We also developed the notion of an 'intervention ladder' of policy options. The bottom rungs of the ladder are the least intrusive options, such as doing nothing or providing information, whilst at the top are the most coercive measures such as banning products and practices and restricting choice. In between are options for guiding/enabling choices without actually compelling people. The further up the ladder you go, the stronger the case has to be.

SUBSEQUENT DEVELOPMENTS

Media reaction to the report was predictable. The Guardian saw it as a "gift in the government's lap", whilst the Times described it as "pseudo-philosophy ..used by those who … chip away at individual freedoms". The health professionals, represented by an editorial in the Lancet, were supportive.

The two opposition parties have struggled to define their position on public health policies. Lib Dem spokesman Norman Lamb suggested that everyone should have a swipe card with which they gain tax credits for taking exercise or other healthy pursuits. I wonder if this might include a card reader by the bedside for an 'after sex swipe'. Meanwhile Andrew Lansley said of obese people, that they "eat too much and take too little exercise.. the buck stops with them". Our report viewed this approach of blaming people for being fat, lazy and greedy as too simplistic. It ignores the fact that genetic predisposition, socioeconomic factors and environmental constraints make it more difficult for some people to lead a healthy lifestyle.

We used our framework to examine four case studies: infectious disease, alcohol and tobacco, obesity and fluoridation. In each of these areas there have been significant developments in the last year, many of them along the lines of the recommendations in the Nuffield report. The Queen's speech made reference to relatively coercive policies on both tobacco and alcohol.

SMOKING

As a result of education, taxation and legislation, the proportion of adults smoking in Britain has declined from over 75% in 1950 to 22% today. Now that smoking is a minority sport, further restrictions are acceptable, including the ban on smoking in public places, justified mainly in terms of reducing harm inflicted on others. Nevertheless there are still significant inequalities in smoking risk and an estimated 200,000 11-15 year olds were found to be smokers in 2007. The latest proposals to restrict access to vending machines and ban displays in shops were justified in terms of protecting the vulnerable and reducing inequalities: it could have been a quote from the Nuffield report!

. . . The two opposition parties have struggled to define their position on public health . . .

. . . with 'business as usual', the health problems arising from obesity and other 'lifestyle diseases' will swamp the NHS. . .

DRINKING

The Government's approach to alcohol has been less consistent. No one doubts that excessive alcohol consumption is a major public health problem, providing an argument for a similar approach on alcohol and tobacco. But, perhaps because most people drink and many are employed in the drinks industry, the Government has taken a much softer line on alcohol. In fact the measures in the Alcohol Harm Reduction Strategy for England (AHRSE), such as providing information, run counter to those found to be efficacious in the World Health Organisation's global review. The most effective policies are restricting availability, restricting marketing, and increasing price. But the more coercive approach on pricing and promotion promised by the forthcoming Policing and Crime Bill would certainly be justified within the Nuffield Council's framework.

INDUSTRY'S ROLE

A study by KPMG for the Department of Health concluded that the drinks industry is falling short on its corporate social responsibility programmes. In the developing world, where smoking is on the increase, cigarettes are overtly marketed at children and teenagers. It seems obvious that manufacturers will put jobs and profit before public health, and in our report we concluded that this is a further justification for state intervention.

INFECTIOUS DISEASE

Some countries, such as France and the USA, have a quasi-mandatory approach to vaccination against MMR, whilst others, including the UK, do not. The Nuffield Council concluded that a quasi-mandatory approach might be justified if it were shown to be effective. In this context, it is worth noting that since the outrageous Wakefield scare and consequent fall off in vaccination, measles cases have risen to a record level. On the question of pandemic flu, whilst the Government has a pandemic flu plan, many of the details of how vaccines and anti-virals are to be distributed and to whom, still remain to be worked out. The House of Lords Science and Technology Select Committee is currently engaged in a follow-up enquiry into the plans.

OBESITY

At about the same time as our report appeared, the Foresight Team produced a report on "Tackling Obesities". Their conclusions were in line with our ethical framework and policy suggestions. Subsequently, the Department of Health launched its £372M

"Healthy Weight, Healthy Lives" strategy. It recognises that no single magic bullet will serve to reverse the rapidly rising prevalence of obesity, and the measures encompass a range of initiatives to improve the diets of children, encourage exercise and provide support for those at risk.

We are still awaiting the results of a study by the Food Standards Agency on which food labelling scheme is the most effective in helping people make healthy choices. Interim findings show that all the main schemes have the potential to cause confusion among consumers. The final recommendations will need to consider a current European Commission proposal to simplify and consolidate existing labelling legislation, which will eventually apply to all member states.

Which? recently reported that leading food companies in the UK are still not doing enough to curb their marketing of less healthy food to children, adding support to the Nuffield Council recommendation that stronger regulation of advertising food to children should be considered. Ofcom is reviewing the current broadcast restrictions on food and drink advertising to children with results due in autumn 2008.

FLUORIDATION

It is surprising how weak the evidence is for both benefits and risks of fluoridation. The most comprehensive review of the evidence to date concludes that it has some benefit in reducing dental caries but it is not possible to quantify this. An important ethical consideration here is consent, since it is hard to opt out once fluoride is added. It is, however, not possible to obtain consent from each individual, so a democratic consultation process has to serve as a proxy. Our conclusion was that decisions should be made at a local level, as the benefits will vary according local conditions such as the amount of fluoride in the water from natural sources.

THE FUTURE

Tackling public health problems, particularly those related to so-called lifestyle diseases, is a major challenge, because of the delicate balance between individual freedoms and benefits to society as a whole. Sir Derek Wanless concluded a few years ago that with 'business as usual', the health problems arising from obesity and other 'lifestyle diseases' will swamp the NHS. Therefore doing nothing is not an option. There is a parallel here with climate change. As individuals we are unlikely to make the radical changes to our lifestyles necessary to tackle the problem without considerable coercion. The challenge for the Government is whether or not it is prepared to take the necessary steps, and the challenge for the electorate is whether they are prepared to vote for politicians who are willing to make hard choices.

WHY DOES PUBLIC HEALTH MATTER?

THE HEALTH PROTECTION AGENCY – CHALLENGING TIMES

Sir William Stewart FRS, FRSE
Chairman, Health Protection Agency

The National Health Service (NHS) has done a good job over the past 60 years, with much more funding available now than ever before, and with primary care and the hospital services focusing rightly on providing ever-improving health care for the individual. The 2008 Darzi report emphasised how such a service should develop further in the foreseeable future. What has received less attention is how the health needs of the overall general public, as distinct from the individual, are best catered for. That is where the Health Protection Agency (HPA) comes in.

> . . . The HPA must continue to be able to deal with public health issues within its remit wherever and whenever they occur. . .

The HPA, established in 2004, has a staff of 3,400, is a non-departmental public body (NDPB) answerable to the Secretary of State for Health and has a budget of £278 million with 60% being core funding from DH; the rest comes from contracts with the public and private sectors. It is the first one-stop-shop in the world which brings together public health protection against radiation, chemicals and infectious disease hazards. For example what can be done to prevent the nation coming down with a new infectious disease, or the impact

of the explosion of a nuclear bomb or when, as in Bhopal in India, toxic chemicals decimate the community. How do you seek to ensure that such potential population dangers and disasters are prevented or mitigated?

Equally, the work of the Agency also underpins and advises on other areas where duty of care by the state is currently essential. For example, in helping provide vaccines and in evaluating and advising on their use; on monitoring and advising on HIV, TB, HPV, mumps, measles, rubella, MRSA, sexually transmitted infections, blood borne viruses, SARS, ebola, arenaviruses, gastrointestinal infections, zoonotic infections, anti-viral drugs, antibiotic resistance, flooding, air pollution, pandemic 'flu preparedness, radiation, mobile phones, nuclear bombs, air pollution, terrorist activity; chemicals and poisons etc, etc.

It is important to note that responsibility for health protection against alcohol abuse, smoking and obesity is placed elsewhere in the DH family. Also, the Food Standards Agency (FSA) leads on food standards. These are important points to make because it is often assumed by members of the public that because we are named the Health Protection Agency we have responsibility for these areas. That is not the case. However, the Agency has good links with other DH NDPBs and works well outside DH with the FSA, Transport, the Home Office, DEFRA, DFID, BERR, MOD, the Cabinet Office, the devolved administrations and others. It is also cognisant of its role in listening to and disseminating advice on health protection issues to the public. This is sometimes a contentious area where it is important not to scare-monger. Nevertheless, in my opinion, openness coupled to fully putting the pro's and con's of any debate are very important. Overall, the HPA seeks to provide a co-ordinated underpinning national resilience able to deal effectively with a huge spectrum of public health protection issues whenever and wherever they arise

Operationally the Agency has 3 major laboratories: the Centre for Radiation, Chemicals and Environmental Hazards, at Oxford (with two satellite laboratories in Leeds and in Glasgow); the Centre for Infections at Colindale in North London, and the Centre for Emergency Planning and Preparedness at Porton Down in Wiltshire. These link with HPA Local and Regional Services and to the HPA Regional Microbiology Network. Approximately 50 per cent of our staff are based in the regions where they work closely with NHS primary care and hospitals trusts, strategic health authorities, local authorities and with the general public. Its headquarters are in central London close to Whitehall. The benefit of such HPA co-ordination was exemplified by the Litvinenko/^{210}Polonium incident where unified Agency co-ordination from specialist laboratories through to local and regional services rapidly minimised any general public health risk. In April 2009 the work of the National Institute for Biological Standards and Control (NIBSC) will become integrated in to the HPA, bringing enhanced hybrid vigour to the working and remit of the Agency.

. . . Increasing global travel, trade, commerce and industry, the expansion of the EU, and immigration/emigration are all impacting on UK public health protection, . . .

. . . The Agency is much involved in safety aspects related to new nuclear power developments. . .

LOOKING TO THE FUTURE

Despite, and because of current challenging and turbulent times, it is important that the Agency's unique role is not compromised. The HPA must continue to be able to deal with public health issues within its remit wherever and whenever they occur. We cannot spend time pontificating. We have to get on with it at the drop of a hat, shifting and prioritising on the use of scarce resources. Additionally, horizon scanning, and focusing on future needs and developments are crucially important. No one can be certain about every future public health protection issue that will emerge, but we have to be generically prepared. My focus has been resolute in seeking to develop an Agency with ongoing underpinning science-based resilience, able to address whatever public health protection issues may arise.

Let me touch on some of the issues on my near-term priority list.

INNOVATION AND EFFICIENCY GAINS MUST BE ONGOING

For a start, the Agency must ensure that the best possible use is made of existing resources as we seek new approaches and technologies to enable us to do things better, safer, faster and more efficiently than ever before. Continual improvement must always be in the mind set.

There will be a huge cross-border international dimension to much of what we do.

Increasing global travel, trade, commerce and industry, the expansion of the EU, and immigration/emigration are all impacting on UK public health protection, because as people travel their microbes travel with them. This is an ever-increasing challenge as HIV and TB surveillance data show. It will also be important in the run-up to, and during, the 2012 Olympic Games. This demands co-ordination of healthcare provision nationally and internationally.

