Spring 2007

SCIENCE IN PARLIAMENT

Research Councils' support for knowledge transfer

UK Science Prospect Marine Environment Satellites

Patient Safety Materials

SCIENCE IN PARLIAMENT

The Journal of the Parliamentary and Scientific Committee.

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

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

The Parliamentary and Scientific Committee

Since 1997, this Government has doubled the amount of money invested in science and engineering, yet significant tensions remain.
It seems that there is a recognition at last that university science and engineering departments are underfunded, with a one-off extra investment to them of £60 million during 2006/07, and a promise of a further £75 million to support applied research during 2007/08.

Sir David Cooksey's report has resulted in a jointly held health research fund of at least £1 billion, to ensure that medical research is translated into health and economic benefits. The pressure to move medical research closer to the clinic is being felt acutely by the National Institute of Medical Research, which is at the centre of a controversial proposal to move it into central London.
PPARC is merging with the CCLRC, and the NERC is reorganising the CEH, with four of its centres closing. According to the public sector union Prospect, "more than 4 in 10 working scientists are either unsure they will be able to stay in science or certain that they will have to leave". No wonder, with all these changes afoot.
2006 was a significant year for the Royal Society. As part of the Queen's 80th birthday celebrations, they organised a special science exhibition at Buckingham Palace, the fourth of the Prime Minister's "Our Nation's Future" series of lectures in Oxford, and Sir Nicholas Stern was present at the Royal Society's HQ, along with the Prime Minister, the Chancellor and the Secretary of State at DEFRA, to launch the "Stern Review on the Economics of Climate Change", which will be hard to ignore.
After more than eight years in the job, Lord Sainsbury announced his retirement as Science Minister in November last year, although he is now carrying out a review of the Government's policies on science and innovation. His successor, Malcolm Wicks MP, will find him a hard act to follow.
2007 will see the launch of "International Polar Year". Therefore, it seems appropriate that the House of Commons Science and Technology Select Committee has launched an inquiry into "Investigating the Oceans".

Dr Brian Iddon MP
Chairman, Editorial Board
Science in Parliament

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OPINION

Conservative Party Science, Technology, Engineering and Mathematics Task-force

Ian Taylor MP
Chairman of the Conservative Party STEM task-force

As global competition intensifies, the UK has to capture and stimulate public and private sector R&D and innovation more effectively. Without the ability to create and retain high-quality, knowledge-intensive jobs and the innovative businesses that develop and apply new technology, our economy and well-being will suffer.

So when David Cameron invited me to chair a Conservative policy task-force to examine future policy on science, technology, engineering and mathematics (STEM), I was delighted to accept. With the help of a group of distinguished colleagues from across business, the universities and politics we have published two reports so far.

It has long been recognised that there is a gap between invention and innovation; that is, between the time when a new idea is shown to be *possible* and the time when it has been shown to be *viable*. Research funds, from Government or industry, support invention; venture capital supports applied innovation. There is little in the middle. Those inventions that make it might rely on years of passionate unfunded work. We believe that Government can tackle the gap between invention and innovation in two ways.

The first thing Government can do is to make better use of the £150 billion a year it spends on goods and services. The concept that we are developing is to shift the emphasis of governmental support for innovation from *input* (subsidising embryonic ideas) to *output* (procuring effective solutions to society's needs). Instead of offering capital, the Government could offer the much more effective incentive of revenue – what innovators lack are customers, especially if an important part of the prospective market lies in the public sector where the risks and rewards are stacked in favour of the second customer, not the brave first one.

One way of using procurement to drive innovation is to offer challenge funds to stimulate industry and universities to come up with innovative solutions to important national problems. The *Longitude Act 1714* famously offered a reward to anyone who could come up with an accurate method of determining longitude. Such an approach could be used today to develop, for example, viable wave power schemes or affordable desalination.

A second bridge between invention and innovation can be built by better focusing some of the resources Government devotes to research and development. The best way to do that would be to take the Labour Government's Technology Strategy Board (TSB) and transform it into something bolder and more effective. We believe that there should be an Innovative Projects Agency (IPA) that uses targeted resources on specific projects. The budget of £1 billion would come not just from the TSB but also from the DTI's innovation programmes, the science aspects of the regional development agencies and some re-allocated from the existing Research Councils. Such an agency would ensure that when the market could not respond quickly to scientific and technological change, there was an effective mechanism for the state to ensure that someone did. All IPA projects would bring together those who have ideas with those who can see a use for a product (or service) that will come from developing the original discovery.

Our vision is of an IPA that would be needs driven and tolerant of risk, working with staff recruited from industry and higher education. Projects would be time limited, goal orientated and selected through a competitive process. This process would both provide opportunities for funding beyond established research communities and companies and attract public attention. Establishing the IPA would raise the profile of STEM in society and show how it can contribute to a better quality of life for all.

It is important to understand that we are not proposing a diminution of the importance or resources of "blue skies" research. What we want to do is to raise the status of those who find viable applications for ideas arising from research or who can turn such ideas into products valued by customers. In many cases, this should enhance the esteem of engineers in this country.

Having examined how the UK Government can better stimulate innovation, my group is now turning its attention to the anti-science culture in Britain. Many of the problems with science education derive from cultural barriers that discourage young people from studying STEM subjects. Distrust of science is a major problem at a time when science has never been more crucial to our economy and society. The international dimension and how science policy should be made in Whitehall and Westminster are the two remaining areas of our work.

This is an exciting time to be looking at future science and technology policy. I am confident that the group I am privileged to lead will continue to develop new ideas for future Conservative policy.

Sir Ian Lloyd 1921-2006

A tribute by Sir John Osborn

Preface: A personal Appreciation

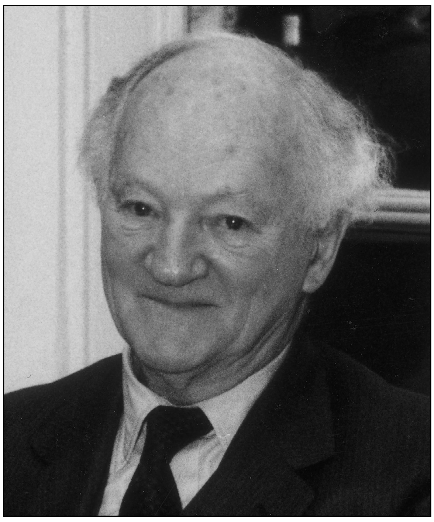
I have known and worked with Sir Ian Lloyd for over 40 years, and we have been life members of the Parliamentary and Scientific Committee. We have had many mutual interests. He has done much to promote the understanding of Science and Technology, especially amongst fellow politicians, and in Government.

I well remember his vision of over thirty years ago, when he predicted that containerisation would become a dominating aspect of the transport of goods by land and sea. It was an interest that concerned us both. He was Economic Advisor to British and Commonwealth Shipping (1956-83), and Chairman of the Conservative Parliamentary Shipping and Shipbuilding Committee (1974-77).

The impact of the computer and IT was also of importance to us at the same time. I chaired a P&S committee which reported in 1968 on "The Collection, Dissemination, Storage, and Retrieval of Scientific and Technological Information". It foresaw the role of the computer in Information Technology and the impact of the memory and random access but for the next fifteen years it was impossible to forecast the implication of it all. The P&SC, an all party IT Committee, and a Conservative Committee chaired by Ernest Marples were interested in developments. Sir Ian was the driving force behind the founding of PITCOM in 1981. I had always used secretaries, typists, and a variety of office machine operators, but he insisted that in the next century all senior officials in Government, civil servants, MPs, and top executives would have to operate their own computers and word processors in order to hold down their posts. Another prediction that is surely true.

He was a member of the UK delegation to the Assemblies of the Council of Europe and Western European Union and served on their Science and Technology Committees (1968-72). I followed him, to learn that his original and thought-provoking work there was greatly valued.

We both took part in many European Parliamentary and Scientific Conferences, and by chance we were



together at the 7th Conference in Ottawa in 1990. I had set in hand the arrangements with a Canadian MP but by 1990 we had both retired. He invited Ian Lloyd, who was leading the UK delegation, and me to have lunch in the dining room of the Canadian Parliament. When we asked how it was possible for a former Canadian MP to have access to "Parliament Hill", he explained that he was President of the Canadian Association of Former Parliamentarians, recognised in an Act of the Canadian Parliament. Ian Lloyd was on the Services Select Committee, and was so briefed by our Canadian host that he was able to insert the appropriate amendments into the 1992 Services Bill. Former MPs now have passes to give them access to many parts of the Palace of Westminster. There is an Association of Former MPs, backed by the Speaker Michael Martin, who has hosted reunions in the Speaker's House. They number 350, but many more Former MPs have been granted passes since the Services Act of 1992.

Sir Ian Lloyd's Contribution to Science and Technology, including the Parliamentary and Scientific Committee

With the Council of Europe he undertook a survey of the use of computers in European Institutions; this survey took him to the USA and Canada, which enabled him to take an active role in the All Party IT Committee formed in 1979. He joined the Select Committee on Science in 1975, and was concerned with Scientific Innovation. He took a deep interest in Energy, being a member of the Parliamentary Group on Energy Studies formed in 1980, and serving on the Select Committee (1979-89). He was a prominent supporter of Nuclear Power.

Sir Ian joined the P&SC in 1965. He was Vice President (1984-87), deputy Chairman (1988-90) and became President in 1990, leading a delegation to China in 1991. Following a brief period as editor in 1997, he has been a regular contributor to *Science in Parliament*, reviewing "Chernobyl – Catastrophe and Consequences" just before his death. He concluded that the authors "Have effectively demolished any excuse for publishing any nonsense on the topic of Nuclear Power".

He worked closely with Sir Trevor Skeet and Sir Gerard Vaughan in 1986 to set up the P&SC Science and Technology Working Group. One aim was to set up a British version of the Office of Technology Assessment in Washington, which they visited. By 1988 briefs were being sent out on key issues to members of the Lords, Commons, and the European Parliament by the Parliamentary Office of Science and Technology (POST), of which Sir Ian was the first Chairman.

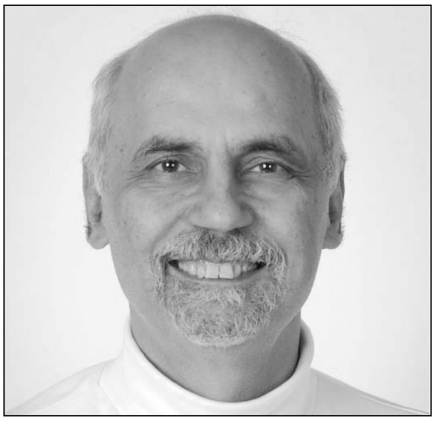
Some other highlights of the Life of Sir Ian Lloyd

Born on 30th May 1921 in Durban, he was educated in South Africa, attending Natal-Witwatersrand University. He read Science at Kings College, Cambridge, becoming President of the Union in 1947. He returned to South Africa and was economic advisor to the Central Mining and Investment Corporation until 1949, entering the South African Board of Trade and Industries. He resigned in 1955, because of a "profound disagreement with Apartheid".

In 1957 he moved to England, becoming MP for Langstone-Portsmouth in 1964. Boundary redistribution created contests, but he continued in Havant & Waterloo, and then Havant until he retired in 1992. He married Frances Addison in 1951 and they had three sons. He was knighted in 1986.

He displayed considerable vision and was a distinguished back-bencher, who made an outstanding contribution to many aspects of Science and Technology.

The European Research Council (ERC): Putting Excellence at the Heart of European Science Policy



Professor Fotis C Kafatos, Imperial College London
ERC President and Chairman of the Scientific Council

The Origins

In 2000 European Commissioner P Busquin enunciated the European Research Area (ERA) concept. In 2001 prominent European scientists debated at the Swedish Academy of Sciences whether Europe should invest more in fundamental research, and in 2002, during its EU Presidency, Denmark organised a broad meeting on "Do we need a European Research Council?" To the surprise of many, the overwhelming response was YES.

Busquin then embraced ERC as a road to ERA, and Director General A Mitsos correctly identified the inherent added value: competition for excellence at the European level. A high level advisory group established by the Copenhagen meeting (lead by F Major) and another from ESF (lead by R Sykes) concurred with arguments. In August 2004 a large number of leading scientists signed the manifesto of the grass-root "Initiative for Science in Europe" in support of the ERC (Science 305, 1327). The new European Commission, in which J Potočnik replaced P Busquin, incorporated an autonomous ERC for frontier research in its April 2005 Framework Programme 7 proposal with a budget that was ultimately agreed at €7.51b over 7 years. Some feared that a Commission-established Executive Agency would compromise autonomy, but an EA was accepted because of Potočnik's strong commitment to ERC autonomy and the pragmatic requirement for speed.

At that stage, a Slovenian and two British political leaders were instrumental in securing support by the European Council. Lord Sainsbury, widely appreciated as Research Minister, supported the ERC despite contrary advice, because its focus on excellence matched the UK's long-standing vision. Potočnik entrusted Lord Patten and his committee of European scientific leaders to identify the members of the ERC's Scientific Council (ScC) amongst some 400 nominations from learned societies, academies and national research councils. Potočnik accepted the committee's 22-person proposal in full. Ever since, the (non-remunerated) ScC has served as the driver for the ERC, even before being established formally (which will occur in early 2007, following the legal decisions for starting FP7).