The HPA serves as the UK National Focal point under the WHO-led International Health Regulations. There is a continuum within the UK through our responsibilities for Port Health, our central and regional diagnostic and surveillance systems to our local and regional interactions with the NHS and local authorities. If a worrying new bug turns up there is a good chance that it will be picked up by an effective national surveillance system as

happened with a recent *Salmonella* in chocolate case. Real time surveillance and diagnostics operating not only at regional level but also at primary care and hospital level, and hopefully in due course at ward levels and GP surgeries, are required. There is still some way to go but global and national surveillance coupled with modern and molecular epidemiology are huge national needs.

EMERGENCY PREPAREDNESS, PANDEMIC 'FLU AND TERRORISM

The Agency has been involved in over 3,000 health protection incidents over the past year. But the really big issues have been, and are, emergency preparedness for things like the recent London bombings and preparedness for pandemic 'flu. The HPA is Category 1 responder under the Civil Contingencies Act. Our emergency preparedness and training work is centred at the Centre for Emergency Preparedness and Response at Porton Down which has first class containment facilities and which also houses some of the most dangerous pathogens in the world. I welcome the fact that the Government has agreed that plans be drawn up for a major forward development of the Centre.

A focus is preparedness against the possible release of biological agents by terrorists. It would be naïve, looking ahead, to believe that the increased opportunities which molecular biology/genetics are bringing to improve public health could not also be used for offensive biological use, albeit that the offensive use of biological agents is prohibited by international convention. Equally, on the radiation front, there is a need to be prepared for the impact which the terrorist use of radiation sources and 'dirty bombs' could make. No one country can be totally prepared against such threats but the UK, with major HPA involvement, is amongst the best prepared in the world.

NUCLEAR POWER AND RADIATION

The use of radiation, particularly ionising radiation, is a major economic, environmental and public health issue. It is also an area of concern to the HPA. Ionising radiation sources, for example, are of significant medical benefit and have been broadly accepted by the public, but concerns have been raised as a result of the use of nuclear bombs in World War II, the proliferation of nuclear power technology, and the fact that accidents can and do happen. The Government issued, in July 2008, a consultation document on the Strategic Siting Assessment Process and Siting Criteria for New Nuclear Power Stations in the UK. The Agency is much involved in safety aspects related to new nuclear power developments and in the event of a Government decision to enable a new programme of nuclear reactors, HPA Radiation Protection Division expects to provide expert advice, based on objective scientific assessments of, for example: likely exposure and health risks to people, interacting international radiation protection principles for UK applications and to provide direct evidence to the public and to Government organisations on areas such as waste management advice, transport of radioactive materials and behaviour of radiation in the environment. I foresee Radiation Protection as a major area of HPA involvement over the next few years.

. . . Chronic diseases make a huge impact on public health and well-being, currently costing over £12 billion per annum. . .

CHRONIC DISEASES

This is an important future area in need of HPA input. Chronic diseases make a huge impact on public health and well-being, currently costing over £12 billion per annum. Whilst the current emphasis is on the treatment of strokes, coronary disease etc, there is increasing evidence that other poorly understood chronic illnesses may be caused by biological and environmental factors to which patients have been exposed, particularly in childhood. This is an important area where the Agency has a key role to play.

FRAGMENTATION OF PUBLIC HEALTH

There is a plethora of bodies with an involvement in public health: the HPA, the National Institute for Clinical Excellence, the Healthcare Commission, NIBSC, the Joint Committee on Vaccines and Immunisation, primary care trusts, acute hospitals trusts, strategic health authorities, a surfeit of independent expert committees, the welcome voluntary sector, charities, the private sector; devolved administrations, and others. It's a busy field and needs further critical review building upon Liam Donaldson's initial *Getting Ahead of the Curve*. It is likely to get this as we move towards a general election. Mooted opinions across the political spectrum on what might be done range from the setting up of a separate Ministry for Public Health, to a coming together of different public health organisations, mutually aligned and overseen by an independent board. Watch this space. Whatever the future holds, it will be challenging!

IN DISCUSSION THE FOLLOWING POINTS WERE MADE

Why was no mention made of mental health as an important component of public health? Other topical issues in public health related to smoking and organ donation requiring the need to balance out choices in relation to social architecture. Degenerative disorder related to old age was also raised as a public health issue with reference to the need to provide medical care and the urgent need for research leading to prevention or cure. People are living longer hence the public health agenda is also shifting. Reduced infant mortality is attributed mainly to public health whereas in areas of high mortality the reverse is apparent. A rapid increase in obesity was discussed as evidence for the urgent need to reinvent and reinvigorate public health in a more innovative approach that takes a broader and current view of the changing threats to human health. Antibiotics are no longer working for a variety of reasons and if we cannot rely on them forever, much greater emphasis will be needed on hygiene in the future. Human health needs better integration with whole earth strategies for the longer term where for example reduction in obesity would also simultaneously assist with carbon emission reduction. New vaccines will come on stream although antibiotics will not provide a cure for everything. There was a final comment on the need for mobile toilets!

LETTERS TO THE EDITOR

Dear Sir,

Lord Hunt of Chesterton's review of Nigel Lawson's "An Appeal to Reason: A Cool Look at Global Warming" (Autumn 2008, pp. 18-19) lacks nuance when it comes to his critique of the science, being partial and overstated. Temperature changes in Antarctica, for example, are highly complex, exhibiting both cooling and warming, while Antarctic sea ice is currently above average. Likewise, the world's average surface temperature, which is what really counts, has unquestionably flat-lined, and then fallen since at least 2001. During the last two years, the curve has plummeted, leading to severe winters in many countries. It is further arguable that we are about to enter a significant cooling phase, partly driven by a phenomenon called the Atlantic Multidecadal Oscillation (AMO) and by the lateness of Solar Cycle 24, leading to an absence of sunspot activity.

Climate models have failed to predict these trends, which is not surprising, because we know little about 80% of the factors – from cosmic rays to clouds and water vapour – driving climate. Belief in 'global warming' is a bit like crossing a bridge for which the engineers have understood only 20% of the forces involved. Moreover, modelling is essentially 'soft' science, entirely dependent on the choice of factors inputted. Models are thus less subject to rigorous falsification, and they can only be judged with respect to historical contingency and real-world outcomes.

Lawson is to be congratulated for raising the dangers inherent in predicating dramatic political and economic actions on the possible effects of just one politically-chosen factor – anthropogenic 'greenhouse gas' emissions – out of the myriad which affect climate, the most complex, coupled, non-linear, semi-chaotic system known. In such a system, doing something (ie emitting gases) and not doing something (ie not emitting gases) at the margins are equally unpredictable as to outcomes.

I fear that our hubristic attempts to manage climate will end in political tears. Lawson is wise to opt for adaptation to change, whatever its direction, hot, wet, cold, or dry, and the only way to achieve this is to sustain strong, flexible economies.

By contrast, in these straightened times, current UK policies on climate change could well undermine the economy, and thus our future capacity to cope.

Yours faithfully,

Philip Stott,
Emeritus Professor of Biogeography,
University of London

Sir,

Lord Hunt's review of Lord Lawson's book "An Appeal to Reason" appears to leave at least two gaps. He doesn't explore Lawson's belief in the historic capacity of mankind to adapt to new environments and although he refers to Lawson's criticisms of the Stern Review he doesn't explain what these criticisms are or discuss their merits. These criticisms are relevant because the Stern Review appears to be influencing Government thinking.

Lawson makes three particular observations:

Firstly, the Stern Review attempts to estimate the present cost of policies designed to reduce carbon emissions, but it was set up only after, not before, the Government had made their policy decision. This appears to be the wrong way round. Logically one would expect the Government to do the sums first before making the decision on what to do. For this reason Lawson believes the Stern Review is "essentially a propaganda exercise in support of the UK Government's predetermined policy of seeking a world leadership role on climate change ... neither its conclusions nor the arguments on which they are based possess much merit". In this respect he compares it with Tony Blair's "dodgy dossier" about the Iraq war.

Secondly, the Stern Review considers as its base case the most extreme of the six scenarios predicted by the IPCC and apparently ignores the qualifying statements included in the IPCC predictions. Lawson quotes Sir John Houghton, former Chairman of the Scientific Working Group of the IPCC saying "when you put models together which are climate models added to impact models added to economic models, then you have to be very wary indeed of the answers you are getting, and how realistic they are."

Thirdly, and perhaps most important, Lawson believes their sums are wrong. Calculating the present value of a possible future benefit, ie comparing the possibility of jam tomorrow with the certainty of jam today, is a conventional practice guided by using accepted rules and discount rates. Lawson says the World Bank uses a discount rate of 8%-10% in evaluating projects but the Stern Review appears to be using a discount rate of only about 2% which he says eminent academic economists at Cambridge and Yale have criticised as "absurd". With "a more normal rate, the argument for radical action now ... collapses completely".

The subject of global warming has generated considerable discussion, but both sides appear to be claiming that the other side is selective in their evidence. It would help those of us who are observers if there was some agreement on what is established fact based on agreed evidence and what is speculation and probability based, for instance, just on linear extrapolation of historic events. And whether it is simply the case that "Chance governs all".

Robert Freer

HOUSE OF COMMONS SELECT COMMITTEE ON INNOVATION, UNIVERSITIES, SCIENCE AND SKILLS

Under the Standing Orders, the Committee's terms of reference are to examine "the expenditure, administration and policy" of the Department for Innovation, Universities and Skills and its associated public bodies. This includes the Government Office for Science, headed by the Government Chief Scientific Adviser.

The new Committee was nominated on 8th November 2007. The current Members of the Committee are:

Dr Roberta Blackman-Woods (Lab, City of Durham), Mr Tim Boswell (Con, Daventry), Mr Ian Cawsey (Lab, Brigg and Goole), Mrs Nadine Dorries (Con, Mid Bedfordshire), Dr Ian Gibson (Lab, Norwich North), Dr Evan Harris (Lib Dem, Oxford West and Abingdon), Dr Brian Iddon (Lab, Bolton South East), Mr Gordon Marsden (Lab, Blackpool South), Dr Bob Spink (UKIP, Castle Point), Ian Stewart (Lab, Eccles), Graham Stringer (Lab, Manchester, Blackley), Dr Desmond Turner (Lab, Brighton Kemptown), Mr Rob Wilson (Con, Reading East) and Mr Phil Willis (Lib Dem, Harrogate and Knaresborough). Mr Phil Willis was elected Chairman of the Committee at its first meeting on 14th November 2007.

ORAL EVIDENCE

The Work of the Engineering and Physical Sciences Research Council

On Wednesday 12 November the Committee held a one-off session with the Chairman and Chief Executive and Engineering and Physical Sciences Research Council as an introductory hearing as they are new in post and on recent developments.

CURRENT INQUIRIES

Engineering

On 29 January 2008 the Committee announced an inquiry into engineering. The inquiry is focused on the role of engineering and engineers in UK society, the role of engineering and engineers in the UK's innovation drive and the state of the engineering skills base in the UK. The Committee completed the evidence sessions on the inquiry in January 2009.