The Rationale and Prospects

One important reason for the ERC is that science and knowledge are at the heart of European civilisation – our identity. Further, Europe can only compete as a Knowledge Society, based on the knowledge triangle: Education/Research/Innovation. And it is a triangle; investment in research excellence is an imperative, not an option. We must generate, attract and retain top research talent by modernising our research system; invest consistently across our narrow borders in a globalised world; encourage the young by establishing attractive career paths and a competitive Champions League for setting standards, as in football.

Since October 2005 the ScC has developed our strategy and made critical decisions. To avoid a fatal split between strategy development and implementation, we created an ERC Board with our Chair and Vice-Chairs, the Director of the EA and our experienced Secretary-General E-L Winnacker. We selected a clear and compelling strategy to address to obvious gaps in Europe: by creating Starting Independent Researcher Grants (StG) for exceptional individual young scientists to become independent and work where they choose, and by funding frontier research projects of the best, already established investigators through Advanced Investigator Grants (AG). To make a difference, they will average €1.5m and €3.0m, respectively over 5 years. All fields of science, technology and scholarship are eligible; excellence will be the sole criterion, permitting overseas investigators to be grant holders if they come to Europe. To keep flexibility, the review panels will decide the funding levels which the investigator can re-budget subsequently. The grants will be portable, allowing investigators to move with these funds within Europe, if their host proves disappointing. We expect that StG will establish ca 200 new investigators pa, some 1400 in 7 years; and that some 1700 AG grants will be funded during the same period.

We hope that through its policies, the ERC will facilitate progress in enhancing the European research structures with a light touch.

We are comfortable being experimental and will monitor developments over time, making changes as required. Provisionally we earmarked 15% of the budget for Social Sciences and Humanities, 40% for Life Sciences and 45% for Physical and Engineering Sciences, the rough average in research-intensive areas of the world, but depending on high-quality proposal numbers we may re-examine this distribution. The StG evaluation panels have been designed not on a narrow disciplinary basis, but by mixing related disciplines to facilitate consideration of boundary-crossing proposals. We invited eminent scientists to serve on them, and interpret the unprecedented high rate of acceptance as a gratifying token of the community's trust in the ERC. Whilst we are focusing on the individual investigator's excellence, we are aware of the importance of critical mass in research, and will be monitoring with interest the impact of the ERC in restructuring the European research landscape. We expect that the StGs will encourage proactive institutions to create poles of excellence with fresh recruitments, including from overseas. We hope to encourage their pursuit of the three Rs: **R**ecruit, **R**epatriate, **R**etain top talent.

OPINION

Nuclear Energy

Giles Chichester MEP

It is abundantly clear to me that the case for nuclear energy does need to be made, repeatedly, both to inform the vast majority of people who don't really know much about it and to counter the negative propaganda so passionately promoted by opponents. So, I have made a list of pros and cons which helps me see the issues clearly.

My first advantage is the basic fact of this technology creating a new and additional source of energy. I am no physicist so it seems all the more remarkable that so much energy can be extracted from so small an amount of material in a way unimaginable a hundred years ago.

The next strength is that nuclear energy is a well-proven and mature technology. 441 reactors operating worldwide, some for over 50 years and some licensed for 60 years working life, make this point. This is not to denigrate other, newer technologies because we need all the energy we can get but things like hydrogen fuel cells have it all to prove while nuclear fission is well established.

The third advantage lies in the bulk, volume base load electricity generated by nuclear energy. Not everyone sees large capacity power plants as a plus in an age where the concepts of distributed, decentralised generation are on the verge of becoming fashionable but for me the fundamental truth is that we keep on using more electricity and there can be no substitute for a 1000MW plant belting out power 24/7.

The fourth strength is the predictability of nuclear power output particularly by comparison with some alternatives such as wind or tidal, never mind gas supplies subject to arbitrary interruption and dramatic volatility in price.

The fifth strength is the operating safety record for nuclear power. Even that disaster the opponents love to mention, Chernobyl, has actually had a positive effect in providing a stimulus for ever greater attention to safety in Western reactors through the efforts of WANO, the World Association of Nuclear Operators, and WENRA, the Western European Nuclear Regulators Association. The industry safety record stands well in comparison with those for oil, gas and coal.

Next, I come to security of supply derived from a proven technology giving a reliable, consistent, predictable volume of output power over a very long working life. Because the fuel component is a relatively small part of overall cost, nuclear is much less vulnerable to raw material price changes or interrupted supplies.

My seventh advantage for nuclear, is long-term price stability. Despite the capital cost of building a nuclear power plant being high, the cost per kilowatt hour is one of the lowest of all generating technologies over the full working life. Having a long working life means it is possible to amortize construction, de-commissioning, waste treatment and disposal costs over a longer period. Above all, it means prices will be stable and predictable over the full working life.

It follows that I also think it cannot be said too many times or emphasised too much that nuclear energy is cost competitive. Statistics regularly compiled by the NEA (OECD Nuclear Energy Agency) underline this fact. Study after study by reputable and independent bodies tell the same story. And new designs of the next generation of reactors promise greater efficiency, lower costs and even better safety with less waste product. The historic fact of some reactor types turning out very expensive, and I can think of the go-it-alone AGR technology we embraced in England for example, is against the trend, in a very small minority and should not be allowed to detract from the overall picture.

My ninth advantage is the excellent long term return on investment prospects offered by nuclear energy. Just look at the USA where PWR's licensed for 40 years operation are being re-licensed for a further 20 years and consider the financial return that implies even after the cost of updating improvements required as a licensing condition. Of course, a stable regulatory and market framework is essential, requiring politicians and officials to swear a self-denying ordinance to leave things alone. This is difficult to imagine, but not beyond the bounds of possibility!

My tenth advantage of nuclear energy has only become apparent since the emergence of climate change theory and concerns about the potentially dramatic impact on our environment of global warming. For some years now climatologists, or most of them, have identified CO_2 emissions from burning coal, oil and gas for energy as the principal culprit. Nuclear energy emits a negligible amount of carbon over its full life cycle and a study by the UK Government Energy Technology Support Unit highlights this advantage. The study calculates the amount of carbon per kilowatt hour of electricity produced. The numbers are striking. Coal 955 grams, oil 828, gas 430, hydro and wind both 8 grams and nuclear a mere 4 grams.

I now turn to the arguments against nuclear energy.

Originally opponents linked the peaceful use of nuclear energy with the military applications of fission and fusion, ie the bomb. This played easily on people's understandable fears about the mushroom clouds and the horrors of Hiroshima and Nagasaki. Gradually over time I think people have come to accept that the physics and engineering of using nuclear fission to generate electricity is fundamentally different and safe but I believe an educational challenge remains.

The next argument was also about exploiting people's fears of the unknown and unseen. Radiation, radioactivity can indeed be dangerous if not handled properly but so can that most innocuous commodity water if you drink too much of it or if you try walking on it, for example. Yet all animal life has lived on earth for hundreds of thousands and millions of years unaware of background radiation from the ground. In Britain the radiation the average person is exposed to is 75% from background sources, 34% from medical and chemical sources and 1% from man's uses in the nuclear industry, other industrial applications and fall-out from the testing and use of nuclear weapons. The challenge remains to inform people about this.

Chernobyl was like manna falling from heaven for the opponents of nuclear energy. Never mind the facts of how it happened, the extent of the damage and the number of deaths and casualties this was a powerful, emotive argument that nuclear energy is dangerous, unsafe, nasty and should never have been invented. There is no doubt in my mind that those scientists and technicians who monkeyed around with and over-rode all the safety mechanisms to the point of precipitating the event have much to answer for in terms of people's perceptions about safety. The only answer can be full explanation coupled with complete openness and availability of information from the whole industry. Those who know have a duty to inform those who don't.

Next, the complexity of the back end of the fuel cycle allowed the still widely held myth and perception that "nobody knows what to do with radioactive waste" to take hold. It clearly worries many people who only hear the line about nobody knows and do not go on to listen to answers giving the facts about decommissioning and the various options for engineered solutions. Yet again there is a crying need for information to be widely disseminated.

A related argument is that nuclear energy is expensive and uncompetitive partly because of the cost of construction, but mainly because of extravagant estimates of the costs of decommissioning, waste treatment and disposal. In my view, the accusation that nuclear is too expensive has been the most serious and effective argument used by opponents and doubters alike. The only thing to say in addition to my remarks above about competitiveness is that we know a lot more now about these costs than was the case twenty years ago.

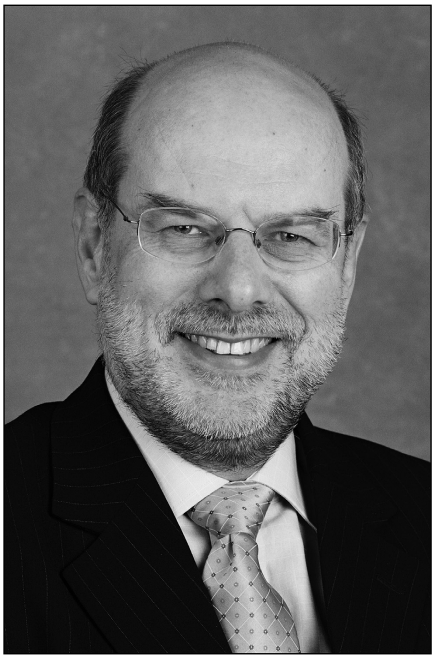
A different point has been made about the security risks arising from the vulnerability of nuclear power stations and spent fuel repositories to some form of terrorist attack or theft of fissile material. I am not a security expert and would not wish to speculate on what form of attack and systems of defence might be involved, but if one considers the size and expense of plant required to re-process spent fuel or enrich uranium then it seems to me the only realistic threat would be from a rogue state in cahoots with a terrorist organisation. I think we should put our trust in modern methods of intelligence and surveillance to counter that risk.

The latest argument concerns the availability of uranium. It goes something like this. There is only 30-40 years supply of uranium at the present rate of utilisation so there is no point in building any more reactors. If a shortage appears likely the price will rise and make deposits with lower concentration viable for extraction. Other responses include: re-processing spent fuel; fast breeder reactor technology; mox fuel fabrication; and more efficient reactor designs. And by the time we have done all that we may be on the threshold of the fusion era.

I make that ten arguments for and seven against with plenty of potential for debate. I want to see more public debate and dissemination of information because I believe the case for safe, reliable, ultra low carbon emitting, secure and competitive energy from nuclear can only benefit. Scientists, politicians and industrialists must all contribute. We have a quality and standard of life to safeguard as well as global warming to cope with and time is short.

Maintaining a world class higher education system

Professor David Eastwood
Chief Executive of the Higher Education Funding Council for England



Higher education in the United Kingdom is world class. It is an indispensable part of the competitive knowledge-based economy and a major force for securing a democratic, civilised and inclusive society.

By any standards it is a high performing sector of which the nation can be proud. Its many achievements – in terms of research output, knowledge transfer, increasing and widening participation, and quality of learning and teaching – have been realised despite a real-terms reduction of one-third in the unit of funding since 1989-90. Higher education is also an international business: it is worth £45 billion to the UK economy, based on a public investment of £15 billion, and generates £3.6 billion in gross export earnings.

Within this broad context HEFCE has a pivotal position in ensuring that the country continues to have a higher education system to match the best in the world. We are and will continue to be the largest single funder. We are responsible for providing sound evidence-based advice to Government.

We are also an influential partner with Government and with universities and colleges in developing policies and spreading good practice to meet future challenges. As a regulator we are accountable for the proper use of public funding, ensuring that higher education institutions are financially healthy and well managed.

Our policies are focused on enhancing the quality of the student experience, encouraging social inclusion, sustaining world-class research and supporting the wider roles of universities and colleges within the economy and society. Uppermost in our mind is the need to maintain institutions' autonomy, and to identify policies and funding methods which minimise burden, provide stability, and help to secure the long-term sustainability, vitality and excellence of higher education.

In 2006-07 HEFCE will allocate £6.7 billion in public funds to 275 universities and colleges in England to support high quality education, research and related activities. These include 132 higher education institutions (88 universities, 2 general colleges, and 42 specialist institutions) and 143 directly funded further education colleges providing higher education courses.

We are committed to funding further growth in student numbers. This is essential if we are to meet the challenges of widening access, increasing participation, and encouraging students to progress to higher education, which all remain crucial to meeting the needs of students and employers and achieving national prosperity.

A key feature of the next 10 years will be maintaining a dynamic, world-class research sector. We will work with the Government, the Research Councils and other funders to ensure that the UK's record in creating new knowledge and opening up new fields of research is matched by achievements in applying them.

The UK has been exceptionally good at generating new knowledge. Although it has only 1 per cent of the world's population, the UK carries out 5 per cent of world research and produces over 12 per cent of all cited papers and almost 13 per cent of papers with the highest impact. On average, UK scientists receive about 10 per cent of internationally recognised science prizes.

This places the UK second in the world in terms of percentage share of citations and high impact research. While we recognise that the Government has made significant steps in increasing investment in research and development over the past 10 years, UK success has occurred in spite of historically lower public and private investment in research and development than our leading competitors.

In 2006-07 HEFCE will distribute £1,342 million in recurrent funding for research. This funding is allocated to institutions selectively to support and reward excellence in research of all kinds and in all subjects. We welcome the Government's continuing commitment, expressed in the pre-budget statement, to the dual support system of public funding for research. Our element of the dual support (the other being the Research Councils) is distributed as quality-related funding. It underpins the costs of the research infrastructure and enables universities and colleges to support path-breaking blue skies research in accordance with their own priorities.

Since 1986 HEFCE, on behalf of the UK funding bodies, has periodically assessed research quality through the Research Assessment Exercise (RAE). This peer review system involves expert panels rating the quality of research conducted in departments across the UK. In addition to informing our grant allocations, the RAE has been influential in driving up the quality of research and of research management, and in benchmarking quality in an international context.

In the December 2006 pre-budget report the Government announced the development of a new framework for the assessment and funding of research, to follow the 2008 RAE. The new system will be designed to reduce significantly the operating cost and administrative burden associated with the RAE, while still producing robust indicators that can be used to benchmark quality and to drive HEFCE's funding for research. We will now undertake the detailed work necessary to develop and implement the new framework, including consultation with the sector. We will seek to ensure a smooth transition to the new arrangements, to be fully in place by 2014.

Publicly-funded research contributes significantly to industrial and economic growth, as the business sector seizes opportunities from the generation of knowledge. We recently announced that we will allocate a portion of quality-related research funds (£60 million in 2007-08) to support and encourage research that directly meets the needs of business and industry. This new element of HEFCE funding will provide the incentives that universities and colleges need to seek commissions from the users of research for activities which are both high quality and directly responsive to their needs.

Universities and colleges are working much more closely with business. The surveys of interactions between higher education and business and the community over the past five years demonstrate the considerable progress made in building relationships with business, not only in R&D, but also through consultancy and training. For example, the surveys highlight that UK higher education institutions are more successful than US institutions in forming spin-out companies (even if at present UK institutions generate proportionally less licence income). We are supporting these activities in partnership with the Office of Science and Innovation, and will be distributing a total of £234 million over two years from the Higher Education Innovation Fund to all the institutions we fund.

Research, increasing links with business and a skilled workforce go hand in hand in securing national prosperity. We welcome the report from the Leitch Review, which rightly sets targets which will challenge higher education in meeting the country's future needs for higher level skills. Some expansion in higher education should be delivered through a demand-led mechanism such as Train to Gain, a brokerage service designed to help businesses get the training and staff development that they need to succeed. We have already established Higher Level Train to Gain pathfinders in three regions, and we will roll these out nationally in the very near future. We will explore with partners how to extend our support for universities and colleges in taking a greater role in workforce development, and increase their capacity to deliver the tailored flexible courses that businesses and individuals need.

It is essential that disciplines and subjects that are of strategic importance to the nation are sustained and developed. Some strategic subjects may be vulnerable because of a mismatch between supply and demand: action to support them needs to be proportionate and tailor-made to the problems.

We have a watching brief on the potential national consequences when institutions are considering the closure of courses or departments. Acting with regional partners, such as Regional Development Agencies, we are able to sustain disciplines of strategic importance in a region where an individual institution's decision may have led to some decline. We also keep abreast of the data so that we can understand trends over time in strategic subjects.

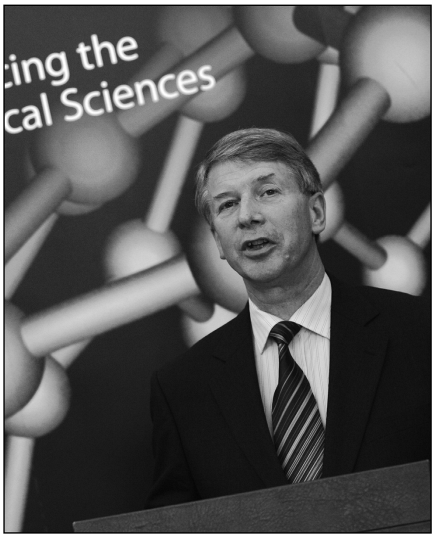
We are acting to raise the aspirations of young people to study certain subjects, in collaboration with the Institute of Physics, the Royal Society of Chemistry, The Royal Academy of Engineering and other professional bodies in science, technology, engineering and mathematics (STEM subjects). We are also working with the Research Councils and the UK's other higher education funding bodies to sustain research capacity and capability in areas that are of critical importance to the nation.

Such demand-raising activity will take some time to deliver increases in student numbers. Therefore we are helping universities and colleges to maintain provision in those subjects that are particularly expensive to teach: chemistry, physics, chemical engineering, and mineral, metallurgy and materials engineering. We announced in November 2006 that we would provide an additional £75 million to sustain capacity in these very high cost subjects over the next three years. Overall, we have committed nearly £250 million to supporting and developing strategically important and vulnerable subjects.

With ever-increasing competition, the challenge for the higher education system in England is to stay ahead. The introduction of variable fees is providing a much-needed stream of additional income. Our approach will be to rely on a combination of market forces and selective interventions to ensure the English higher education sector maintains its leading global position.

Strategic Influence: My Vision for the RSC

Dr Richard A Pike
Chief Executive, Royal Society of Chemistry



The Royal Society of Chemistry (RSC) is one of the UK's leading science organisations with a global reach. This year, 2007, brings new challenges and opportunities in a world where the chemical sciences can contribute constructive solutions to so many of the problems that we face.

For example, take the current Session of Parliament. MPs and Peers will be dealing with some of the major issues facing the UK – such as climate change, energy policy and the future shape of public expenditure to promote innovation – and the role of science is absolutely vital and central to each of these issues.

The scientific community, of which the RSC is a key part, wants to be fully engaged in the public and parliamentary debates on these and other issues.

My vision for the RSC is to develop our strategic influence.

As an organisation, the RSC does a remarkable job in many different areas, and as its Chief Executive I want to weld all these strands together into an effective and efficient whole.

Our key priorities, as we look ahead, can be stated very simply:

Influence the Decision Makers

We want to ensure that the RSC is influential in a world where there is enormous competition for attention in every area of public life. We seek to participate in, and influence, science and education policy discussions across the UK and within the EU, and be recognised as a key source of expertise and advice on the chemical sciences.

The spirit in which we do this is equally important. Our Royal Charter specifically requires us "to serve the public interest", and the RSC does this in its work with Government, Parliament, the devolved bodies in Scotland and Wales, the European Parliament and Commission, and with a wide range of other public and private bodies.

We also see the RSC continuing to play an active part with the Parliamentary and Scientific Committee, which does such a tremendous job in bringing science to Parliament.

The last year brought significant engagement between the RSC and Government, in developing the Chemistry Innovation Knowledge Transfer Network (CIKTN), and launching the Chemistry For Our Future (CFOF) initiative to improve curriculum development and teaching. We also highlighted the adverse funding gap between income and expenditure in teaching laboratory-based subjects at university, and this resulted in further governmental commitment over the next three years. We have also broadened our contact with industrial leaders, and see the engagement of key decision-makers right across society as vital for the future prosperity of the country.

Broaden Our Science Base

Chemistry is an enabling and expanding science that underpins so many different fields. We want to promote the importance of chemistry to energy, materials, the environment, sustainability, food and health, identifying it as the key science in addressing future global issues and offering business opportunities in these sectors. We seek to nurture the core chemical sciences, including supporting the chemical sciences in chemistry-using industries, promote and facilitate innovation, expand our scientific footprint, enhance the support for applied science, and provide services to companies of all sizes.

During the last few months we have engaged with Government over energy and global warming, in particular, and contributed to changes in legislation in other fields within both the UK and EU.

The RSC is in a unique position to bring together its academic and industrial component parts, and we want to invest, in a prioritised way, in our many subject and interest groups to broaden RSC involvement in the chemical sciences and related topics, including the life sciences.

Encourage the Study and Teaching of the Chemical Sciences

The educational work of the RSC is probably its most enduring contribution to the cause of science. We encourage the study, and enhance the teaching, of the chemical sciences at all levels, from the primary to tertiary sectors. This means securing the role of chemistry in a modernised school curriculum and augmenting the supply and capability of teachers. We will continue to lobby for improved teacher training while for our part we will continue to provide RSC-managed inset training and opportunities for scientists to consider a career change to teaching.

It will be essential that this is linked to university education, and to the overall needs of industry and society at large. The RSC already plays a key role in accrediting degree and training courses to support this.

Enhance Our Membership

The RSC has over 44,000 members in all its various categories (including over 1,000 school children), and we aim – like any modern organisation – to make membership worthwhile and beneficial. Old-fashioned notions of what "chemistry" comprises need to be discarded. We strive to become increasingly relevant, receptive and responsive to a broader range of chemical scientists across the UK, the EU and internationally. Our objective is to develop and enhance current networking opportunities and activities to support members, bringing together the local, the academic and the industrial networks that exist all over the UK. This will also improve synergies in addressing key issues.

Promote Professionalism and Ethics

The RSC is responsible for important professional qualifications which are the bedrock of the RSC's scientific and other expertise. We seek to promote our professional qualifications, as well as best practice, in the chemical sciences and encourage members to participate in Continuing Professional Development (CPD). We also want to secure our members' rights to practise their profession by influencing European and national legislation and standards and professional mobility. At the same time, it is important that we continue to uphold the highest ethical standards.

Expand Our Publishing Activity

Publishing is a vital part of the life of the RSC, and our journals (23 in all) have well-deserved and well-established reputations for excellence. We seek to build upon our international reputation by improving our service to authors and subscribers, adding value to our existing products and developing innovative ones to serve new areas of science. As science continues to expand, we are targeting to produce new or enhanced journal and book titles to cover emerging areas of the chemical and related sciences. This activity will increasingly link with our other roles in education and the wider promotion of science and technology. The last year saw our monthly magazine *Chemistry World* acclaimed as the best in its class of professional journalism.

Improve Our Channels of Communication

Every modern forward-looking organisation needs to pay special attention to the way it communicates, both internally and externally. We seek to enhance the perception and image of the chemical sciences and its practitioners amongst our own members, the international scientific community and the general public. A good relationship between the world of science and that of society at large is vital to both. This calls for more effective listening, insightful comment that captures the imagination, and conveying information that is relevant to the needs of society.

Develop Our Partnerships

Science is international, and no scientific society can be effective without developing partnerships with its scientific "neighbours" – both at home and abroad. We must build national and international alliances to further the impact of the chemical sciences and its practitioners. We aim to build on partnerships with other professional and learned societies, and trade associations, within the UK. This multi-disciplinary approach will help deliver the solutions needed in an increasingly complex society like ours.

We already have good relationships with chemical societies from the developed world. We are now building new partnerships with emerging economies – especially in Asia. We aim to refine our international strategy, taking account both of country characteristics, and the competition that we face, and place our priority on our commercial and high-level networking activities (including, where appropriate, formal co-membership arrangements) in Europe, China, India, Singapore, South Africa, Japan and Brazil. There are also great opportunities for developing our educationally-based activities elsewhere, in support of teaching and promoting science.

Improve Our Governance

As a registered charity, with an annual turnover of around £30 million, and extensive member-based activities supported by over 300 staff at two sites (London and Cambridge), it is always important to have the best governance possible, especially now that "science" has at last been included formally as a definition in the Charities Act 2006. We are already implementing a new governance structure fit for the challenges of the 21st Century, and the provision of the necessary resources and frameworks to deliver effectively our new strategic plan.

Invest in Our Staff and Volunteers

Finally, the RSC depends for its effectiveness upon its own staff and volunteers. We know that if we are to deliver our strategy, we need to develop our staff capacity and support our volunteer network. This will involve training programmes and development initiatives to enhance the competencies of our staff.

The RSC is a tremendously dynamic organisation which covers a surprisingly wide range of activities: scientific, publishing, educational, professional, learned, public and parliamentary. The more effective and efficient we are, the greater the strategic leadership we can offer.

We are a scientific society on the move.

Research Council Support for Knowledge Transfer

Professor Philip Esler

Globalisation is both a process and a precipitator of turbulent change. It is one of the key challenges facing the UK in coming decades. In order to create and maintain the highly skilled, knowledge-based economy that will allow this country to thrive when other countries can undertake manufacturing so cheaply we need to harness the world-leading research in our universities and research institutes. As the Chancellor reminded us in his statement on his Pre-Budget Report, "Economies like ours have no choice but to out-innovate and out-perform competitors by the excellence of our science and education."[1]

With a combined budget of around £2.6 billion, the Research Councils comprise the largest single funder in the UK research base. We currently support around 50,000 researchers on 18,000 grants and each year almost 7,000 doctorates are awarded as a result of our funding. Research Councils will therefore play a significant role in meeting Mr Brown's challenge, funding the social, environmental and life sciences, through to chemistry, physics and engineering, as well as my own domain in the arts and humanities. We are clear that the benefits to the economy are derived from the full spectrum of our investments.

With this scale of activity, it is appropriate that the Government looks to us as central contributors to the establishment of the UK as a world-leading knowledge based economy. It is also right that our activities are open to close scrutiny and the early part of 2006 saw two major exercises.

The House of Commons Science and Technology Committee looked at Research Council Support for Knowledge Transfer. Its report was published on 15 June 2006. In parallel, Sir Keith O'Nions, the Director General of Science and Innovation, invited a group of Research Council chief executives, senior academics and business people, to form an Economic Impact Group, led by Peter Warry, the Chairman of the Particle Physics and Astronomy Research Council, to advise him on how Research Councils can deliver – and demonstrate they are delivering – a major increase in the economic impact of their investments. It published its report on 14 July 2006.

Similar themes emerged from the two exercises. The Research Councils had pivotal roles, both as funding bodies and as leaders of the research base and had made great strides in increasing the impact of their investment, but there was more that could be done. For example:

- There was scope for more co-ordination between Councils and there needed to be greater leadership within the Councils.
- There needed to be greater national co-ordination of knowledge transfer and the Research Councils had a significant role in bringing the main players together.
- Research Councils needed to increase their engagement with users and their requirements must be fully considered when determining funding priorities
- Research Councils needed to evaluate the impact of their knowledge transfer schemes and of the impact of their investments.