The engineering inquiry is wide-ranging and as well as the main inquiry the Committee has been exploring some of the themes using four case studies. The first concerned nuclear engineering and focused on the UK's engineering capacity to build a new generation of nuclear power stations and carry out planned decommissioning of existing nuclear power stations, the value in training a new generation of nuclear engineers versus bringing expertise in from elsewhere, the role that engineers play in shaping the UK's nuclear future and the overlap between nuclear engineers in the power sector and the military. The evidence sessions concluded in November with evidence from the minister and officials at the newly created Department of Energy and Climate Change.

The second case study concerned plastic electronics and focused on the current and future roles of engineers in the field of plastic electronics, the potential for plastic electronics in the UK/global economy, how universities, industry, venture capital and Government are involved in the development of the UK plastic electronics sector and whether the UK engineering and manufacturing sectors are set up to handle growth in this area. The evidence sessions concluded in November with evidence from the ministers at the Department for Innovation, Universities and Skills and the Department for Business, Enterprise and Regulatory Reform.

The third was geo-engineering which examined, among other matters, the current and potential roles of engineering and engineers in geo-engineering solutions to climate change, national and international research activity, and research funding related to geo-engineering and the relationship between, and interface with, this field and research conducted to reduce greenhouse gas emissions. During the autumn of 2008 the Committee took evidence from a number of interested parties including academics from the UK and the USA, and representatives from Greenpeace, the Met Office, Research Councils UK, the Royal Academy of Engineering, the Institution of Mechanical Engineers, the Chief Scientific Adviser at the Department for Environment, Food and Rural Affairs and ministers at the Department for Innovation, Universities and Skills and the Department of Energy and Climate Change.

The fourth case study concerned engineering in Government which examined, among other matters, the role and effectiveness of the Government Office for Science and the Chief Scientific Advisers in providing engineering advice across Government and communicating issues relating to engineering in Government to the public, and the use of engineering advice in Government policy making and project delivery. During the autumn of 2008 the Committee took evidence from a number of interested parties including academics and representatives from the Council for Science and Technology, the Royal Academy of Engineering and engineering institutions and the Chief Scientific Adviser at the Department for Communities and Local Government.

In addition to the oral evidence sessions, the Committee launched and completed two e-consultations. The first sought the views of engineering employers on four questions: how easy is it to recruit the engineering staff they need; are they optimistic about the future of engineering in the UK; what are the biggest challenges and opportunities facing engineering

companies; what one thing could the Government do to help engineering employers? It ran for six weeks closing on 28 October. The second invited views from young engineers on four questions: what would they do to improve engineering in the UK; has their education prepared them for engineering; is engineering a good career choice; and what or who inspired them to consider engineering as a career? It ran for six weeks closing on 9 December.

After Leitch: Implementing Skills and Training Policies

On 4 March 2008 the Committee announced an inquiry into the implementation of skills and training policies following the Leitch Report and how responses to the agenda set out in the Leitch Report will affect the broader structures of further education, higher education and lifelong learning. The Committee concluded its evidence sessions in October with an evidence session with the minister from the Department for Innovation, Universities and Skills. The Committee report was published on 16 January 2009.

DIUS's Departmental Report 2008

In October and November the Committee took evidence on DIUS's Departmental Report, *Investing in our Future: Departmental Report 2008,* (Cm 7392, May 2008) from the Secretary of State for Innovation, Universities and Skills, the Permanent Secretary and officials at the department and from the Government Chief Scientific Adviser. The focus of the inquiry was how DIUS and the Government Chief Scientific Adviser have set about their work and how they are performing. The report was published on 20 January.

The work of the Committee

The Committee published a report on its own work during the 2007-08 session on 16 January.

Students and universities

On 30 October 2008 the Committee announced an inquiry into students and universities. The Committee will focus on admissions, the balance between teaching and research, degree classification and student support and engagement. Oral evidence sessions started in January 2009.

Putting science and engineering at the heart of government policy

On 13 November 2008 the Committee announced an inquiry, putting science and engineering at the heart of government policy. The Committee will focus on whether the Cabinet Sub-Committee on Science and Innovation and the Council for Science and Technology put science and engineering at the heart of policy-making and whether there should be a Department for Science, how Government formulates science and engineering policy (strengths and weaknesses of the current system), whether the views of the science and engineering community are, or should be, central to the formulation of government policy, and how the success of any consultation is assessed, the case for a regional science policy (versus national science policy) and whether the Haldane principle needs updating, engaging the public and increasing public confidence in science and engineering policy, the role of GO-Science, DIUS and other Government departments, charities, learned societies, Regional Development Agencies, industry and other stakeholders in determining UK science and engineering policy and how government science and engineering policy should be scrutinised. Oral evidence sessions started in January 2009.

REPORTS

The Draft Apprenticeships Bill

On 5 December 2008 the Committee published its Seventh Report of Session 2007-08, *Pre-legislative Scrutiny of the Draft Apprenticeships Bill*, HC 1062-I. The Government's Response is expected in February 2009.

GOVERNMENT RESPONSES

Renewable electricity-generation technologies

On 16 October 2008 the Committee published its Eighth Special Report of Session 2007-08, *Renewable electricity-generation technologies: Government Response to the Committee's Fifth Report of Session 2007-08*, HC 1063.

Biosecurity in UK research laboratories

On 27 November 2008 the Committee published its Ninth Special Report of Session 2007-08, *Biosecurity in UK research laboratories: Government Response to the Sixth Report from the Committee, Session 2007-08*, HC 1111.

FURTHER INFORMATION

Further information about the work of the Innovation, Universities, Science and Skills Committee or its current inquiries can be obtained from the Clerk of the Committee, Sarah Davies, the Second Clerk, Glenn McKee, or from the Committee Assistant, Ana Ferreira on 020 7219 2792/8367/2794; or by writing to: The Clerk of the Committee, Innovation, Universities, Science and Skills Committee, House of Commons, 7 Millbank, London SW1P 3JA. Inquiries can also be emailed to iuscomm@parliament.uk. Anyone wishing to be included on the Committee's mailing list should contact the staff of the Committee. Anyone wishing to submit evidence to the Committee is strongly recommended to obtain a copy of the guidance note first. Guidance on the submission of evidence can be found at http://www.parliament.uk/commons/selcom/witguide.htm. The Committee has a website: www.parliament.uk/ius where all recent publications, terms of reference for all inquiries and press notices are available.

HOUSE OF LORDS SCIENCE AND TECHNOLOGY SELECT COMMITTEE

The members of the Committee (appointed 11 December 2008) are Lord Broers, Lord Colwyn, Lord Crickhowell, Lord Cunningham of Felling, Lord Haskel, Lord Krebs, Lord May of Oxford, Lord Methuen, Baroness Neuberger, the Earl of Northesk, Lord O'Neill of Clackmannan, the Earl of Selborne, Lord Sutherland of Houndwood (Chairman) and Lord Warner. Lord Jenkin of Roding, Baroness Finlay of Llandaff and Baroness Whitaker have been co-opted to the Select Committee for the purposes of a short follow-up inquiry into pandemic influenza, and Baroness O'Neill of Bengarve, Lord Patel (as Chairman of Sub-Committee II), Lord Taverne and Lord Winston have been co-opted to Sub-Committee II for the purposes of its continuing inquiry into genomic medicine.

PANDEMIC INFLUENZA

In December 2005, the Committee published a report on pandemic influenza (Session 2005-06, HL Paper 88). The Committee took the view that the first line of defence against a potential human influenza pandemic was effective surveillance and control of avian influenza, in particular in south east Asia. The Committee recommended more support for generic health services in Asia, where new strains of flu had emerged in recent years, and for Government departments to work together to produce a contingency plan in case of an outbreak of a strain of avian-flu that easily transferred to human beings.

On 24 June 2008, the Committee decided to conduct a brief follow-up to its 2005 report. As a result, on 25 November the Committee took evidence from Dawn Primarolo MP, Minister of State for Public Health at the Department of Health, and also from officials from the Department of Health, the Cabinet Office, the Department for the Environment, Food and Rural Affairs and the Department for International Development. The Minister and officials were invited to answer questions about the United Kingdom's preparedness for flu pandemic and whether the National Health Service was adequately resourced and prepared for a flu outbreak, and also to give their view on how essential public services would cope with a large-scale loss of staff due to illness caused by pandemic influenza.

The Committee received further expert briefing at a seminar on 4 February and is likely to publish a follow-up report during spring 2009.

GENOMIC MEDICINE

During the last session (2007-08), the Select Committee appointed a Sub-Committee (Sub-Committee II), chaired by Lord Patel, to hold an inquiry into genomic medicine. The call for evidence was published on 25 February 2008 with a deadline for submissions of 21 April. The Sub-Committee was reappointed at the beginning of the current session (2008-09) and Lord Patel remains as chairman.

The inquiry is examining the policy framework in genomic medicine, the latest research and scientific developments, translation opportunities into the clinic, genomic databases and the use of genetic information in a healthcare setting. The Sub-Committee has held a number of public meetings since April 2008 and has taken evidence from a wide range of witnesses. They have included the Medical Research Council, the Department of Health, the Wellcome Trust, Cancer Research UK, the Royal College of Physicians, the National Institute for Clinical Excellence, representatives of the pharmaceutical industry and representatives of the insurance industry.

In early June 2008, Members visited the National Human Genome Research Institute in Washington DC where they spoke to experts in fields including population genomics, ethics, and translational research. They also met representatives from other organisations including the Food and Drug Administration, Harvard Medical School, and the American Society of Human Genetics.

The final evidence session, with Ministers, took place in late January 2009. It is expected that the Committee's report will be published in spring 2009.

NANOTECHNOLOGIES AND FOOD

Following a seminar in November 2008, the Select Committee decided to appoint a Sub-Committee (Sub-Committee I), to investigate nanotechnologies and food. The Sub-Committee, under the chairmanship of Lord Krebs, held its first meeting in January 2009. A Call for Evidence was published on 3 February. The deadline for submissions is 13 March 2009.

SYSTEMATICS AND TAXONOMY

During session 2007-08, the Select Committee undertook a short inquiry into systematics and taxonomy. The inquiry was a follow-up investigation from the Committee's past inquiries into this subject (in 1991 and 2002) and looked at the UK's capability in this field, taxonomic data collection and management, and the skills base. The inquiry also looked at the application of taxonomic data, for example, in environmental change monitoring. The Committee took a range of evidence and published its report on 13 August 2008. The Government have responded to the Committee's recommendations and a debate in the House will take place during the forthcoming session.

PERSONAL INTERNET SECURITY

The Committee's report on personal Internet security was published on 10 August 2007 (Session 2006-07, HL Paper 165), and was widely reported in the media. The inquiry, chaired by Lord Broers, looked at a broad range of security issues affecting private individuals when using the Internet. The Government response to the Committee's report was published as a Command Paper (Cm 7234) on 24 October 2007. The Committee sought comments on the Government response from those who gave oral evidence during the original inquiry and also took oral evidence from Ministers. The Committee published a short follow-up report, *Personal Internet Security: Follow-up*, on 8 July 2008 (Session 2007-08, HL Paper 131). The original report and the follow-up report were debated by the House on 10 October 2008.

AIR TRAVEL AND HEALTH

The Committee's report *Air Travel and Health – an Update* was published on 12 December 2007 (Session 2007-08, HL Paper 7) and was widely reported in the media. The Government response was received at the end of February 2008 and was published with a commentary on 19 May. The report and the commentary were debated by the House on 24 November 2008.

WASTE REDUCTION

During session 2006-07, the Select Committee appointed a Sub-Committee (Sub-Committee I), chaired by Lord O'Neill of Clackmannan, to inquire into waste reduction. The Sub-Committee heard from civil servants, academic experts and the Environment Agency on the various types of legislation which impact upon waste reduction. It also looked in detail at the various roles that designers, manufacturers and retailers can play in reducing waste. The inquiry examined a range of sectors. Evidence was heard from a number of industry organisations, directly from companies, from officials at the European Commission and from Ministers. The Committee's report was published on 20 August 2008 and received widespread coverage in the media. The report was debated by the House on 12 December 2008.

FURTHER INFORMATION

The written and oral evidence to the Committee's inquiries mentioned above, as well as the Calls for Evidence, 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.

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (POST)

RECENT POST PUBLICATIONS

Renewable Energy in a Changing Climate
October 2008 *POSTnote 315*

Concerns over climate change (see POSTnote 295) have led to an increasing focus on the renewable energy sector. The EU has agreed a binding target of 20% of renewable energy by 2020, with a proposed UK target of 15% of energy from renewable sources. This POSTnote looks at UK options for meeting this target, and discusses how climate change could affect both the UK capacity to produce renewable energy and demand for energy in general.

Cervical Cancer
October 2008 *POSTnote 316*

Cervical cancer is the twelfth most common cancer in women in the UK and the second most common worldwide. It causes around 1,000 deaths each year in the UK. Cervical screening programmes have reduced mortality rates by 62% between 1987-2006. From autumn 2008, a UK-wide programme will immunise adolescent girls using a new vaccine against a sexually transmitted virus that can cause cervical cancer. This note gives an overview of cervical cancer prevention strategies, including vaccination, and the issues arising. *This note was sent to all members of the House of Commons at the time of the launch of the national vaccination campaign in autumn 2008.*

Future Nuclear Technologies
November 2008 *POSTnote 317*

The 2008 Energy White Paper announced the Government's intention to allow private companies to propose the building of new nuclear power plants. This POSTnote provides an assessment of nuclear power generation technologies. It looks at the designs of any new UK reactors and outlines details of the regulatory design assessment process, with an emphasis on safety, security and waste. It also examines longer term research into reactor design and waste management.

The Transition to a Low Carbon Economy
December 2008 *POSTnote 318*

Fundamental changes to the UK economy will be required to meet the greenhouse gas emission targets of the Climate Change Act

(2008). This POSTnote examines UK emission trends since 1990 and considers how the UK might achieve a technological and behavioural transition to meet the targets.

ICT and Carbon Dioxide Emissions
December 2008 *POSTnote 319*

The global greenhouse gas emissions from information and communication technology (ICT) are comparable with those of the aviation industry. This POSTnote focuses on the energy consumption of ICT equipment, and looks at action being taken to reduce it. It also mentions the wider environmental impact of ICT, and looks briefly at the significant contribution that ICT can make to reducing emissions in other sectors.

River Basin Management Plans
December 2008 *POSTnote 320*

The EU Water Framework Directive (2000/60/EC) seeks to protect, improve and maintain the environmental condition of surface and ground waters. Under the directive, all inland, estuarial and coastal waters must aim to achieve "good ecological status" by 2015. More than 80% of water bodies in England and Wales currently fail to reach this status. This POSTnote outlines some of the challenges in implementing River Basin Management Plans (RBMPs) in the UK to meet Water Framework Directive (WFD) objectives.

CURRENT WORK

Biological Sciences – Assisted Reproduction, Single Embryo Transfer, Animal Cruelty and Interpersonal Violence, Internet Pharmacy and Counterfeit Medicines, Behavioural Economics and Deferred Rewards, Personalised Medicines, Food Hygiene Regulation and Diet and Cancer

Environment and Energy – Security of Energy Supply, Geo-engineering, Carbon Capture and Sequestration and Effects of Rising Deer Populations in the UK

Physical Sciences and IT – E-democracy, Digital Preservation, Marine Renewables, Intelligent Transport, Cyber-warfare and Network-enabled Capabilities

Science Policy – Lessons from History

SEMINARS

During the autumn 2008 period POST collaborated on two occasions with the Foresight initiative of the Government Office of Science, to hold parliamentary seminars timed for the launch of two Foresight reports – on Mental Capital and Wellbeing, and on Sustainable Energy Management and the Built Environment.

The Director of POST made the keynote introductory presentations for parliamentary sessions held by the Royal Society for its MP-Scientist Pairing Scheme, and for the National Endowment for Science, Technology and the Arts, for its "Carbon Crucible" postdoctoral fellowship scheme.

In November POST was invited by the US Embassy in London to organise a special seminar for MPs and peers for a dialogue with Dr Nina Federoff, Science Adviser to the US Secretary of State (Hillary Clinton) and to the US Agency for International Development, on the subject of Science Diplomacy.

In December POST collaborated with OfCom to organise a parliamentary seminar on "Healthcare and Transport in Tomorrow's Wireless World". This examined IT applications such as new technologies in cars to reduce collisions and wireless devices to remind patients to take medication.

WORK FOR SELECT COMMITTEES

Dr Martin Griffiths has been assisting the House of Commons Transport Committee with advice on technical aspects of airspace management for its current inquiry on the subject.

STAFF, FELLOWS AND INTERNS AT POST

Autumn 2008 has seen a record intake of doctoral fellows supported by UK research councils and learned societies, as follows:

Nancy Acosta-Villegas, Birmingham University, Institute of Food Science and Technology Fellowship

Daniel Bradley, Manchester University, Royal Society of Chemistry Fellowship

Laura Haynes, Cambridge University, British Psychological Society Fellowship

Sue Kirk, Cambridge University, Institute of Physics Fellowship

Kesson Magid, University College London, Economic and Social Research Council Fellowship

Melissa Smith, Manchester University, Economic and Social Research Council Fellowship

Laura Spence, Cambridge University, British Ecological Society Fellowship

Gerald Weldon, Cambridge University , Engineering and Physical Sciences Research Council Fellowship

INTERNATIONAL ACTIVITIES

The Chair and Director participated in the 2008 Science and Technology in Society Forum in Kyoto in early October. The Chair was one of the panellists for a discussion session on the relationship between politicians and scientists, while the Director presented a follow-up to a workshop POST had organised at the previous forum, on International Migration of Scientists and Engineers. The Chair was one of a small group of presenters invited for a private audience with the Crown Prince of Japan.

In late October, the Director chaired a session of the 2008 annual conference of the European Parliamentary Technology Assessment network, held at the Tweede Kamer of the Netherlands Parliament in The Hague. The subject was European perspectives on climate change.

HOUSE OF COMMONS LIBRARY SCIENCE AND ENVIRONMENT SECTION

RESEARCH PAPER

The following is a summary of a paper produced for Members of Parliament.

Information and copies of papers can be obtained from Michael Crawford at the House of Commons Library on 0207 219 6788 or through http://www.parliament.uk/parliamentary_publications_and_archives/research_papers.cfm

Climate Change Bill [HL]: Committee Stage Report

Research Paper 08/79

The Bill includes provisions to set legally binding targets for reducing UK carbon dioxide emissions by 2020 and 2050. The Bill would commit the Government to publishing 5 yearly carbon budgets and create the Committee on Climate Change to advise the Government on these budgets.

The Bill also amends the provisions in the Energy Act 2004 on the renewables transport fuel obligation and includes measures for variable waste charging.

During the Committee Stage a number of successful opposition amendments relating to climate change made in the Lords were removed or amended by the Government. In addition powers to require that specific retailers charge for the single use carrier bags they provide for customers were introduced. All Government amendments were successful. No opposition amendments were agreed to.

The Bill received Royal Assent on 26 November 2008.

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 6th October to 18th December 2008 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

HIGHER EDUCATION

University Research Funding

Debate in the House of Commons on Wednesday 15 October

Mr Chris Mullin (Sunderland, South): Let me acknowledge that the Government have greatly increased the funding available from the science and innovation budget for high-quality research; last year it amounted to £1.5 billion, and it is due to increase to £1.9 billion by 2010-11. That is to be welcomed. The problem is that most of it goes to a small number of institutions, with the majority receiving relatively little. While this is good news for the universities that receive the bulk of the research funding, it has a negative impact on the research infrastructure of universities such as the one I represent – Sunderland. It is also, I submit, not in the national interest.

Research funds are allocated by the inelegantly named HEFCE – the Higher Education Funding Council for England. It takes the form of an annual allocation payable over a five or six-year period, according to priorities laid down by the Government. The last allocation was in 2002, when it was decreed that only excellent research of international significance should qualify for public funding. The result was that just 19 universities received 76 per cent of the available funding. Newcastle, for example, received £33 million, while Sunderland got just £1 million – and that despite the fact that Sunderland was rated in 2001, by *The Times,* as the "best new university for research". Were the same criteria to be applied this time around, the result, inevitably, would be that the same universities would benefit and that the research capacity of other universities would continue to wither.

Everyone accepts that it would make no sense to spread resources so widely that standards

become diluted, and that only research of the highest standard and relevance should be funded. However, we do not accept that excellence is confined to such a relative handful of universities, or that little or no account should be taken of research of national significance. If current policy is continued, we shall inevitably see a widening gap between the haves and the have-nots. The best and brightest graduates and academics will drift away from the four fifths of universities at the lower end of the funding table, and the capacity of those universities to offer postgraduate courses for domestic or international students will continue to diminish. Some of our best brains will have no chance to fulfil their true potential, and our economy may suffer as a result.

That is certainly the case in Sunderland, where the university has enjoyed a close partnership with Nissan. Indeed, it is arguable that the partnership between Nissan and the computing and technology department of Sunderland university has helped Nissan to achieve cost reductions that have kept the company in the UK. It is one of the largest manufacturing companies in the country, so keeping it here is surely in the national interest. Yet under the criteria currently applied, such a collaboration has not qualified for public research funding since 2001, even though it has been assessed as nationally excellent.

Sunderland is promoting itself as a centre for software businesses. The university, along with local companies such as the Leighton Group, is playing an important part in that with nationally excellent and internationally recognised research in software and digital technology. However, under the current rules, little or none of that research, which is so important to the local, regional and national economy, attracts public funding. That does not make sense. It is a matter of record that universities that do not qualify for significant public funding have a much better record of leveraging in funds from industry and elsewhere than those that do qualify. On average, Russell group universities, which receive the bulk of the core public research funding, attract less external funding than they receive from the public purse, whereas Sunderland, for example, has attracted more than four times as much funding from local industry and elsewhere than it has received in core public funding. The weakness of having to fund research on an ad hoc basis, however, is that the funds are not dependable and predictable in the same way as public funds allocated on a stable basis over a five or six-year period. I merely request a tweaking of the criteria, to permit perhaps 10 per cent of the research and innovation budget to be spent in universities that specialise in research of national, as opposed to international, significance.