The Research Councils are willing to take up these challenges, working together through Research Councils UK (RCUK), the strategic partnership of the eight Councils. We have set up a new high level strategic cross-Council group, chaired by myself to drive the necessary changes. While there are differences in Research Councils' knowledge transfer activities, depending on remit and the level of intramural research, there is the potential for greater learning from one another's experience and for rationalisation and joint branding. We aim to report on the options in autumn 2007.

Knowledge transfer by the Research Councils

- Co-operation in education and training at masters and doctoral level. We will spend £83 million this year on collaborative training. This includes awards for some 3,000 PhD students who are being trained collaboratively. The scheme involves over 500 companies and users range from Reebok UK to BP to county councils.
- People and knowledge flow. Through a range of schemes, we aim to fund researchers to work in industry or government for a period.
- Collaborative research with users. Next year we expect to spend £260 million on collaborative research.
- Commercialisation including IP exploitation and entrepreneurial activities. We aim to maximize the opportunities from the research in our institutes and encourage entrepreneurial activity in universities.

1. HC Deb, 6 Dec 2006, Col 306

A new national forum will enhance co-ordination with partners including higher education and research institutions; the four UK Funding Councils; users of the research in the private, public and voluntary sectors; and organisations such as the Regional Development Agencies that play a role in mediating between the researchers and other users. RCUK will enable sharing of best practice across the Research Councils and among higher education institutions in collaboration with other stakeholders.

All the Councils have a mechanism by which research users can influence their strategies. To improve these channels, we will be commissioning a pilot user survey to be conducted by about the middle of 2007. We anticipate that such surveys will be undertaken regularly in the future, providing valuable data to the Research Councils individually and collectively.

Demonstrating the impact of our investments and the effectiveness of our knowledge transfer programmes is a major challenge for the Research Councils, and indeed for research funders the world over. We are determined to be at the forefront of world efforts to demonstrate the economic impact of funded research. PriceWaterhouse has now done economic impact studies for two Research Councils and we are working to apply this approach across all eight.

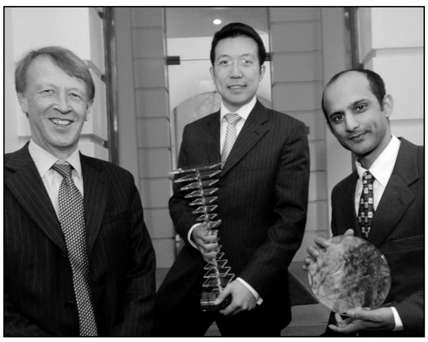
Generating the data is only one part of demonstrating the impact of our investments; it also requires effective communication. Some of the criticism that has been levelled against the Research Councils in relation to knowledge transfer and economic impact in the last couple of years stems from our failure adequately to tell our success stories. We believe that better communication with our stakeholders of our activities and successes will not only correct negative impressions but also create a more positive environment in which to achieve our aims.

Research Councils will play a pivotal role in ensuring that all those with a stake in the success of the UK research base are pulling in a common direction. By achieving this, the UK can achieve its potential to be a dynamic and successful knowledge economy. That will prove that for us globalisation proved an opportunity and not a threat.

Professor Philip Esler is Chief Executive of the Arts and Humanities Research Council. And Chair of the Research Councils UK Knowledge Transfer and Economic Impact Group.

Business Plan Competition

The RCUK Business Plan Competition provides researchers who have ideas with commercial potential the skills, knowledge and support needed to develop a first-rate business plan. This is provided through expert trainers, coaches and mentors. The competition provides the opportunity to win funds to help with the development of business ideas. The 2006 winner, announced in December, was Warwick Warp (http://www.warwickwarp.co.uk/), which is developing a highly accurate fingerprint identification technology for use in personal ID cards, passports and access control systems. It is not just the winners who benefit. All the entrants benefit from expert guidance on how to make their research a commercial success. www.rcuk.ac.uk/innovation/fundingkt/bpc/



Warwick Warp, a spin-out company from the University of Warwick, display the 2006 Research Council Business Plan Competition trophy. Warwick Warp is developing a unique software-based fingerprint identification system which is substantially more reliable and also faster than those currently available. Warwick Warp's technology can be incorporated into identity cards and biometric passports - and so could help combat crimes such as identity theft, social security fraud, people trafficking and terrorism.

Some success stories

More than 14 million people were glued to BBC2 when Arts and Humanities Research Council award holders lifted the lid on the *Lost World of Mitchell and Kenyon*. Thousands more turned up to touring exhibitions throughout the country, the book sold out, and the DVD has sold almost 20,000 copies.

Research funded by the Biotechnology and Biological Sciences Research Council led to a vaccine that protects chickens against the disease coccidiosis, and of which around eight million doses are sold annually worldwide.

Oxensis, a spinout company from the Council for the Central Laboratory of the Research Councils, is developing advanced instrumentation for gas turbines in the aviation and power sectors; this is designed to achieve major reductions in greenhouse gas emissions as well as considerable fuel savings.

A hi-tech 'watermark' that can show whether a digital image has been tampered with has been developed by researchers funded by the Engineering and Physical Sciences Research Council. This has applications in legal cases where CCTV footage or digital images are used as evidence.

Work undertaken by the Economic and Social Research Council's Violence Research Programme has enabled the Metropolitan Police to better decide which domestic violence 999 calls require the fastest response.

Medical Research Council trials in Africa of a vaccine against *Haemophilus influenzae* type b (Hib) have shown how the lives of hundreds of thousands of children can be saved worldwide each year. Hib infection is a major cause of pneumonia and meningitis.

Natural Environment Research Council-funded research at the University of Nottingham has used the Research Councils' Follow-on Fund to develop a revolutionary technique called hydropyrolysis that will be valuable in oil exploration and the detection of steroid abuse.

Particle Physics and Astronomy Research Council-funded researchers at Cambridge University have set up a company Geometrics, to apply a geometric algebra theory to the computer games industry. The technology rapidly calculates how light and shade fall on objects as they move producing more realistic images.

State of Science UK

Political rhetoric about the health of the UK science base does not match the reality, according to Prospect's survey of almost 1,000 scientists and technologists

More than four in 10 working scientists are either unsure they will be able to stay in science or certain they will leave.

That is the key finding of a State of Science survey, undertaken at the end of 2006 by the scientists' union Prospect, which reveals a huge level of anxiety about their personal future among both public and private sector scientists. The figure is all the more disturbing when more than three quarters of all respondents – 77 per cent – say they would prefer to stay in science.

A total of 952 members from both public and private sectors responded to the union's survey, using a questionnaire on the Prospect website or printed in its members' magazine. Overall, just 58 per cent of respondents say they expect to stay in science, with a slightly higher level of confidence among the private sector (62 per cent) than the public sector (57 per cent). The reason why 42 per cent are fearful for the future has nothing to do with the nature of the work. An encouraging 70 per cent find their work interesting, and 78 per cent consider they are working at an appropriate skill level.

But a significant group expect to be forced out through redundancy or early retirement, while a desire for better pay and conditions is the most common reason cited for wanting to leave. Others are low morale; lack of confidence in the long-term prospects for their organisation; better career progression; more control over their own work; and more family-friendly employment.

Sue Ferns, head of Prospect research who analysed the survey results, said: "In a climate in which scientific skills are in increasingly short supply, this seepage of talent must be a major concern."

Why are so many planning to drop out of science?

One major cause of career dissatisfaction leaps out from the figures: a dramatic decline in promotion opportunities, reported by more than half of all respondents compared to just 7 per cent who say they have increased. This decline has taken place in the last five years, pointing to accelerating pressures as round after round of cutbacks, relocations, reviews and contracting out take their toll of job opportunities.

Younger respondents were more upbeat in their assessment as were respondents from the private sector: 12 per cent of those under 35 and 11 per cent from the private sector reported an increase in promotion opportunities. But overall, 51 per cent of members say promotions have declined – easily outweighing any other issue of concern.

Next on the list of personal gripes is pay. Thirty-five per cent of respondents say they are dissatisfied with their rate of pay, and that dissatisfaction rises with age. But professional issues are almost as important:

- one in three scientists does not believe they have opportunities to influence the nature of their work
- lack of training is a major demotivator, rated as insufficient by 28 per cent of respondents
- more than one in four say they do not have the opportunity to develop their own ideas
- almost as many are dissatisfied with their opportunities to publish research
- one in four cannot make enough contact with others in the same field of research.

Chasing the money, instead of doing science

Whatever the Government and industry may say about putting more money into research and development, that's not the experience of Prospect members. More than two in three of all respondents – and 63 per cent of those in the private sector – report that their team's work has been affected by funding cuts over the past five years. Fewer than one in five have not been affected by cuts, and the number voicing concern over this issue rises with age, probably reflecting additional managerial responsibilities acquired with seniority.

The consequence of this financial squeeze is that large numbers of scientists have to chase funding for science rather than doing science. A quarter of all scientists now spend one day of each working week trying to secure funding, and one in ten respondents spend a staggering 20-50 per cent of their time seeking funds. Again, these pressures increase with age.

These new patterns of funding come at a price. Seven in ten say that the limited duration of project funding interferes with the quality of science undertaken. This trend is consistent across both public and private sectors. Almost half of those surveyed report that the proportion of core funding for their work has decreased over the past five years, making it less secure. Over the same period, nearly two-thirds of respondents report an increase in the volume of work, in part because "budget constraints have resulted in fewer staff to do the same amount of work as before." This problem is widespread across the private sector (52 per cent) as well as the public sector, though a higher proportion in industry have seen their work volume fall (17 per cent, compared to 8 per cent in the public sector).

Has your team's work been affected by cuts in funding over the last five years? (%)

Yes	68
No	17
Don't know	13

Does the limited duration of project funding interfere with the quality of science? (%)

Yes	68
No	27

1 in 4 is asked to doctor their findings

Exactly one in every four respondents to the Prospect survey has been asked to tailor their research findings or advice – and these pressures are greatest in the private sector.

The same proportion reports that it is difficult to maintain independence from their sponsor, and this has been a consistent finding of Prospect science surveys for the past 15 years. Usually scientists are asked to tailor their findings to suit the customer's preferred outcome, but often they have to do so to obtain further contracts or to discourage publication. Equally disturbing is that half of all respondents say that contracting out or privatisation have impacted negatively on their ability to provide independent advice in the public interest, including 8 per cent who simply don't do it any more.

As one respondent noted: "The continual push towards privatising public sector science is undermining the independence it was set up to achieve. If it is not stopped soon there will not be enough left to save." In the words of another: "Government is making a business out of something that is not naturally so."

Have you ever been asked to tailor your research conclusions or resulting advice to: (%)

	All	Public Sector	Private Sector
Suit the customer's preferred outcome	17	15	20
Obtain further contracts	8	6	14
Discourage publication	3	3	3
Never been asked	75		

The future in jeopardy

Despite all the frustrations, scientists remain dedicated to the work they do and maintain a strong commitment to the public interest.

Two thirds of all respondents would advise their own children to pursue a career in science and technology, though disenchantment increases with age and is higher in the public than the private sector. Respondents give a sense of being caught between their own enjoyment of science and the reality of working in it. One said: "I would advise my children to become well educated about science, but it is honestly difficult to recommend it as a career choice. My experience is that careers that involve working in a laboratory or making calculations are seen as less valuable than management roles. This is reflected in pay and status within the organisation and the absence of any scientists from the senior management team."

The figures show that it would be wrong to paint a uniformly grim picture of UK science today. But its world-class reputation will be lost unless it is valued and nurtured by decision-makers, said Sue Ferns.

"Prospect is not opposed to change and this is not an anti-science Government – far from it. But the voices of those who are best qualified to comment should give us all cause for concern. Prospect is bound to conclude that there is a strategic failure across Government to take on the key responsibility of care for the national science base.

"If the Prime Minister is serious about encouraging more people to take up science, he must also answer why they should do so when jobs are limited, poorly paid and highly competitive.

"Our survey demonstrates that while newer entrants still have a reasonably positive outlook, the reality is that many people can only stay in science if they make personal sacrifices and work very long hours. However much the PM might wish it, this is not the way to build the path to the future."

For more information about the survey or Prospect please contact the communications department on 020 7902 6607 or visit the website at www.prospect.org.uk

Prospect is a trade union representing 102,000 scientific, technical, managerial and specialist staff in public service, related bodies and major companies.

It is the main union for scientists in the public sector, with members ranging from chief scientific adviser to laboratory technician, spanning government departments, agencies and non-departmental public bodies.

HOW CAN SCIENCE HELP TO SAVE THE MARINE ENVIRONMENT?

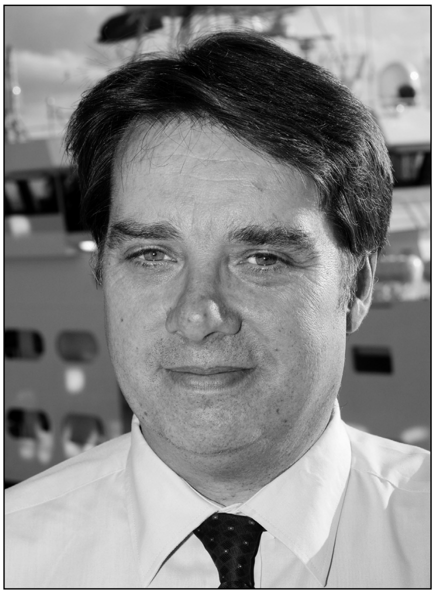
MEETING OF THE PARLIAMENTARY AND SCIENTIFIC COMMITTEE ON MONDAY, 23RD OCTOBER

The effort to protect and preserve marine life is the "second biggest environmental challenge the world faces after climate change" – Ben Bradshaw, Fisheries Minister, on the Today programme. The oceans have been under attack from a massive influx of carbon dioxide and toxic elements derived from burning fossil fuels since the beginning of the industrial revolution.