Mr Philip Hollobone (Kettering): Many of my constituents attend the university of Northampton, which would like to access this quality-related funding. To many of my constituents it would seem absurd that 76 per cent of this budget should go to just 15 per cent of the universities. The modest proposal that he is making would mean £5 million or £10 million a year for many more universities, which would make a huge difference to their budgets.

The Minister of State, Department for Innovation, Universities and Skills (Mr David Lammy): I am of course aware of the concerns that fundamental or blue-skies research – such as investigating the origins of the universe – is favoured in an unhealthy way over research that is done jointly with business or with a clear application in mind, and the HEFCE and the Department share those concerns. A new research assessment exercise is under way, with the results due in December, and it will form the basis of the allocations for the next academic year. I know that the HEFCE has made a number of changes to improve the exercise and give it the clear goal of properly valuing excellence across a range of research types. That will include applied research and research with business, wherever that is conducted.

Ensuring that we have an excellent research base is the starting point for encouraging work with business, but it is by no means the end of the process. Recently, the HEFCE has started to allocate part of the quality research funding to reward research income from businesses, while the higher education innovation fund invests in knowledge transfer capability between higher education and business. That fund helps institutions to attract further funds from businesses and other users, and it also helps to support collaborative and contract research as well as consultancy and training.

We have also created the new technology strategy board, one of whose key aims is to help businesses to access the best research base. Of course, it is early days, but as a result of setting up the board, we are doubling the number of knowledge transfer partnerships. Those programmes have been running for many years, and they are a highly respected way for universities to work with businesses. Again, many of the institutions that do well in attracting those funds are not the biggest research institutions.

We are also working with the regional development agencies to introduce innovation vouchers to encourage small and medium-sized businesses to work with a range of universities. All that is bringing great rewards and inward investment. There has been a huge increase in interaction with businesses, public services and others, and the latest higher education business and community interaction survey shows that the income going to universities from users has risen to almost £2.6 billion per annum.

Mr Mullin: I very much welcome what the Minister says. May I pin him down on one point? Will he confirm that I am right in thinking that although Ministers obviously do not have a say in the day-to-day allocation of funds, they do set the priorities and the criteria? Secondly, will he confirm that he will be talking to the HEFCE about its priorities for the next funding round?

Mr Lammy: I can confirm both those things. Ministers cannot cherry-pick for particular universities, and we must absolutely protect the integrity of that approach. However, he is right to say that the framework for that research must be set by the Government and the HEFCE, working in co-operation.

HIGHER EDUCATION: BUSINESS

Question and Written Answer on Thursday 18 December

Dr Kumar (Middlesbrough South and East Cleveland): To ask the Secretary of State for Innovation, Universities and Skills what steps his Department is taking to encourage the greater integration of higher education with business and industry.

Mr Lammy: The Government encourage integration of higher education with business and industry in many ways, a number of which are as follows.

The High Level Skills Strategy sets out why and how the Government are encouraging higher education institutions (HEIs) to help meet the demands of business through knowledge exchange, as well as by supplying skilled graduates and post-graduates and by providing high level skills learning for those in the workforce. For example, the 2008 Higher Education Funding Council for England (HEFCE) Grant letter allocated over £100 million of new resources over the spending review period to support new co-funded entrants, infrastructure development and wider employer engagement activity within HEIs.

The Higher Education Innovation Fund (HEIF) gives every English HEI funding to build its capacity to work with business. This fund will reach £150 million per annum by the end of the spending review period. There is a business support element of quality-related (QR) funding to HEIs, which in 2008-09 totals £61.7 million. Allocation is based on the amount of research income institutions receive from UK industry, commerce and public corporations.

During 2008-11 the Technology Strategy Board (TSB) will co-ordinate a £1 billion programme in partnership with research councils and the regional development agencies (RDAs) with a key aim of helping businesses to access the research base. In addition to this, the TSB invests in business-university collaborations through Knowledge Transfer Partnerships.

Research councils have a strong economic impact agenda and support activities which encourage working with business, including significant amounts of collaborative research. RDAs will provide Innovation Vouchers to at least 500 businesses as a means for smaller firms to collaborate with knowledge institutions to help those firms boost their innovation.

Together, these measures will help the HE sector work with Government, business and industry to ensure that the needs of a 21st-century knowledge economy are met, even in challenging times for the global economy.

ENERGY AND CLIMATE CHANGE

Stern Report

Debate in Westminster Hall on Wednesday 19 November

Mr Peter Lilley (Hitchin and Harpenden): I am grateful for this opportunity to discuss the Stern report, two years after its publication. The globalisation and global poverty group was considering ways of trying to improve the lot of people in developing countries who live on a fraction of the money that we have in the developed world. We were conscious that climate change was likely to have a more adverse impact on them than on anyone else. Yet, by definition, people in those countries cannot be held to blame for carbon emissions, their emissions per head being a fraction of those in the developed world. However, they are likely to suffer most, and are already experiencing climate change, which in many areas has had adverse consequences, but they have the greatest need to use energy to raise their living standards. I accepted and took it for granted that we in the developed world should bear the brunt of the costs of mitigating climate change and helping people to adapt.

Professor Stern's conclusion is that we can prevent or mitigate the impact of CO_2 and other greenhouse gas emissions, that it will cost relatively little, and that the cost of inaction far exceeds those of decarbonising the economy. In reaching that conclusion, however, he had to adopt several rather unusual assumptions, and he has been criticised for, among other things, using low discount rates and far-distant horizons, making high but unspecified estimates of the impact cost of global warming and low and optimistic assumptions about mitigation costs, and assuming that little adaptation takes place. The report is not explicit about the rate that he uses, and it then emerged that his basic discount rate for future benefits from mitigating the impact of climate change is 1.4 per cent per annum. That is far lower than that used by other people and in other circumstances. It has two unsatisfactory consequences.

First, as Professor Stern projects the benefits of mitigating global warming far into the distant and indefinite future, using a low discount rate gives great weight to supposed changes that will not occur until centuries ahead. A second consequence is saying that if we do nothing, by the end of this century, people's incomes will, on average, be 20 per cent below what they would be if we were to stabilise greenhouse emissions to 450 to 550 parts per million between now and then. However, he is still assuming that people will have incomes that are a multiple of what we have now. He is saying that if we do nothing, people's incomes will, for example, be four times what they are now. However, if we take strenuous and costly action, their incomes will be five times what they are now. In other words, we are being asked to make sacrifices now so that, in nearly a century's time, our great-grandchildren will be five times richer than us – instead of only four times richer. When challenged about that, Lord Stern says, "Well, we could've used different assumptions that said we value the extra income from rich people far less than we value extra income from poor people now in the world. But, since we don't believe in redistribution in the present, we shouldn't believe in treating rich people differently in the future from poor people now."

The Government have effectively repudiated the use of such a low discount rate, it emerged that they were using the standard Treasury discount rate of 3.5 per cent a year, falling to 3 per cent after 60 years. That is still far lower than the rate used by most people who do commercial feasibility studies. The Government failed to mention or address that fact during debates. However, the fact they are using a more normal discount rate leads them to a different assessment of the relative balance of costs and benefits from that reached by Professor Stern.

In the impact assessment, the Government refer to excluding transitional costs, which they put at between 1.3 and 2 per cent of gross domestic product up to 2020, and excluding the effects of driving businesses away from this country to overseas, where they will continue to emit the same amount of carbon dioxide – although we will receive none of the economic revenues generated by them. The Government make the heroic assumption that industry adapts instantly and perfectly with full knowledge to use the best and most efficient technology to reduce carbon emissions. Even making such an assumption, the potential cost of this country meeting its former target of a 60 per cent reduction in emissions is £205 billion. Yet the same report from the

Government shows that the maximum benefit from reducing the amount of global warming via the programme enshrined in the Climate Change Bill is £110 billion.

In short, the potential costs are nearly twice the maximum benefits. That was when the target was still 60 per cent. When I asked the Government to update their estimate to take account of the fact that we were increasing emission targets by a third to 80 per cent, they said that they would do so only after the Bill has received Royal Assent. So, we are not to know the cost of what we have voted for until the measure is enshrined in law.

I have three questions for the Minister. First, does she stand by the discount rate used by her Government, or does she think that that rate was wrong and Professor Stern was right? Secondly, if they do stand by the discount rate that they used, why do they still quote the conclusions about the balance between costs and benefits in the Stern report and never mention the costs and benefits in their own impact assessment? Thirdly, when will we receive a revised impact assessment telling us how much additional cost and benefit we can expect as a result of increasing the emissions target from 60 to 80 per cent?

The Parliamentary Under-Secretary of State for Energy and Climate Change (Joan Ruddock): We as a Government stand by the Stern review, which estimates that the costs and risks of not acting to tackle climate change will be equivalent to losing 5 to 20 per cent of global GDP each year, now and forever. In contrast, the costs of taking global action to avoid the worst impacts of climate change are expected to be only about 1 per cent of global GDP by 2050. The modelling shows that the cost of action will vary between 1 per cent for a 550 parts per million stabilisation goal and 3 per cent for a 450 parts per million stabilisation goal. The costs are significant – nobody disputes that – but we believe that they are manageable against the potentially catastrophic impacts of climate change. It is important to understand that Stern was producing an analysis not for the UK but for the world, and his arguments need to be understood from a global perspective. The Stern review sets out a framework for reducing emissions, and UK policy is fully in line with it, as highlighted in the Government's response to the review published last year. First, we have put a price on carbon not only through emissions trading and taxation but implicitly through regulation. Secondly, we are implementing the right technology policy, including investing £400 million to support commercialisation of low-carbon technologies between now and 2011. Thirdly, we are removing the barriers to behavioural change through measures such as the carbon emissions reduction target and the "Act on CO_2"campaign. The Government have been committed to the climate change agenda and emissions mitigation since 1997, well before the report was produced. The case for action has been demonstrated by overwhelming scientific evidence, notably that brought together by the Intergovernmental Panel on Climate Change and representing the consensus of thousands of scientists worldwide based on peer-reviewed research. That process, despite what has been said today, has been widely acclaimed as an example of comprehensive, thorough and fair assessment of a complex scientific problem.

HEALTH HAZARDS

Air Travel and Health (Science and Technology Committee Report)

Debate in the House of Lords on Monday 24 November

Lord Sutherland of Houndwood rose to move that this House takes note of the Report of the Science and Technology Committee, Air Travel and Health: An Update (First Report, HL Paper 7). In 2000, the Science and Technology Select Committee of the House published a report that brought together for the first time the wide spectrum of health issues associated with air travel. That report stimulated research into aircrew and passenger health, not only in the United Kingdom, but well beyond it, so our understanding of major health issues connected with air travel is much improved since then. However, there are still some crucial gaps in our knowledge. The Government changed the law in 2006 to give the Secretary of State, "the general duty of organising, carrying out and encouraging measures for safeguarding the health of persons on board aircraft". The Civil Aviation Act 2006 gave the CAA responsibility for the health of all persons aboard aircraft. Much has changed for the better since our original report in 2000, but to members of the committee there were many good reasons for returning to the issues because there are still unresolved matters and uncertainties, that require further inquiry and research.

The Aviation Health Unit was set up in 2003 within the CAA to act as a focal point for aviation health in the United Kingdom. We think that having such a focal point is a big step forward. However, we believe that there is a risk that this good initiative and other positive initiatives from the Government and elsewhere in the UK may come under threat with the impending transfer of responsibilities from the CAA to the European Aviation Safety Agency. The regulation to extend EASA's competence to air operations is expected to be adopted in the next few weeks. We are concerned that the CAA has failed to follow up the recommendations of its own research and increase the regulatory minimum seat pitch to above 28 inches. In the event of an emergency the current minimum of 26 inches would not allow many passengers to adopt the recommended brace position. Most airlines currently operate with a 28-inch seat pitch, but the committee believes that should be guaranteed rather than a matter for good practice.

A great deal of activity has been stimulated by our original report. For example, the WRIGHT project, carried out under the auspices of the WHO, published its report as we were initially taking evidence. The project set out to find whether the risk of venous thromboembolism was increased by air travel, to determine the magnitude of the risk and to consider other factors. The study came up with some very interesting findings.

Lord Tunnicliffe: In 2000, the committee's report was a milestone in raising the profile of aviation health. However, shortly after came the 9/11 attack on the World Trade Centre and passenger security became the top priority for Ministers and the aviation industry.

Nevertheless, looking back, I can say confidently that the Government, the Civil Aviation Authority as the UK's aviation regulator, and airlines have responded actively to the committee's

recommendations. The extent of progress was recognised in the committee's report, *Air Travel and Health: An Update,* published in December 2007. In February 2008, the Government responded and, in May, the committee published that response.

As regards cabin air, the committee recommended in the 2007 update report that the research to identify the substances produced during a fume event should be completed urgently. I am pleased to report that this work is actively in hand and is progressing well. The Department for Transport has secured the interest of five airlines to participate in this groundbreaking research, and other countries are watching it closely.

Pesticides: Crop Spraying

Question and Written Answer on Thursday 11 December

Mr Roger Williams (Brecon and Radnorshire): To ask the Secretary of State for Environment, Food and Rural Affairs what steps his Department plans to take on regulation of pesticide spraying following the recent High Court ruling by Mr Justice Collins on the matter.

Huw Irranca-Davies: This is a complex judgment and we need to consider it carefully.

The protection of human health is paramount. Pesticides used in this country are rigorously assessed to the same standards as the rest of the EU and use is only ever authorised after internationally approved tests. These explicitly include impacts on people who live next to fields, consumers who eat treated crops and farmers who do the spraying.

WiFi: Health Hazards

Question and Written Answer on Wednesday 17 December

Norman Baker (Lewes): To ask the Secretary of State for Health (1) what discussions he has had with the chairman of the Health Protection Agency on the possible health implications of the use of wireless technology; (2) what research he has (a) commissioned and (b) evaluated on the potential effects on health of the use of wireless technology.

Dawn Primarolo: Exposure guidelines published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), are based on a comprehensive review of health effects of electromagnetic fields from sources including WiFi, mobile telephones and any wireless technology that emits radio signals. All these wireless devices are expected to comply with the ICNIRP exposure guidelines following the recommendations of the Independent Expert Group on Mobile Phones, chaired by Professor Sir William Stewart who now holds the position of Chair of the Health Protection Agency (HPA).

The HPA issued the following advice in 2007:

"There is no consistent evidence to date that WiFi and WLANs adversely affect the health of the general population. The signals are very low power, typically 0.1 watt (100 milliwatts) in both the computer and the router (access point) and the results so far show exposures are well within internationally accepted (ICNIRP) guidelines. Based on current knowledge and experience, radio frequency (RF) exposures from WiFi are likely to be lower than those from mobile phones."

The HPA is currently carrying out a systematic programme of exposure measurements from wireless local area networks (WLANs). Further information about this study and wireless technology more generally is available on the HPA website at:

www.hpa.org.uk/webw/HPAweb&;Page&HPAwebContent AreaLanding/Page/1153822623782

Progress of Legislation before Parliament

A comprehensive list of Public Bills before Parliament, giving up-to-date information on their progress through Parliament, is published regularly when Parliament is sitting in the Weekly Information Bulletin, which can be found at:

http://www.publications.parliament.uk/pa/cm/cmwib.htm

RSC BILL BRYSON SCIENCE PRIZE

See page 36 for presentation and winners

As you may recall, Bill Bryson's book *A Short History of Nearly Everything* won widespread admiration in 2005 throughout the UK and further afield, both within the scientific community and with the general reader. The Royal Society of Chemistry (RSC) subsequently sent a copy of the book to every school and college in the country to help stimulate young people to take an interest in science. Bill generously donated his royalties from these sales to set up the award. His donation was matched by his publishers, Transworld and the RSC who have now instituted an annual **RSC Bill Bryson Prize** which is awarded to the winners of a nationwide science communication competition.

The competition aims to inspire and engage students in a particular topic of science and to encourage clear science communication in its widest form. Participants are asked to produce an original piece of work, in any format, relaying the chosen aspect of science to an audience outside their own peer group. The competition is judged in two categories (primary school and secondary school) by a panel of judges comprising Bill Bryson, the RSC President and the Editor of the RSC magazine *Education in Chemistry*. Cash prizes of £500 for the school plus £100 for the students are awarded to the top entries in each category. Every entrant also receives a certificate for participation.

The theme for this year's competition was 'Science and Sport'. Entries showed how science supports the world of sport in a huge variety of ways – from methods used in drug testing and enhanced sportswear and equipment, to specialised training techniques and more. The entries included PowerPoint presentations, posters, poems, magazine and newspaper articles, information booklets, web pages, written projects, magazines and films.

EURO-NEWS

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

EU Pesticides Legislation

The European Parliament has approved new EU pesticides legislation which will increase the number of pesticides available in Member States, while in due course banning the use of certain dangerous chemicals in these products. Measures to ensure the safer use of pesticides in daily life will also be introduced. Toxic chemicals will be banned but producers can sell more easily across borders. The key points of the regulation, which deals with the production and licensing of pesticides, are as follows:

A positive list of approved "active substances" (the chemical ingredients of pesticides) is to be drawn up at EU level. Pesticides will then be licensed at national level on the basis of this list. Certain highly toxic chemicals will be banned unless exposure to them would in practice be negligible, namely those which are carcinogenic, mutagenic or toxic to reproduction, those which are endocrine-disrupting, and those which are persistent, bioaccumulative and toxic (PBT) or very persistent and very bioaccumulative (vPvB). For developmental neurotoxic and immunotoxic substances, higher safety standards may be imposed. If a substance is needed to combat a serious danger to plant health, it may be approved for up to five years even if it does not meet the above safety criteria. Products containing certain hazardous substances are to be replaced if safer alternatives are shown to exist. MEPs successfully demanded a shorter deadline for their replacement, of three years rather than five. Substances likely to be harmful to honeybees will be outlawed.

Manufacturers and pesticide users will benefit because:

Member States will be able to license pesticide products at national level or through mutual recognition. The EU will be divided into three zones (north, centre and south) with compulsory mutual recognition within each zone as the basic rule. This will make it easier for manufacturers to gain approval for their products across borders within a given zone and thus make more pesticides available to users more quickly. However, following pressure from MEPs, individual States will be entitled to adopt additional conditions or restrictions on the use of new pesticides approved within their zone, and even refuse approval for pesticides if they can adduce special environmental or agricultural circumstances. Product approval times will be speeded up, as Member States will have to decide on mutual recognition within 120 days. Until now there has been no deadline. The new legislation will only gradually supersede existing EU law. Pesticides that can be placed on the market under current legislation will remain available until their existing authorisation expires. There will thus be no sudden or large-scale withdrawal of products from the market. The agreement with Council was based on a scientific assessment by the Swedish Chemicals Agency that only around 22 dangerous substances are likely to be removed from the market as a result of the new safety criteria.

Reducing pesticide use and managing it better. The main points of the directive on the sustainable use of pesticides are as follows:

The principle of Integrated Pest Management is laid down, ie the promotion of non-chemical pest control methods such as crop rotation, to be used wherever possible as alternatives to pesticides. Member States must adopt National Action Plans for reducing "risks and impacts" of pesticide use on human health and the environment, including timetables and targets for use reduction. MEPs dropped their demand for a specific reduction target of 50% for chemical substances of particular concern, to help secure a deal with the Council. Aerial crop spraying will in general be banned, albeit with exceptions subject to approval by the authorities. No spraying will be allowed in close proximity to residential areas. Member States must take measures to protect the aquatic environment and drinking water supplies from the impact of pesticides. These are to include "buffer zones" around bodies of water and "safeguard zones" for any surface and groundwater used for drinking water. There must also be protected areas along roads and railways. The use of pesticides must be minimised or prohibited in specific areas used by the general public or by vulnerable groups, such as parks, public gardens, sports and recreation grounds, school grounds and playgrounds and in the close vicinity of healthcare facilities. New rules are introduced on the training of pesticide users and salespeople, on handling and storage, on information and awareness-raising and on the inspection of pesticides application equipment. The directive must be implemented by the Member States by early 2011. The MEP responsible for its passage through Parliament, Christa Klaß (EPP-ED, DE), said "This directive is step in right direction to protect European consumers and the environment. The aim is to use as few pesticides as possible, but at the right time and in the right dosage." She stressed "Risk management is the key, with training for professional users and adequate information for private users." Both pieces of legislation must now be endorsed by the Council but this should be a formality in view of the agreement reached in December.

SCIENCE DIRECTORY

DIRECTORY INDEX

Aerospace and Aviation
C-Tech Innovation
EPSRC
Semta
National Physical Laboratory

Agriculture
BBSRC
CABI
Institute of Biology
LGC
Newcastle University
PHARMAQ Ltd
Society for General Microbiology
UFAW

Animal Health and Welfare, Veterinary Research
ABPI
Academy of Medical Sciences
Biosciences Federation
Institute of Biology
The Nutrition Society
PHARMAQ Ltd
UFAW

Astronomy and Space Science
Natural History Museum
STFC

Atmospheric Sciences, Climate and Weather
Natural Environment Research Council
Newcastle University
STFC

Biotechnology
BBSRC
Biochemical Society
Biosciences Federation
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Royal Society of Chemistry
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LGC
London Metropolitan Polymer Centre
Newcastle University
Plymouth Marine Sciences Partnership
Royal Institution
Royal Society of Chemistry
STFC

Colloid Science
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Construction and Building
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Education, Training and Skills
ABPI
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Economic and Social Research Council
EPSRC
The Engineering and Technology Board
Institute of Biology
Institute of Physics
Institution of Chemical Engineers
Institution of Civil Engineers
Institution of Engineering and Technology
LGC
London Metropolitan Polymer Centre
NESTA
National Physical Laboratory
Natural History Museum
Newcastle University
Plymouth Marine Sciences Partnership
Royal Institution
The Royal Society
Royal Society of Chemistry
Royal Statistical Society
Semta

Energy
C-Tech Innovation
EPSRC
Institute of Physics
Institution of Chemical Engineers
Institution of Civil Engineers
Institution of Engineering and Technology
Newcastle University
Plymouth Marine Sciences Partnership
Royal Society of Chemistry
STFC