The Marine Bill currently in preparation will attempt to address and reconcile the multitude of overlapping and conflicting interests of government departments, devolved administrations, public bodies, defence, energy from renewables, oil and gas, environmental, fishing, shipping, ports, aggregates and recreation. The UK is the world-leading centre of marine renewables technology and home to the greatest concentration of wave and tidal stream technology developers with plans for offshore power generation. Scientific advice on effective environmental monitoring and fisheries management is an essential basis for a sustainable marine fisheries policy.

How then can science help to provide a rational basis for preservation in the longer term of the marine environment combined with effective economic management of this strategic resource on which we all ultimately depend?

How can Science Help Protect the Marine Environment?



Professor Edward Hill
Director, National Oceanography Centre, Southampton

The marine environment is the subject of growing public interest. It is now widely recognised that the oceans are integral to the regulation of our planet as the major reservoirs of carbon and heat, and so understanding our oceans is key to better prediction of future climate scenarios. We also expect that the largest impacts on people arising from climate change will be the increased exposure to flood risk from the sea.

There is a progressive international trend towards more integrated policies for maritime activities and the marine environment (eg Australia's Ocean Policy; Canada's Oceans Act 1997; USA's Oceans Act 2000). The European Commission is presently consulting on a broad-ranging Maritime Policy Green Paper. The Marine Thematic Strategy Directive (intended as the environmental pillar of the proposed Maritime Policy) is presently being negotiated. In the UK, the proposed "Marine Bill" is part of the Government's proposed response to this wider call for a more integrated approach to marine regulation which has for some time been perceived as complex and confusing.

The underlying vision is that of achieving sustainable development, namely striving for a balance between social, economic and environmental considerations whilst ensuring that we live within environmental limits. A move towards an "ecosystem-based" approach to management of human activities in the marine environment is a common thread through all proposals.

The result should lead to much more sophisticated approaches to management of the marine environment. Any regulation must be based on robust science if it is to be proportionate to the risks posed; consistently applied; transparent and defendable in its underlying basis, and is targeted on the real issues. A robust scientific underpinning gives the best prospect of challenging vested interests, winning public confidence for unpopular measures that may be required and enabling those whose role is to enforce measures to demonstrate their accountability.

The fundamental context for management of the marine environment is global change, including climate change. Our planet is out of range compared to its natural "self regulating state" before human influence. In the 21st century marine science is fundamentally concerned with decadal scale variability (and the science integral to observing on these scales) and its interaction with shorter and longer time scale phenomena in the marine environment. We increasingly view the marine environment as part of the larger earth system. There is consequently strong interest in the interfaces between the ocean and other parts of the earth system (land-ocean, atmosphere-ocean and ice-ocean interactions).

Within this context the key roles for science are three fold:

gain deeper understanding of fundamental earth system processes (so we know what is going on);

develop better prediction and scenario testing systems (models) and sustained and properly specified global and regionally observing systems – so we are more continually aware of changes in the earth system – and can predict what might happen next;

inform and guide public policy, regulation and management and help find the innovative solutions and opportunities to live and do business in a changing world.

Sustained observation is central to the science of decadal variability – if the object of 20th century (environmental) science was to understand better the processes at work on our planet, then the goal of 21st century science is to enable us *to be more continually aware* of those processes. This is because living on a planet that is well outside its normal range of behaviour than has prevailed for all human existence, and probably much longer, calls for us to be much more in tune with changes taking place so we can rapidly assess their significance and adapt and respond accordingly.

The key roles for marine science in helping formulate practical policy and regulations such as those under consideration in the UK and Europe include:

identifying and filling key knowledge gaps;

investigating the non-linearities (possible "tipping points") in the marine system;

contributing to developing a definition of "good environmental status" that is more than just a "value judgement by society" and one that can be turned into a sound basis for effective monitoring and assessment and recognises the inherent variability in natural systems;

designing, optimising and reviewing the effectiveness of monitoring programmes;

developing novel technologies for reliable measurements in the parts of the marine system that matter;

providing the techniques to include the fourth dimension (time) into marine spatial planning systems;

developing next-generation modelling and simulation tools for marine spatial planning and ecosystem based management;

putting the marine system in its wider earth system context with better knowledge of the key earth system interfaces;

horizon scanning, evaluating and rapidly communicating to policy-makers new knowledge (eg ocean acidification was not fully appreciated until a couple of years ago);

In order to be effective the role that science can play in the policy making process must be acknowledged and well structured routes and linkages established to ensure that timely, broadly based independent science input feeds into the policy process (IPCC for the seas).

It is noted that in developing new legislation and regulation, the UK seeks to apply the following tests. Is the measure (a) proportionate – relative to risk; (b) accountable – can decisions can be justified objectively; (c) consistent – joined-up and fair, (d) transparent – open and user friendly (e) targeted – focused on the real problems. Robust science, well communicated, can provide the evidence and information base necessary to support the above objectives by underpinning sensible, defensible risk-based approaches.

In the UK, Europe and globally the marine science community is becoming progressively more "self organised" as it strives to rise to the major challenges ahead through more coordinated approaches and address the science challenges that cannot be undertaken by a single institution or nation on its own. For example, in the UK, seven major marine science institutions have joined forces to develop "Oceans 2025" a 5-year programme of strategic research to run from 2007-2012, funded by the Natural Environment Research Council (www.oceans2025.org). Oceans 2025 will address the key science challenges outlined above, embracing knowledge transfer to the wider stakeholder community, and provide the basic underpinning to ensure that the best UK science is available to protect our marine environment.

The big science challenges:

Climate variability and long-term change (now the context for all long term management)
The role of the oceans in fundamental earth system (the earth's life support systems)
Marine biodiversity and ecosystem function (the diversity of life)
The deep oceans and continental margins (where life on earth originated, but the last frontier to be explored)
Coastal and shallow continental shelf seas (our backyard)
Natural hazards (all disasters are global in a global economy)
Environment and human health (health of people and the environment are intertwined)
Pollution and waste (a problem solved or a legacy waiting to bite?)
Sustainable use of natural resources (energy, bioresources, water)
Technology (giving us the capacity to measure new things in new ways)
Ocean predicting and forecasting (science is ultimately valued by its ability to make reliable predictions – that we can act on)
Sustained observing (continually taking the pulse of the oceans)

Ocean Acidification – the Other Half of the CO_2 Problem

Dr Carol Turley
Plymouth Marine Laboratory

Marine ecosystems make up approximately two thirds of the Earth's surface, carry out about 50% of global primary production and support a great biodiversity. Oceans also play an important role in transfer of heat around the planet and in determining weather systems and climate at sea and on land. Oceans are also key in the cycling and storage of the Earth's elements. For example, the oceans are the largest reservoir of carbon (other than that in rocks) on the planet, around 19 and 54 times greater than that in the terrestrial biosphere or in the atmosphere, respectively. Marine ecosystems also provide livelihoods for millions of people through fisheries, aquaculture, transport, tourism and recreation. In essence, marine ecosystems play a large role in providing the Earth's life support system.

Marine ecosystems are already being affected by climate change through ocean warming. For example, long term records from Plymouth, of microscopic animals called plankton which are the food of many fish show substantial geographical shifts in their distribution in European Shelf water in response to the ~1.5ºC rise in seawater temperature.

That same manmade CO_2 that we observe to be the major greenhouse gas causing climate change is also altering the chemical balance of the oceans. This – "the other half of the CO_2 problem" – has received little attention until quite recently, but it may turn out to be as serious as the more familiar one.

The surface waters of the oceans have already taken up over 500 thousand million tonnes of CO_2 (500 Gt CO_2), about half of all that generated by human activities since 1800. By absorbing all this additional CO_2 the oceans have buffered the effects of atmospheric climate change. But there is a cost. CO_2 reacts with seawater to form a weak acid (carbonic acid) and results in a greater seawater acidity (expressed as a reduction in pH). Surface ocean pH has already declined by about 0.1 since pre-industrial times which may not sound much but as pH is measured on a logarithmic scale and measures the amount of hydrogen ions (H^+) in the water it means that the amount of H^+ has increased by 30%. If this trend continues and we burn all available fossil-fuel reserves, ocean pH will fall further (and acidity increase) by as much as 0.4 units from its current level of around pH 8.1 by the year 2100 and 0.67 by 2300. It will take tens of thousands of years for ocean chemistry to return to that of pre-industrial times because it will take this long for the surface oceans to mix with deep waters and react with the calcium carbonate sediments and through their dissolution raise pH again.

Such a reduction in pH is far greater than the annual variation that organisms currently experience and has not occurred for at least 420,000 years and probably for the past tens of millions of years. Marine organisms have therefore had a constant pH environment to evolve in. About 55 million years ago ocean pH did decline to levels we can expect to see at 2300 and this resulted in the extinction of many marine bottom dwelling calcifying (shell producing) organisms even though it took thousands of years for the pH to fall. The current decline in ocean pH will happen far more rapidly, over decades to a couple of centuries. It is not then surprising that scientists are concerned with not only the level of decline in ocean pH but also the speed at which it will happen.

Increase in seawater CO_2 results in a decrease in the amount of carbonate ions which are used by calcifying organisms to make calcium carbonate shells, skeletons and liths (small platelets). Currently most surface waters of the world's oceans are saturated with carbonate ions. However, the lower the concentration of carbonate ions, the harder it will be for calcifying organisms to make their shells or skeletons. In waters undersaturated in carbonate ions the shells of organisms will dissolve. Recent studies predicting future carbonate ion concentration using the IPCC "business as usual" scenario of fossil fuel burning show that the carbonate ion in aragonite, used by corals to make their hard skeletal reefs, will be so low in tropical waters with a doubling of CO_2 that coral calcification will be reduced by 20-60% so the framework of the reefs may be weakened and more erodible. Warm water corals also suffer from another climate change impact, coral bleaching, through rising sea surface temperature caused by global warming. Our current understanding would suggest that corals could become rare on tropical and sub tropical reefs by around 2050 because of raised sea temperature and declining aragonite concentrations. Coral reef ecosystems harbour a huge number of species and are the most diverse of marine habitats. They are also important socio-economically through tourism, fishing and their role in protection of shores from waves.

In polar and sub-polar waters the aragonite concentration is predicted to become marginal or undersaturated (so low that it will become corrosive to shells and they will dissolve) by 2100. All of the Southern Ocean, the ocean around the Antarctic, and large parts of the Arctic will suffer from aragonite undersaturation. Organisms that use aragonite to make their shells such as pteropods (the sea butterfly) and shellfish, which form an important part of the food web, in some areas as important as krill, will not be able to live there. Whales and salmon are amongst the animals that eat pteropods while mammals such as walruses feed on shellfish.

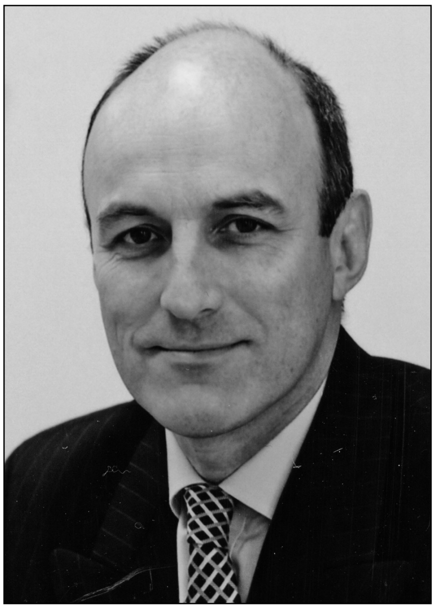
The importance of cold water corals as a habitat and their substantial geographic distribution is only just emerging as is concern over their vulnerability to the rising of the aragonite saturation horizon. Below this horizon aragonite is undersaturated, above it aragonite is saturated. This horizon is currently 100's to 1000's of meters deep but as the surface oceans take up more and more CO_2 it will move upwards towards the sea surface. In high latitudes, it may even surface this century so that those waters will be undersaturated and corrosive to organisms such as the deep cold water corals.

Microscopic plants called coccolithophores produce blooms that are so extensive they can be seen from space. They are currently thought to be the largest producers of calcite on the planet. When they die their calcium carbonate platelets, which are known as liths rain down to the ocean floor where over geological time they are buried and can form vast structures such as the white cliffs of Dover. The liths also act as "ballast" making the aggregates sink faster to the deep sea bed and thus transferring carbon before it has time to be recycled and respired to CO_2 in the surface of the ocean. This "biological pump" helps to control the exchange of carbon between the oceans, atmosphere and sediment. Without it, there could be large changes in the Earth's carbon cycle. Scientists have shown that one important coccolithophore species' ability to form calcite (calcium carbonate) liths is impaired when grown at CO_2 concentrations expected by the end of the century so much so that the calcification is reduced and liths deformed. The impact of this on the extent of the biological pump is of concern.

The study of the impact of altered ocean chemistry on these organisms is still in its infancy and scientists are currently using seawater and seabed mesocosms (large volume natural enclosures) dosed with future CO_2 concentrations as well as complex ecosystem models to predict future impacts. At Plymouth Marine Laboratory mesocosms are being used to look at the impact of a high CO_2 ocean on animals that live on the seabed and within the sediments and their biodiversity and biogeochemistry. Some of these animals (eg starfish, sea urchins and shellfish), which burrow and plough through the sediments, play a key role in maintaining the biodiversity and important chemical feedback processes to the overlying seawater that help sustain primary production.

Ocean acidification is now a mainstream scientific concern for the majority of international marine research organisations. As the research of impacts of ocean acidification is just emerging or still in the planning stage there will undoubtedly be impacts and adaptations that have not been addressed here. Understanding these and predicting what future marine ecosystems will look like and determining the feedbacks to the functioning of the Earth's life support system will undoubtedly be one of the biggest challenges for marine scientists in future decades.

Surface ocean acidification is happening now and will continue as humans put more CO_2 into the atmosphere. It is happening at the same time as the world is warming. Organisms and ecosystems are going to have to deal with a number of major rapid global changes at once – unless we urgently introduce effective ways to reduce CO_2 emissions. These changes are happening on human time scales so that our children and grandchildren will experience them. Avoiding even more serious ocean acidification is a powerful additional argument to that of future dangerous climate change for the urgent reduction of global CO_2 emissions. It is for this reason that Plymouth Marine Laboratory has also worked to bring this issue to the attention of stakeholders and policy makers at the national and international level (eg English Nature, Environment Agency, Royal Society, Defra, Dti, NERC Intergovernmental Panel on Climate Change, OSPAR, The London Convention, UNFCCC, UNEP, EU, IGBP, SCOR, IWC, GECC).



Sustaining our Marine Inheritance

Mark Farrar
Chief Executive, Centre for Environment, Fisheries and Aquaculture Science (Cefas)

Living on an island should provide ample reason for all of us to pay close attention to the surrounding marine environment. The marine inheritance we pass on to future generations will partly depend on how we provide for clean, safe and healthy seas whist ensuring effective economic management of a strategic resource that dominates many aspects of our lives.

Marine science has a particularly important role to play in providing an underpinning evidence base to aid understanding of an environment that is constantly changing, where access is both difficult and costly and our current knowledge is far from complete.

However, if science is to provide solutions and help influence our actions, it cannot act alone. To succeed it must align with the policy needs of Government and work alongside the many individual and commercial stakeholders with an interest in marine resources.

The scale of the task is immense, requiring an understanding of long-term trends and changes in global terms at one end of the spectrum, through to a need for detailed monitoring, assessment and advice on more localised issues at the other.

The challenge is to harness the wide range of skills and knowledge across the UK Marine Science base, to provide such assessment and advice. For example, at Cefas we have developed our strategy recognising Government priorities for future science and technologies and partnering with other research organisations to provide integrated science across Europe. Our science covers analysis of the wider ecosystem interactions, understanding of organism health and input to how resource managers utilise both the biological and non-biological resources available to them.

The following examples provide an insight into how Cefas and other UK marine scientists can provide a pivotal role in advising Government and others on the best course of action in particular circumstances.

Firstly, at a global level, it can be shown that fish provide more than 50% of the essential protein and mineral intake for c400 million people around the world. Initial research carried out for DfID suggests that some countries, particularly those in Africa, will face difficulties in adapting to the impacts of climate change on their fisheries. Further work is now needed to examine on a finer scale how policy levers and working practices might best be adjusted to support local communities.

Closer to home, managing the high profile nature of the European fishing industry requires a thorough understanding of an extremely complex food web and associated distribution changes in the whereabouts of fish. Data from research cruises and other industry sources is utilised to support complex models and simulations and so predict the impact of future management actions.

This is not without its challenges. The complexity of the food web needs to take account not just of man's interaction, but the fact that fish eat other fish. And of course there is also the interaction with the bird population. Acoustic surveys, hard sampling and modelling all help to supplement reported catch information and aid interpretation and prediction.

Through a Defra-funded programme the fishing industry is now engaged in ongoing surveys, gear and catch studies. Harmonising the power and buy-in of industry knowledge alongside scientific skills has proved a powerful, positive benefit.

Recent work in the Irish Sea has examined spawning and settlement locations underpinning Plaice distribution. This is a response to the need to understand which pathways Plaice followed and which behavioural processes were important to the settlement distribution. Once it was understood how the larvae moved vertically in the water column, this understanding combined with tidal, wind and other environmental information enabled fine-scale models to be developed. Without an ability to interpret information at this level it would not be possible accurately to predict movement and, in turn, link this to control of man's interaction in fisheries.

Studies to reduce the environmental impacts of trawling perhaps provide a particularly tangible example of how science can make a positive difference. Working with the fishing industry, one programme of work examined beam trawling with a view to ensuring nets released non-target, bottom-dwelling invertebrates rapidly, unharmed and close to the point of capture. The practical solutions used to amend traditional net mesh panels produced a 75% release rate with over 90% survival.

Equally important is the need to understand and influence man's interaction with the wider marine environment as offshore energy and other sectors are further developed.

This encompasses aggregate extraction sites, disposal grounds, windfarms, oil and gas platforms, wells, pipelines and cables for example. Scientists are not only involved in the initial environmental impact assessments but also have a continuing role in ongoing monitoring to ensure that lessons learnt are incorporated in the planning and licensing of future developments.

Of course, operating in a difficult environment provides challenges of its own in data collection. Here science and industry can assist by developing new methods for better (and cheaper) data capture. A network of "Smartbuoys" around the UK coastline now collects increasing amounts of information on key indicators, enabling models to be refined still further and support policy needs and decision-making.

Studies using small electronic data storage tags on Rays have dramatically changed our understanding of their movement during the year, in turn suggesting different actions were required to ensure this safe management. Historic measures aimed at sustaining this pressured species went so far, but science has now shown that more effective measures are possible.

Looking to the future, there is a need to ensure marine science adapts to changes in the environment and mankind's evolving behaviours. The UK's Marine Monitoring Assessment Strategy must ensure that sufficient comparable data are available to underpin our knowledge of climate change and a wide swathe of ecology. New compounds we do not even know about may be influencing the marine environment and the impact of nanotechnology needs to be better understood. As information becomes more complete in one area, attention needs to turn to others where activity may have been traditionally less comprehensive.

All of this underpins the need both to maintain and develop the UK's marine science skill base. There is a need to ensure strong linkages to coherent policy architecture, and orchestrate our science resource appropriately. The recent European green paper on Marine Policy will draw our European partners into the debate and the UK's own Marine Bill is seeking to provide a common spatial planning and licensing framework for the marine environment. The UK's marine science base will need to ensure it is positioned appropriately.

For all of us, whether scientist or not, perhaps the importance of the marine environment is best underlined by the opening quotation, attributed to Arthur C Clarke, in the European Commission's recent green paper. "How inappropriate to call this planet Earth when it is quite clearly Ocean".

In discussion the following points were made:

The present organisational structure underpinning marine science in the UK came in for strong criticism as being a rather unusual and poorly defined mixture comprising a Research Council, University based Institutes and a Government Agency. It is therefore not easy for anyone to identify areas of responsibility and the roles of the various components of the structure and the nature of formal linkages to other topics such as the atmospheric science community, for example. Indeed the National Oceanic and Atmospheric Administration (NOAA), a highly regarded Government Agency in the USA, was hailed as an exemplary model for the UK to follow compared with the UK muddle in the organisation of marine science. It was also pointed out however that the NOAA also lacked satisfactory linkages to other Government Agencies and Universities. Marine science is highly technology dependent and therefore depends on close relationships being developed between Government funded organisations and SMEs who develop and manufacture the innovative technology required for marine research. However there has been a notable decline in the introduction of innovative technology, which suggests that collaboration between Regional Development Agencies (RDAs) and SMEs is not all that it should be in order to ensure that academia, Research Councils and SMEs and Defra will have access in future to the technology required to undertake state of the art science in the marine environment. These will be important issues for the Marine Bill to consider.

SATELLITES FOR SCIENCE, ENGINEERING, TECHNOLOGY AND BUSINESS

PARLIAMENTARY AND SCIENTIFIC COMMITTEE BREAKFAST BRIEFING ON WEDNESDAY 8TH NOVEMBER

Hardly a day goes by without reports on new discoveries being made from space by unmanned satellites. While manned spaceflight consumes the greatest proportion of funds allocated internationally to space research, unmanned satellites continue to deliver the goods on time and to budget and at minimal risk to the people involved. Indeed satellite technology is evolving so rapidly that manned spaceflight is now mainly reserved for work requiring human intervention. This is an innovative technology where the UK is a world leader in the science, technology and manufacture of satellites and in creating successful business applications with the help of London's comprehensive financial expertise in this field.

Satellite technology underpins television, weather forecasting, telephone, internet and navigation, with applications in agriculture, fisheries, urban planning, geological exploration, risk management, humanitarian aid and disaster relief. Satellite-based positioning and timing is used by transport, aviation, banking, emergency services and for military applications. Satellites support the information society by generating and transferring data at regional and global scales and thereby contributing to e-learning, telemedicine, and monitoring global climate change. It is a fertile technology stimulator with spin-offs leading to innovative and commercial applications in manufacturing and the service sector. Unmanned satellites are increasingly being used to promote science and economic and social well-being on a global scale.

Professor John Zarnecki
Particle Physics and Astronomy Research Council (PPARC)

The Particle Physics & Astronomy Research Council (PPARC) is responsible for delivering fundamental scientific research – some of this is delivered through the medium of activities in space, either in order to escape the deleterious effect of the Earth's atmosphere or to give the opportunity to visit our own cosmic neighbourhood. PPARC is one of the partners within the British National Space Centre (BNSC) which provides the "glue" that binds together the various space "players" Other participants include industry, from SMEs up to large multinationals who build the spacecraft, after competitive selection, and who sometimes work with scientists to design and build the innovative instruments that are needed to make the scientific measurements. Much, though not all, of the UK's space science is done through the European Space Agency, who have overall responsibility for the complex task of putting together a space project.

There are 10 University research groups who actively design and build space hardware and some 30 who teach some aspects of space science and technology.

Apart from the basic science, there are three other principal outcomes of PPARC Space Science research. First there is the driving effect on innovation – very often, the demands of scientific space missions push the technology to the limits of what is achievable. Secondly, in delivering its programme of scientific research, a raft of trained people, scientific and technical, are produced, the majority of whom end up working beyond the PPARC domain in both the public and private sector. The City, large industry and small IT companies have traditionally all been beneficiaries of trained PPARC students.

Thirdly is inspiration and outreach. Some of these space missions are truly inspirational. Who can forget the Beagle 2 Mars lander – although ultimately unsuccessful, it caught the imagination of the nation during Christmas in 2004. Or the landing of the Huygens Space Probe on the surface of Titan, Saturn's largest moon, in January 2005? Events such as these can be quite inspirational and are instrumental in the business of attracting the next generation of scientists and engineers.

Space science missions can be divided into 4 broad categories:

(i) Earth orbiting space telescopes (such as the Hubble Space Telescope or the XMM-Newton X-ray observatory) which need to be lofted above the degrading effects of the atmosphere;

(ii) missions which visit their targets within the Solar System such as Mars or a comet;

(iii) Sun-Earth missions which study our "star", the Sun, and the environment between the Sun and Earth which has such an impact on our local terrestrial environment;

(iv) Fundamental Physics measurements in space for purposes such as the detection of gravity waves or to confirm the principles of Einstein's General relativity.

UK scientists and engineers have been involved in a veritable Who's

Who of successful space missions. In the past, ESA's Giotto spacecraft flew past Halley 's Comet in 1986 while more recently, the NASA Swift spacecraft has been studying gamma ray bursts, the most violent explosions that we have detected. The UK is involved in spacecraft currently orbiting Venus and Mars and is also working on the James Webb Space Telescope, the replacement for the Hubble Space telescope. Scientific results from recent and present space science missions ensure that the UK is well represented in terms of papers in the front line scientific literature. There are also very tangible benefits from our involvement in space science and technology. The spin off or knowledge transfer from these very demanding space programmes is increasingly being recognised as having significant economic benefits. Companies such as E2V, CODASciSys and Logica, to name only a few, all benefit from the extremely demanding requirements placed on them by these space programmes and increasingly are able to transfer the knowledge developed into other applications.

Space science and the associated technology have often been regarded as "the jewel in the crown" in the UK's space programme. And certainly the outputs place the UK close to the international forefront in many areas. But the picture is not universally rosy. The UK's investment is falling behind our European competitors. Judged by the percentage of GNP invested in civilian space activities, the UK is well down the table, committing as little as one third (in relative terms) of what our main competitors do. And furthermore the national space programme (as opposed to our contribution to ESA) is woefully under-funded. This situation shouldn't be allowed to continue if the UK's standing is to be maintained.

Colin Paynter
Managing Director, EADS Astrium Ltd

"I didn't know Britain *had* a space policy" – a common enough response when the subject is ever raised in Parliament. After all, Britain doesn't have a manned space programme, it doesn't support the International Space Station, and it doesn't build rockets. So what then *is* UK space policy and why does it matter so much that it merits a full inquiry by the Science and Technology Select Committee?

Firstly, because UK space policy does matter. The global reach, reliability and accuracy of satellites can help improve both the evidence base behind decision making and its implementation.

Secondly, the timing of the inquiry could not have been more crucial. In fact, Britain does have a space strategy, a strategy that is currently being rewritten, in only its third strategic review. Space investment is also under scrutiny through the Comprehensive Spending Review.