Engineering
C-Tech Innovation
EPSRC
The Engineering and Technology Board
Institution of Chemical Engineers
Institution of Civil Engineers
Institution of Engineering and Technology
London Metropolitan Polymer Centre
National Physical Laboratory
Plymouth Marine Sciences Partnership
Royal Academy of Engineering
Semta
STFC

Fisheries Research
AMSI
Institute of Biology
Plymouth Marine Sciences Partnership

Food and Food Technology
Biosciences Federation
British Nutrition Foundation
CABI
C-Tech Innovation
Institute of Biology
Institution of Chemical Engineers
LGC
Newcastle University
The Nutrition Society
Royal Society of Chemistry
Society for General Microbiology

Forensics
LGC
Royal Society of Chemistry

Genetics
ABPI
BBSRC
HFEA
Institute of Biology
LGC
Natural History Museum
Newcastle University

Geology and Geoscience
AMSI
Institution of Civil Engineers
Natural Environment Research Council

Hazard and Risk Mitigation
Health Protection Agency
Institution of Chemical Engineers

Health
ABPI
Academy of Medical Sciences
Biochemical Society
Biosciences Federation
British Nutrition Foundation
British Pharmacological Society
British Society for Antimicrobial Chemotherapy
Economic and Social Research Council
EPSRC
Health Protection Agency
HFEA
Institute of Biology
Institute of Physics and Engineering in Medicine
LGC
Lilly
Medical Research Council
National Physical Laboratory
Newcastle University
The Nutrition Society
Royal Institution
Royal Society of Chemistry
Society for General Microbiology

Heart Research
ABPI
Lilly

Hydrocarbons and Petroleum
Institution of Chemical Engineers
Natural History Museum
Newcastle University
Royal Society of Chemistry

Industrial Policy and Research
AIRTO
Economic and Social Research Council
Institution of Civil Engineers
Royal Academy of Engineering
STFC

Information Services
AIRTO
CABI

IT, Internet, Telecommunications, Computing and Electronics
CABI
EPSRC
Institution of Civil Engineers
Institution of Engineering and Technology
National Physical Laboratory
Newcastle University
STFC

Intellectual Property
ABPI
The Chartered Institute of Patent Attorneys
C-Tech Innovation
Lilly
NESTA
Newcastle University

Large-Scale Research Facilities
C-Tech Innovation
London Metropolitan Polymer Centre
National Physical Laboratory
Natural History Museum
STFC

Lasers
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
STFC

Medical and Biomedical Research
ABPI
Academy of Medical Sciences
Biochemical Society
British Pharmacological Society
British Society for Antimicrobial Chemotherapy
CABI
HFEA
Institute of Biology
Lilly
Medical Research Council
Merck Sharp & Dohme
Newcastle University
Plymouth Marine Sciences Partnership
UFAW

Motor Vehicles
London Metropolitan Polymer Centre
Semta

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

Oil
C-Tech Innovation
Institution of Chemical Engineers
LGC

Particle Physics
STFC

Patents
The Chartered Institute of Patent Attorneys
NESTA

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

Physical Sciences
Cavendish Laboratory
C-Tech Innovation
EPSRC
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
Newcastle University
Plymouth Marine Sciences Partnership

Psychology
British Psychological Society

Public Policy
Biosciences Federation
The British Ecological Society
British Nutrition Foundation
British Society for Antimicrobial Chemotherapy
Economic and Social Research Council
The Engineering and Technology Board
HFEA
Institute of Biology
Institution of Civil Engineers
Institution of Chemical Engineers
NESTA
Prospect

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

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
Biosciences Federation
The British Ecological Society
British Nutrition Foundation
British Pharmacological Society
British Science Association
CABI
Clifton Scientific Trust
Economic and Social Research Council
EPSRC
The Engineering and Technology Board
HFEA
Institute of Biology
Institute of Physics
Institution of Chemical Engineers
Institution of Civil Engineers
LGC
Lilly
Medical Research Council
NESTA
National Physical Laboratory
Plymouth Marine Sciences Partnership
Prospect
Research Councils UK
Royal Academy of Engineering
Royal Institution
The Royal Society
Royal Society of Chemistry
Semta
STFC
UFAW

Seed Protection
CABI

Sensors and Transducers
AMSI
C-Tech Innovation
STFC

SSSIs
Kew Gardens
Natural England

Statistics
EPSRC
The Engineering and Technology Board
Royal Statistical Society

Surface Science
C-Tech Innovation
STFC

Sustainability
Biosciences Federation
The British Ecological Society
CABI
C-Tech Innovation
EPSRC
Institute of Biology
Institution of Chemical Engineers
Institution of Civil Engineers
London Metropolitan Polymer Centre
Natural England
Newcastle University
Plymouth Marine Sciences Partnership

Technology Transfer
CABI
C-Tech Innovation
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

Viruses
ABPI
Health Protection Agency
Society for General Microbiology

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

Wildlife
Biosciences Federation
The British Ecological Society
Institute of Biology
Natural England
Natural History Museum
UFAW

Research Councils UK

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

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

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

Arts and Humanities Research Council

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Website: www.ahrc.ac.uk

Each year the AHRC provides approximately £100 million from the Government to support research and postgraduate study in the arts and humanities, from archaeology and English literature to dance and design. Awards are made after a rigorous peer review process, to ensure 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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Website: www.bbsrc.ac.uk

BBSRC is the UK's principal public funder of research and research training across the biosciences. It supports five research institutes and a number of specialist centres; including six systems biology centres, as well as research 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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E-mail: jenny.whitehouse@epsrc.ac.uk
Website:www.epsrc.ac.uk

EPSRC is the main government agency for funding research and training in engineering and physical sciences, investing around £740 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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Tel: 020 7636 5422 Fax: 020 7436 2665
E-mail:
simon.wilde@headoffice.mrc.ac.uk
Website: www.mrc.ac.uk

The Medical Research Council (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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Swindon SN2 1EU
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E-mail: requests@nerc.ac.uk
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, National Oceanography Centre and Proudman Oceanographic Laboratory

Science & Technology Facilities Council

Mark Foster
Public Affairs Manager
Rutherford Appleton Laboratory
Harwell Science & Innovation Campus
Didcot OX11 0QX
Tel: 01235 778328 Fax: 01235 445 808
E-mail: mark.foster@stfc.ac.uk
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. It also manages international research projects in support of a broad cross-section of the UK research community. The Council also directs, co-ordinates and funds research, education and training.

Association of the British Pharmaceutical Industry

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Director of Science & Technology
12 Whitehall, London SW1A 2DY
Tel: 020 7747 1408
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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

Association of Marine Scientific Industries

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Association of Marine Scientific Industries
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London EC2R 8AY
Tel: 020 7628 2555 Fax: 020 7638 4376
E-mail: amsi@maritimeindustries.org
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.

The Academy of Medical Sciences

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Executive Director
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Fax: 020 7969 5298
E-mail: info@acmedsci.ac.uk
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.

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.

Biochemical Society

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Chief Executive,
16 Procter Street,
London WC1V 6NX
Tel: 020 7280 4133 Fax: 020 7280 4170
Email: chris.kirk@biochemistry.org
Website: www.biochemistry.org

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.

BIOSCIENCES FEDERATION

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Biosciences Federation
PO Box 502, Cambridge, CB1 0AL
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Fax: 01223 246858
E-mail: rdyer.bsf@physoc.org
Website: www.bsf.ac.uk

The Biosciences Federation is a single authority representing the UK's biological expertise. The BSF directly represents 54 bioscience organisations, and contributes to the development of policy and strategy in biology-based research – including funding and the interface with other disciplines – and in school and university teaching by providing independent opinion to government.

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

Contact: Ceri Margerison, Policy Officer
British Ecological Society
26 Blades Court, Deodar Road, Putney,
London, SW15 2NU
Tel: 020 8877 0740 Fax : 020 8871 9779
Website: www.BritishEcologicalSociety.org
Ecology into Policy Blog
http://ecologyandpolicy.blogspot.com/

The British Ecological Society's mission is to advance ecology and make it count. The Society has 4,000 members worldwide. The BES publishes four 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
52-54 High Holborn, London WC1V 6RQ
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Fax: 020 7404 6747
Email: c.price@nutrition.org.uk
Websites: www.nutrition.org.uk
www.foodafactoflife.org.uk

The British Nutrition Foundation is a scientific and educational charity which promotes the well-being of society through the impartial interpretation and effective dissemination of scientifically based knowledge and advice on the relationship between diet, physical activity and health.

Central to all our work is the distillation and dissemination of evidence-based nutrition science.

BRITISH PHARMACOLOGICAL SOCIETY

Today's science, tomorrow's medicines

Contact: Kate Baillie
Chief Executive
British Pharmacological Society
16 Angel Gate, City Road
London EC1V 2PT
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

The British Psychological Society

Contact: Dr Ana Padilla
Parliamentary Officer
The British Psychological Society
30 Tabernacle Street
London EC2A 4UE
Tel: 020 7330 0893
Fax: 020 7330 0896
Email: ana.padilla@bps.org.uk
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 Bioservices, CABI
Bakeham Lane, Egham, Surrey TW20 9TY
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

Founded 1882
Royal Charter 1891

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. 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
Capenhurst Technology Park,
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

An independent innovation and technology development organisation. Activities range from contract and grant funded research to commercialisation of technology, exploitation of intellectual property, multi-disciplinary innovation consultancy and process and product development.

C-Tech now has almost 40 years experience of the management and delivery of major technology and innovation based business support projects both nationally and regionally.

The Engineering and Technology Board

etb
Progress through partnerships

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Fax: 020 3206 0401
E-mail: ccox@etechb.co.uk
Website: www.etechb.co.uk

The Engineering and Technology Board (ETB) is an independent organisation that promotes the vital role of engineers, engineering and technology in our society. The ETB 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.

Health Protection Agency

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Health Protection Agency Central Office
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Tel: 020 7759 2700/2701
Fax: 020 7759 2733
Email: webteam@hpa.org.uk
Web: www.hpa.org.uk

The Health Protection Agency is an independent organisation dedicated to protecting people's health in the United Kingdom. We do this by providing impartial advice and authoritative information on health protection issues to the public, to professionals and to government.

We combine public health and scientific expertise, research and emergency planning within one organisation. We work at international, national, regional and local levels, and have many links with many other organisations around the world. This means we can respond quickly and effectively to new and existing national and global threats to health including infections, environmental hazards and emergencies.

Human Fertilisation and Embryology Authority

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21 Bloomsbury St
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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.

Institute of Biology

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The biological sciences have truly come of age, and the Institute of Biology is the professional body to represent biology and biologists to all. A source of independent advice to Government, a supporter of education, a measure of excellence and a disseminator of information - the Institute of Biology is the Voice of British Biology.

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.

Institute of Physics and Engineering in Medicine

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York, YO24 1ES
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E-mail: r.w.neilson@ipem.ac.uk
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 29,000 members.