Today, satellites provide our Armed Forces with a secure global communications system. Elsewhere in Whitehall, satellite navigation, or satnav, could become the basis of a fairer national road use taxation scheme, which taxes use not ownership, helping to reduce emissions and improve the efficiency of our roads. Satnav is also being trialled by the Metropolitan police to help deploy their forces more effectively. And the Home Office is trialling the tracking of offenders by satellite. Aid agencies already rely on satellites both for emergency mobile communications in the field and for the imagery that helps them locate and monitor disasters.

Satellites keep an eye on our planet 24:7. They monitor land use, coastal erosion, fishing stocks and other scarce resources; they help predict and monitor natural disasters, and they monitor the impacts of climate change, such as rising sea-surface temperatures and melting ice caps.

More immediately, we all benefit from satellite based weather forecasting. The Met Office's forecasting has improved by 25% in the last ten years, much of this thanks to advances in satellite meteorology. Oxford Economics estimates the economic value of satellite-based weather data at between £400m and £1 billion a year.

And satellites are themselves *green*. Satellites can help deliver Stern's vision of a low-carbon economy. Satellites run on sunshine – ground-based infrastructure doesn't. Take the digital switchover as an example. Britain's 1,100 UHF transmitters emit 250,000 tons of CO_2 every year. Just one of today's advanced satellites can carry 150 HDTV channels.

Some of the striking benefits are economic. Satellite technologies and applications are a major catalyst in high growth sectors such as the media and communications. Mobiles are expected to be routinely fitted with satellite navigation chips by 2020. So when you ask Directory Inquiries for Thai restaurants in your area, it can direct you to the nearest one. How much is that worth to advertisers?

As a result, the sector scores well against the Chancellor's hot buttons. Its value added is four times the national average. It employs the most highly skilled workforce in manufacturing – with two thirds of its workers holding a degree or equivalent. Space is six times more R&D intensive than the economic average. And the sector is growing consistently four times faster than the rest of the economy. Moreover, Britain enjoys a 7.3% stake in a global industry forecast to be worth $1 trillion by 2020. Space also inspires Britain's next generation of scientists and engineers. 38% of respondents to an IMechE poll of its engineer members said space influenced their education choice. How much is each extra engineer worth to our economy?

So is UK space policy working? Britain's Space Strategy is supposedly "user driven" – the end users across Government decide what to put in and where. In the centre, it is left to around 35 civil servants to do the co-ordinating. The French space agency, CNES, employs around 1,500. Does Britain's approach work? In December 2005, Defra led the UK decision to put in a minimal amount into Europe's flagship environmental monitoring programme GMES.

How can the UK maximise the commercial opportunities? Space is a fast-moving industry – today's media satellites are 24 times as powerful as those built only ten years ago. This pace of change is driven by technology. And yet last December, the DTI cut its space technology fund from £20million to £8million, and it will disappear altogether in two years. Yet DTI figures point to a return of 7:1. How will this level of investment impact the future competitiveness of UK Space?

Space is undoubtedly one of Britain's great opportunities, both economically and politically. Across the world, satellite technology is cherished as a strategic national asset. Yet Britain, the world's fourth biggest economy with one of the world's leading space sectors, ranks 16th in the world in GDP terms when it comes to investing in space – behind Belgium, amongst others. I believe that Space technology and applications will help to shape the world we live in. UK technology and UK policy provide Britain with an opportunity to play a lead role. Now is the time to decide.

Sir Martin Sweeting
Surrey Satellite Technology Ltd (SSTL)

We have come to take space for granted – so much so that we do not realise how deeply embedded it has become in our everyday lives.

Of course, if we stop to think for a moment, most people would recognise that space provides us with satellite TV, weather pictures, stunning images of far galaxies from Hubble, the excitement of landing on Titan or rovers on Mars – but all too few outside the space community realise that their personal in-car navigation system is using transmissions received directly from 4-5 US military satellites orbiting some 20,000 km above us.

The world is increasingly dependent on satellites – and space technology is delivering major benefits to UK citizens: indeed, as a nation, we have become fundamentally reliant on space to underpin our lifestyle and security.

Space addresses UK Government priorities, such as:

Creating prosperity in a competitive globalised economy;

Responding to and driving rapid technological change;

Climate change & environmental constraints – it was space that alerted us to climate change, ozone depletion and desertification;

Sustainable development and inclusion – satellites bridge the digital divide;

New complex security threats including terrorism – transparency from space underpins risk assessments and international security; distant operations need maps, navigation and mobile communication from space; BBC World Service Arabic satellite TV for trusted, independent news and cultural understanding;

Fostering scientific excellence that creates wealth and guides policies – space attracts youngsters to science, maths and engineering; space is at the heart of international science co-operation;

Rising to public expectations of world-class public services – transport planning and management

Furthermore, active participation in space creates political opportunities that allow the UK to achieve a more balanced relationship with the USA, to increases its influence in Europe, and to shape standards worldwide (critical for the success of our industry).

Fortunately, the UK possesses a vibrant and capable space industry – both manufacturing large and small satellites and exploiting their use once in orbit – contributing billions into the UK economy and creating a world-class technical workforce. Recognising the need to concentrate on specialist areas appropriate to our national skills and resources, the UK space industry focuses on:

applications and services;

satellite payloads;

innovative small satellites;

cost reduction and capacity building;

innovative financing strategies (HYLAS, Paradigm) and international co-operation (DMC).

The Government has a key role to play alongside industry and commerce in space. Global space markets are growing and the UK can increase its market share and create wealth, but this needs significant investment by industry and the capital markets *and* complementary seed-corn investment by Government where the risks are too high for industry to bear alone. The Government needs to be an investor *with* industry in major wealth creation opportunities – and there are many examples demonstrating the high financial returns achieved from such investments.

Government and industry decisions to date have been largely sound in principle – investment through ESA produces significant leverage to both science and enterprise and positions UK academia and commerce to take advantage of international opportunities. However this is only half the picture; a complementary *national* space focus is also needed, both to position UK organisations to bid successfully for worthwhile activities through ESA and then subsequently to exploit them. Other member countries in ESA recognise the value of this and recently have increased their support for national programmes accordingly.

There are therefore four urgent issues that need to be addressed by Government:

Renewed public investment in space technology – the UK should invest sensibly in Galileo, GMES and Aurora; and create a national satellite programme supporting research, technology development and pre-service demonstrations;

Security & defence – to develop key military space skills with UK-controlled operational smallsats providing independent optical and radar surveillance;

Improved co-ordination across Government – co-ordinating policy, strategy and action on space across departments, so that the UK can maximise its benefit and financial return;

Review regulation – to stimulate free and competitive markets for space-derived services.

Unfortunately, however, space does not command much attention or priority at the top levels of UK Government and this represents a real risk to the nation. So, in conclusion and to put all of the above into context, just contemplate some of what would happen if, hypothetically, we "switched off space":

Disruption to telecommunications to remote locations around the world; to ships or aircraft in flight; no live news feeds from many parts of the world; no ability to support disaster relief operations; no satellite TV and consequential loss of revenues to the UK;

Loss of accurate weather forecasts – with a £1.5bn/year impact to the economy of the UK alone. We would be blind to the progress of global warming;

Loss of SatNav – most vehicle fleets could not operate efficiently; our military campaigns would falter – or increase collateral damage and civilian losses

In discussion the following points were made:

Recently social research has informed us that children benefit from contact with their parents and that attraction is initially based on physical appearance before other factors come in to play. How can we as a nation justify spending money on this type of junk science to provide insights into the obvious and at the same time under-resource planetary science and engineering?

Can space technology assist us to continue working from home in the event that a pandemic should strike and disrupt normal working practices? The UK response model will differ significantly from emerging economies due to the prior investment in copper wire and glass fibre communications to individual domestic residences that already provides an effective communications network. In emerging economies lacking this infrastructure the situation is much more likely to be dependent on satellite communication.

Industrialisation of the launching platform technology has significantly reduced the cost of unmanned spacecraft compared with the additional costs attributable to manned spaceflight for which more expensive safety standards are obligatory. Solar electric propulsion has been used following a satellite launch.

It was pointed out that the 66 satellites in the Iridium LEO constellation are due for renewal in 2013. Given that the constellation provides truly global coverage, all of the time, it was considered a generally good idea to take this opportunity to piggy-back scientific packages on commercial space craft.

There is a long history of national underfunding of UK space initiatives, in spite of the great opportunities recognised by scientists, engineers and latterly economists. Is this mentality still prevalent and what needs to be done about it? Is it possible that the undoubted successes of the UK space research community with minimal financial resources from Government sources has had the perverse effect of persuading Government to reduce its financial commitment? Should we not be emphasising difficulties requiring further investment rather than successes which generate income? The relative advantages of the Galileo (EU) over the GPS (US) were discussed in relation to the high precision location system available on the former that is not under the control of any single government. All Parliamentarians should visit French Guiana to see the investment made by the French Government in satellite launching technology, and Toulouse that has been transformed by the aerospace industry. Government investment in space should be a high priority.

ARE PATIENTS SAFE WITH THE NHS?

MEETING OF THE PARLIAMENTARY AND SCIENTIFIC COMMITTEE ON MONDAY 20TH NOVEMBER

In a recent report into safety aspects of the National Health Service the House of Commons Public Accounts Committee commented, "Every day over one million people are treated successfully by the NHS. Although patient care is generally of a high standard, the scale and complexity of patient interventions means that patients can sometimes suffer unintended harm and official estimates show that one in ten patients admitted to NHS hospitals is unintentionally harmed. There were 940,000 reports of incidents and near misses last year, which include blunders ranging from medication errors and drug interactions to missing emergency equipment and the wrong limbs being amputated. Even more patients are at risk since this does not include 300,000 reports of hospital-acquired infections each year including MRSA. Around 50 per cent of all actual incidents might have been avoided if NHS staff had learned lessons from previous ones. There are big differences between similarly-sized trusts in the number of incidents reported. Massive under-reporting of deaths and serious incidents means the NHS has no idea how many people are dying each year from patient safety incidents."

Nevertheless these startling statistics are not significantly different from those reported in several other developed countries. So how can the further application of science, technology and engineering help to improve a situation arising predominantly as the result of human failure?

Are Patients Safe with the NHS?

Bill Murray OBE
Acting Chief Executive, National Patient Safety Agency

A healthcare system involves often very complex technology, consultations with different individuals at different locations and the end result may mean a variety of medication to be taken at specific times or intervals. These multiple interactions have to combine seamlessly to result in an improvement of the patient's condition. Given this complexity, preventing error and harm within these systems is an increasingly important challenge for many modern health services across the world.

Patient safety is an international concern and broadly similar levels of patient safety incidents have been found across healthcare systems in developed countries. The most detailed information on the frequency of incidents in the developed world comes from a number of studies which used a review of patients' notes to identify events that caused harm.[1-10] It should be noted however that these studies have used broad definitions of adverse events.[11]

In recognition of the scale of adverse events or error within healthcare systems, the World Health Organisation has launched the World Health Alliance for Patient Safety, led by our Chief Medical Officer Professor Sir Liam Donaldson, to tackle and prevent unintended harm to patients.

As part of the drive to improve the quality of care in the NHS, the National Patient Safety Agency (NPSA) was established in July 2001 to help the NHS learn from its mistakes so that it can improve patient safety. The blueprint for the NPSA was described in the Government report *Building a safer NHS for patients – Implementing an organisation with a memory*.[12] The report highlighted that the Agency's first step towards improving the safety of patients and understanding medical error was to help the NHS learn from what goes wrong. The NPSA was charged with creating a central repository for information about patient safety incidents and finding a way to interrogate the data to identify trends and hotspots. This intelligence would inform a programme of work.

The NPSA developed the National Reporting and Learning System or NRLS, the first national reporting system for patient safety incidents in the world. The system covers England and Wales and integrates into existing NHS local reporting systems. This has minimised disruption to NHS staff; they only report to their local system with the data uploaded to the NPSA regularly. The NRLS collects information spanning the breadth of the NHS; Figure 1.0 breaks down the source of incident reports as at September 2006.

Those NHS organisations that do not have a local risk management system can report directly to the NPSA through an electronic reporting form (eForm) on the internet.

Number of incidents to end of September 2006		
Acute/general hospital	72%	701,874
Ambulance service	0%	3,579
Community and general dental service	0%	283
Community nursing, medical and therapy service (incl community hospital)	10%	96,442
Community optometry/optical service	0%	12
Community pharmacy	0%	2,809
General practice	0%	4,105
Learning disabilities service	3%	29,801
Mental health service	14%	135,751

Figure 1.0 Breakdown of care settings reporting to NRLS (November 2003 to September 2006)

The primary purpose of an incident reporting system is to help make healthcare safer for patients. Incident reporting typically involves staff actively recording information on events that lead to unintended harm or potential harm to patients. Most incidents involve a complex interplay of individual, team, technical and organisational factors. Although each incident is unique, there are likely to be similarities and patterns which may otherwise go unnoticed if incidents are not reported and analysed.

Systems to collect data on errors in other industries, such as the aviation and petrochemicals industry, have found that a commitment to confidentiality increases reporting levels. The NPSA chose to take this approach and does not request information about the names of staff or patients involved in reported incidents.

How is this information used to improve patient safety?

Incidents reported by staff to the NRLS provide a national picture of patient safety in England and Wales. They help the NPSA identify new patient safety concerns and recognise those that are causing the greatest harm to patients. All NHS trusts have reported incidents to the NRLS and reporting to the system is increasing.

The NRLS currently contains over one million incident reports – it is important to note that high incident reporting rates do not equate to unsafe care: organisations with a strong reporting culture and effective local mechanisms for investigating incidents would be expected to report more. The majority of reports in the NRLS relate to patients suffering no harm – a breakdown is given in Figure 2.0.