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www.icheme.org

Institution of Civil Engineers

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E-mail: vernon.hunte@ice.org.uk
Website: www.ice.org.uk

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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Website: www.theiet.org

The Institution of Engineering and Technology was formed in 2006 by the Institution of Electrical Engineers and the Institution of Incorporated Engineers. The IET has more than 150,000 members worldwide who work in a range of industries. The Institution aims to lead in the advancement of engineering and technology by facilitating the exchange of knowledge and ideas at a local and global level and promoting best practice.

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 activities:

- 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

Contact: Prof Simon J. Owens
Tel: 020 8332 5106
Fax: 020 8332 5109
Email: s.owens@kew.org
Website: www.kew.org

Two stunning gardens-devoted to building and sharing knowledge

LGC

Setting standards in analytical science

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Fax: +44 (0)20 8943 2767
E-mail: info@lgc.co.uk
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 21 laboratories and centres across Europe and in India.

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Lilly UK is the UK affiliate of 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.

London Metropolitan Polymer Centre

LONDON metropolitan university

Sir John Cass Department of Art, Media & Design

Contact: Alison Green,
London Metropolitan University
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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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David Gregory
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Main Business Activities
Retailer – Clothing, Food, Home and Financial Services

We have over 620 UK stores, employing over 75,000 people - 278 stores internationally in 39 countries.

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Fax: 01992 441907
e-mail: margaret_beer@merck.com /
rob_pinnock@merck.com
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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

NESTA Making Innovation Flourish

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Website: www.nesta.org.uk

NESTA's aim is to transform the UK's capacity for innovation. We work across the human, financial and the policy dimensions of innovation. We invest in early stage companies, inform innovation policy and encourage a culture that helps innovation to flourish. The unique nature of our endowed funds means that we can take a longer term view, and develop ambitious models to stimulate and support innovation that others can replicate or adapt. NESTA works across disciplines, bringing together people and ideas from science, technology and the creative industries.

National Physical Laboratory

NPL National Physical Laboratory

National Physical Laboratory
Hampton Road, Teddington
Middlesex TW11 0LW
Tel: 020 8943 6880 Fax: 020 8614 1446
E-mail: enquiry@npl.co.uk
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

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.

Natural History Museum

NATURAL HISTORY MUSEUM

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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.

Newcastle University

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Website: www.ncl.ac.uk

Newcastle University is confirmed by external review as having world-leading or internationally excellent researchers in all 38 subject areas spanning medicine, the sciences, engineering, humanities and the arts.

The University has an active technology transfer programme forming five spin-out companies per annum. The University is committed to excellence with a purpose, interdisciplinary research and external engagement.

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
The Laboratory, Citadel Hill
Plymouth PL1 2PB

Tel: +44 (0)1752 633 234
Fax: +44 (0)1752 633 102
E-mail: forinfo@pmsp.org.uk
Website: www.pmsp.org.uk

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.

Prospect

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E-mail: sue.ferns@prospect.org.uk
www.prospect.org.uk

Prospect is an independent, thriving and forward-looking trade union with 102,000 members. 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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3 Carlton House Terrace
London SW1Y 5DG
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E-mail: philip.greenish@raeng.org.uk
Website: www.raeng.org.uk

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

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E-mail: gail@ri.ac.uk Website:
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

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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 prepare for 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.

RSC | Advancing the Chemical Sciences
The Royal Society of Chemistry

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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

ROYAL STATISTICAL SOCIETY
175 years of progress

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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 celebrates 175 years since its foundation 1834.

semta

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Wynyard Park House, Wynyard,
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Website: www.semta.org.uk

Semta - working with employers to improve performance through skills

Semta is the employer-led Sector Skills Council for Science, Engineering and Manufacturing Technologies. Semta supports UK businesses in achieving global competitiveness through investment in skills.

Every business depends on the skills of its workforce to drive productivity, growth and success. Semta works with companies in its sector to understand skills needs and provide solutions to meet those needs.

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 Cosmetic Scientists

FOUNDED 1948
SCS
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

UFAW
Established 1926

Contact: Dr James Kirkwood,
Scientific Director
The Old School, Brewhouse Hill
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Tel: 01582 831818. Fax: 01582 831414.
Email: ufaw@ufaw.org.uk
Website: www.ufaw.org.uk
Registered 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.

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SCIENCE DIARY

THE PARLIAMENTARY AND SCIENTIFIC COMMITTEE

Contact: Annabel Lloyd
020 7222 7085:
lloyda@pandsctte.demon.co.uk
www.scienceinparliament.org.uk

Monday 9 March 12.30-20.30
SET for BRITAIN
Poster Exhibition for early-state researchers.

Thursday 12 March 14.00-18.00
National Science and Engineering Week Seminar
Do we Need Multiskilled Scientists and Engineers to manage Economic Recovery and Change?

Tuesday 21 April 17.15
Annual General Meeting
followed by Discussion Meeting
Security Technology and Individual Freedom

Tuesday 19 May 17.30
Discussion Meeting

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.

Monday 2 February 19.00
The fiction lab

Saturday 7 February, drop in between 11.00 and 16.00
Family Fun Day

Tuesday 17 February 19.00
Feed the world

Tuesday 24 February 19.00
The search for life beyond Earth
Dr Lewis Darnell

Monday 2 March 19.00
The fiction lab

Tuesday 3 March 19.00
The quantum theory of space and time
Prof Chris Isham

Wednesday 4 March 19.00
Watching the Earth from Space
Prof Alan ONeil, Prof Shaun Quegan, Dr Seymour Laxon, Prof Keith Haines, Prof Barry Parsons

Saturday 7 March, drop in between 11.00 and 16.00
Family Fun Day

Tuesday 10 March 19.00
Nature's patterns
Dr Philip Ball

Tuesday 17 March 19.00
Art and the brain: the evolving story
Prof Raymond Tallis, Prof Semir Zeki

Wednesday 18 March 19.00
Understanding dementia through opera

THE ROYAL SOCIETY

The Royal Society runs a series of events, both evening lectures and two day discussion meetings, on topics covering the whole breadth of science, engineering and technology. All the events are free to attend and open to all.

Highlights in the next few months include:
Wednesday 18 February 18.30
What's going on underground? Tunnelling into the future
Professor Robert Mair FRS FREng

Monday 11 and Tuesday 12 May (all day)
Darwin and the evolution of flowers

All Royal Society lectures are available from the Royal Society website. The collection includes over 200 lectures with speakers including David Attenborough, Eleanor Maguire and James Lovelock. Details of all of these plus our forthcoming events programme can be found at royalsociety.org

THE ROYAL SOCIETY OF CHEMISTRY

Contact: Dr Stephen Benn on
benns@rsc.org

Tuesday 10 March
Voice of the Future 2009
for young scientists and engineers, featuring a Science Question Time with MPs at the House of Commons

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

21 April 2009 18.00
Electrifying the Future; Nuclear Energy's key role in a Carbon Constrained World
The 2009 Lloyd's Register Educational Trust Lecture and optional Dinner
Dr Sue Ion OBE FREng
Contact faye.whitnall@raeng.org.uk to book a place.

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
All events require registration and, unless otherwise indicated, take place at the RSE.

Thursday 26 February 18.00
Alcohol our favourite drug: from Chemistry to Culture
Public Discussion Forum

Friday 27 February (all day)
Alcohol our favourite drug: from Chemistry to Culture
Conference

Monday 2 March 18.00
Gannochy Trust Innovation Award Prize Lecture
Dr Colin Urquhart, Dimensional Imaging Ltd

Wednesday 11 March 18.00
The i-LIMB Hand - engineering innovation drives business success
Hugh Gill and Philip Newman, Touch Bionics

Tuesday 21 and Wednesday 22 April (all day)
Sustainable Aquaculture – A rational approach
Conference (Held at Heriot-Watt University)

BRITISH SCIENCE ASSOCIATION

National Science and Engineering Week (6-15 March 2009)

As part of National Science and Engineering Week scientists, engineers, science communicators and the general public host thousands of events across the UK, in order to engage as many people as possible with science, engineering, technology and their implications. It is coordinated by the British Science Association in partnership with the Engineering and Technology Board (ETB) and funded by the Department for Innovation, Universities and Skills (DIUS). See www.nsew.org.uk for further information, including an online programme of events.

ROYAL PHARMACEUTICAL SOCIETY OF GREAT BRITAIN

Contact: events@rpsgb.org
www.rpsgb.org/events
Unless otherwise stated events are held at the Royal Pharmaceutical Society of Great Britain, London

Monday 2 – Tuesday 3 March

Formulating Better Medicines for Children

One-day conference presented by the RPSGB, in partnership with the Academy of Pharmaceutical Sciences and the European Paediatric Formulation Initiative.

Friday 6 March

Traditional herbal medicines: opportunities and challenges in a changing regulatory environment

One-day conference presented by the RPSGB and the Centre for Pharmacognosy and Phytotherapy of the University of London, in association with the Society for Medicinal Plant and Natural Product Research (GA), the International Society for Ethnopharmacology (ISE) and the Academy of Pharmaceutical Sciences (APS).

Monday 9 March

Unlicensed medicines for the NHS in the 21st Century: Moving Practice Forward

RPSGB in partnership with the NHS Pharmaceutical Aseptic Services Group.

Thursday 12 March

Travel Medicine – moving practice forward

RPSGB in partnership with the Faculty of Travel Medicine of the Royal College of Physicians and Surgeons of Glasgow

Wednesday 18 March

Combating Counterfeiting – Current Status of the New Technologies and Raising Public Awareness

Seminar of the industrial pharmacist group of the Royal Pharmaceutical Society

Monday 27 April

The Development of Veterinary Medicines

RPSGB in partnership with the Academy of Pharmaceutical Sciences and the Veterinary Pharmacists Group of the RPSGB

Sunday 17-Thursday 21 May

The Eleventh Advanced Level Workshop on Pharmacokinetic - Pharmacodynamic Data Analysis:

Four-day residential course organised by the RPSGB and the Swedish Academy of Pharmaceutical Sciences, Madingley Hall, Cambridge

ENGINEERING AND PHYSICAL SCIENCES RESEARCH COUNCIL

Wednesday 4 March 09.30-18.00

Pioneers09 - Connecting business with pioneering research

A major exhibition of world-leading university research – from healthcare to sustainable energy to the next generation of the internet.

Olympia Conference Centre, London

Wednesday 4 March 16.00-17.00

Privacy in the Digital World

A panel of distinguished guests from business, academia, the media and government will examine our changing perceptions of privacy in the digital world and the implications for businesses, researchers and policy-makers. Part of the Pioneers09 event and exhibition.

Olympia Conference Centre, London

Register free for both events at http://pioneers.epsrc.ac.uk or contact Jenny.Whitehouse@epsrc.ac.uk

The Parliamentary and Scientific Committee

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SCIENCE IN PARLIAMENT sip

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IOP Institute of Physics

Physics is how we find the answers to the big questions

Physicists undertake fundamental research for one prime reason – to enhance our understanding of the world we live in.

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- the development of radical new technologies;
- the inspiring ideas that draw young people into science;
- the capacity of our industry to meet new challanges through innovation.

The Institute of Physics is a scientific charity devoted to increasing the practice, understanding and application of physics. It has a worldwide membership of over 36 000 and is a leading communicator of physics-related science to all audiences.

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