No harm	665,673	68.2%
Low	244,420	25.1%
Moderate	52,821	5.4%
Severe	9,091	0.9%
Death	3,837	0.4%

Figure 2.0 Breakdown by degree of harm of NRLS reports (November 2003 to September 2006)

Themes and trends are analysed and solutions to broad and general themes developed. The NPSA has issued 16 safety solutions in the form of alerts as well as a range of advisory reports to promote safer care for patients, for example, the award winning cleanyourhands campaign to improve hand hygiene amongst healthcare staff. We recommended placing alcohol based handrubs close to every patient for speedy and effective cleansing and encouraged patients to ask staff if they had cleaned their hands. This campaign is one of the central planks of the government's strategy against healthcare associated infection. We have trained over 8,000 NHS staff in the incident investigation technique of "root cause analysis" to ensure maximum understanding – and learning – from things that go wrong. This training has in turn been cascaded down to more than 47,000 front line staff.

In summary

The NPSA was established to help the NHS learn from its mistakes.

Through the National Reporting and Learning System the NPSA receives reports about patient safety incidents from NHS organisations throughout England and Wales. The majority of these reports come directly from local information systems.

Local NHS organisations continue to have primary responsibility for investigating and acting on local patient safety incidents.

Clinical teams review all reported deaths.

Computerised data analysis tools help identify potential clusters, patterns and trends across these reports.

The reports help the NPSA learn from incidents and develop interventions to reduce risk for patients.

The NPSA regularly publishes a quarterly breakdown of NRLS data on its website.

The NRLS feeds back analysis and benchmarking to the NHS to allow organisations to better understand their safety profile.

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Are Patients Safe with the NHS?

Professor Tom Treasure MD MS FRCS
General Thoracic Surgeon, Guy's Hospital

I open by rising to the bait. The title I have been given carries within it the implication that it is the NHS specifically, rather than the delivery of health care services in general, which is associated in some way with lack of safety. Hospitals are high risk places in any country and in any system. Sick and dying people are gathered in and doctors with strong medicines and sharp instruments do things to them. The challenges are to keep the risk of interventions to the minimum, to maintain high standards of expertise so that we deliver the most good to the most people, and to avoid additional illness such as MRSA infection caught in hospital. The range of quality of care in the United States is much wider: at one end no effort or expense is spared to the point of inappropriate over treatment while at the other end, there are many who go without[1]. In Britain, most health care is delivered within a national service and part of the equity of care in which we believe is that we should be able to maintain uniformly good standards. As a short answer, it might be said that patients are safer with the NHS than they would be without it.

In this presentation I illustrate some of what has been achieved in cardiothoracic surgery by collection of data about surgical outcomes. I will touch upon the use and abuse of data – apart from anything else that might be said of routine data collection, it is inefficient as a means of picking up comparatively poor practice. I will then look at another way of capturing the knowledge and experience of the whole of the medical profession to identify recurring features of care which could be improved. This is the work of the National Confidential Enquiry into Patient Outcome and Death (NCEPOD) which I chair.

Cardiac surgery from its inception lent itself to counting. Because of the need for the very expensive heart lung bypass machinery and the expertise to run it, cardiac surgery was centralised on relatively few sites. Each operation was a major event and death was both common enough and unequivocal evidence of failure to achieve the objective. It was the surgeons (through the Society of Cardiothoracic Surgeons of Great Britain and Ireland or SCTS) who collected the data and circulated the anonymised results so that we could reflect on our practice in comparison with pooled national data[2]. That has continued and has become increasingly sophisticated but the secrecy has had to go. Both hospitals and surgeons have now to be identified[3;4].

In order for the outcomes to be used for fair comparisons risk adjustment was essential and if we were to pick up slipping practice, the data would have to be regularly scrutinised. We devised and put into widespread use means of displaying risk adjusted outcomes case by case[5]. But what rules should we set to trigger an investigation? The problem is inherent in proper use of statistics. To explain I will use an analogy. A domestic burglar alarm can be set up so that every passing car, gust of wind or stray cat will trigger an awful noise and wake up all the neighbours. Alternatively, it might be set so it will only trigger when an intruder has actually gained access to the safe. In cardiac surgery very sensitive setting to trigger an alert at the first hint of possible trouble results in many teams being subjected to scrutiny at a level which disrupts the service. The consequence is that to avoid this unhappiness and disruption, surgeons may well practise defensively, denying surgery to the "riskiest" patients, the very patients for whom surgery would make the biggest difference, that is to say between life and death. On the other hand, to wait until the conventional statistical tests prove beyond reasonable doubt that there is poor practice requires many deaths maybe over a period of years.

So far I have referred to cardiac surgery and to the counting of deaths but when death is a rare outcome (for example after cleft lip and palate surgery) other measures much more difficult to capture and quantify must be used. In palliative care of terminal cancer, death is the expected outcome; it is comfort and dignity while dying that is the index of the quality of care. A process based on counting deaths cannot discriminate quality of practice in any but a few clinical circumstances.

While of limited value in measuring quality, these data do have some value in studying process. We have used the Society of Cardiothoracic Surgeons' data to explore practice in non-cardiac thoracic surgery. For the very common condition of pneumothorax (a collapsed lung) we were able to show a concerning variation in implementation of the new "keyhole" technology to replace major surgery[6]. A review of practice subsequently shows an increase in the proportion from 57% in 2000-2002 to 73% in 2003-2005. We have also explored the interaction of process and outcome to see if the number of lung cancer operations a surgeon performs affects the perioperative death rate[7]. The data themselves do not flag up any concern. It is their analysis, interpretation and dissemination for comments that help to promote safer care.

I will turn now to a fundamentally different approach. The National Confidential Enquiry into Patient Outcome and Death does not collect data routinely. We receive from any individuals or groups suggestions about aspects of care that might merit investigation. These are openly discussed by a steering group of about forty people, representing all aspects of health care but largely nominated by Royal Colleges and other organisations. The topics for study emerge from an awareness that some aspect of care is not going well and should be done better. A study is then carefully planned to investigate this area of practice. I will give three examples.

The confidential enquiry first made its mark when it reported on the deaths associated with night time surgery. At the time it was the norm for patients requiring urgent surgery to join an inpatient queue waiting to be operated upon. It was not uncommon for this list to start well into the evening when all the day's work was finished and the night nursing staff came on. However the doctors did not change shifts. It was usual for the trainee surgeons who had been working all day and would work again tomorrow to be doing these operations in the small hours of the morning, with the help of equally junior and exhausted anaesthetists. That this was wrong did not require sophisticated statistical analysis and certainly could not have been subjected to a randomised trial. The documentation that it was happening and was commonplace was enough to lead to the "NCEPOD theatre" to be staffed by consultants operating in normal waking hours.

In 2004 we reported on the practice of inserting feeding tubes through the abdominal wall into the stomach (percutaneous endoscopic gastrostomy or PEG). Of 719 instances the expert panel regarded nearly a fifth as futile and 43% were dead within a week from their underlying condition. Again description of the practice and reflection upon it was enough to make the point that this was not appropriate care.

In 2005 we published an investigation of repair of abdominal aortic aneurysm, the commonest major vascular operation. It may be done as a planned operation or as an emergency. We found that a fifth of these operations are done in hospitals doing fewer than 30 a year and by surgeons doing fewer than fifteen a year. This is surgery for which surgeon and hospital numbers affect the likelihood of surviving.[8;9]

Much as I love dealing with data, and I am committed to randomised trials when appropriate, there are times for other methods[10]. Routinely collected and complete databases are a rich source for analysis but they are set up at a particular point in time with a finite number of fields and count the countable. NCEPOD on the other hand captures the amalgamated sense that things are not well in an area of practice and sets out to investigate the specific problem and to report on it, whilst also disseminating instances of excellent practice. Patients and doctors are protected by careful attention to confidentiality. We do not seek whistle blowers or scapegoats. NCEPOD captures much of what is hard to count and may be impossible to measure.

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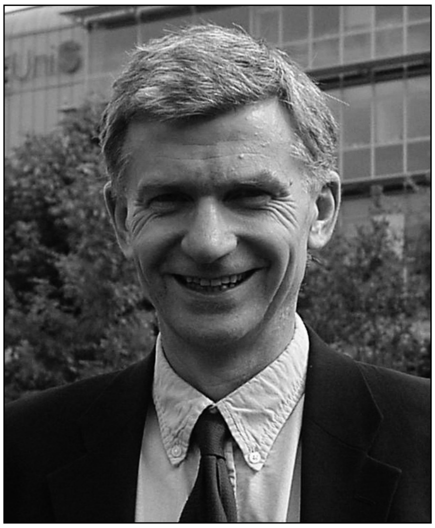
Patient Safety, Systems Design and Ergonomics

Professor Peter Buckle
Robens Centre for Health Ergonomics, University of Surrey



Introduction

The health service is a highly pressured complex system where the potential for error and accidents is ever present (Clarkson et al 2004). The scope for error in all parts of the system is high, although research studies have tended to focus on only limited components of this complex system.

Design is a structured process for identifying problems and developing, testing and evaluating user focused solutions. Application of the design process to healthcare could generate products, services, processes and environments that are intuitive, simpler, safer to work within, easier to understand and more efficient to use. By contrast, design that does not follow such a structured approach is likely to be confusing, less effective and potentially dangerous to medical staff or patients.

The importance of effective design thinking in healthcare is now starting to gain recognition (Bristol Royal Infirmary Inquiry, 2001; Department of Health, 2001). Three years ago we undertook a study for the Department of Health and the Design Council. It sought to deliver ideas and practical recommendations for a design approach to reduce the risk of medical error and improve patient safety across the NHS. The full investigation included the development of baseline information, including examples of international best practice on the efficacy of a design-led approach to patient safety. This paper seeks to demonstrate the importance of this approach and the need for further investigation and funding.

Systems Engineering, Ergonomics and Error

Ergonomists and systems engineers have long since recognised that enhancing performance requires an emphasis on design (or re-design) at a systems level. In typical work systems this includes a consideration of people, equipment, jobs, tasks and the socio-technical context of the work. Those involved with such design have traditionally examined the system goals, the allocation of functions and tasks (eg to teams, individuals, equipment, IT), the equipment design, the interactions between sets of equipment and groups of people, the work organisation and the job design.

A recent model (fig 1) (Moray, 2000) enables the various levels of the system to be conceptualised for the purpose of understanding, interpreting, evaluating, information collection, and design purposes. The relevant information needed to reduce error in the design of equipment to be used by humans is readily available. Each level of the system can be considered with respect to medical error.

Physical devices: At the centre of the system is the physical device or tool being used. There are many illustrations and examples of errors and difficulties associated with the use of equipment (see Obradovich and Woods, 1996.)

Factors affecting the individual: Omissions (ie the failure to carry out some of the actions required to achieve a desired goal (Reason, 1990)) are a common source of error. The role of such errors is evident when considering the giving of drugs to the wrong patient. Understanding why omissions occur (eg what aspects of drug administration require high levels of attention) may lead to improved design of products and work organisation that reduce the probability of such errors occurring. Blaming the individual who made the error is rarely a successful way of dealing with the cause and may make it more likely to happen again.

Physical environment: The physical layout of, for example, an operating theatre may increase the likelihood of errors. Noise levels in working environments may cause messages to be misunderstood and can lead to interruptions.

Team and group behaviour: In healthcare, most people work within a team and so a consideration of factors such as communication, supervision and responsibility is required. Absence of, or poor, communication between and within teams is likely to contribute to errors. For example, in a hospital setting the most junior medical officer is usually called upon to take a patient's medication history on admission. These doctors are often called upon to prescribe drugs and do so without asking questions under the assumption that this is the correct procedure. In some instances supervision is seen as inadequate and other issues, for example, overlapping responsibilities between teams also contribute to errors (Dean et al, 2002).

Traditionally, information flows vertically through a hierarchy and orders are sent from the top down with the expectation that lower levels will implement them (West, 2000). Adverse events can occur because individuals of lower status experience difficulties challenging decisions of a person of higher status.

Organisational and management behaviour: Although factors affecting individuals have been highlighted there is limited value in focusing on individual activity, as this tends to perpetuate a blame culture. The focus needs to widen to include systems issues underlying the problems that are present in any complex work environment. System failures are sometimes difficult for "front line" staff to recognise because the decisions underpinning these systems may have been made in the past by those at a higher level of the organisation (Leape et al, 1995). System changes to reduce errors suggested include adjusted work schedules simplifying work systems and enlisting the help of frontline personnel.

Legal and social pressures: The behavioural options available to those working in a system may be tightly constrained by regulatory rules. For example, only certain drugs may be administered or procedures undertaken. As systems become more complex, the task of regulating becomes ever more difficult. For example, how do regulators cope with the issues that arise when multiple pieces of equipment are used conjointly (eg in intensive care units) or when "intelligent" software is embedded within drug delivery systems, thereby blurring the boundaries between equipment design and clinical decision-making?

Relationship between elements within complex systems: There is an added level of complexity that occurs when elements are linked. Our research (Buckle et al, 2006) has demonstrated that stakeholder groups rarely have any clear idea of what happens "further down the chain". Thus drug wholesalers have little idea of the problems, and potential medication errors, they cause for high street pharmacists with the way medication is packed and delivered. Worse, drug manufacturers rarely consider the difficulties they generate for patients who attempt to adhere to their medication despite often being unable to distinguish between the medications because of confusing packaging, tiny font size and hard to access tablets. Those prescribing are often unaware of the enormous complexity of having to manage 10 or more medications in complex treatment regimes.

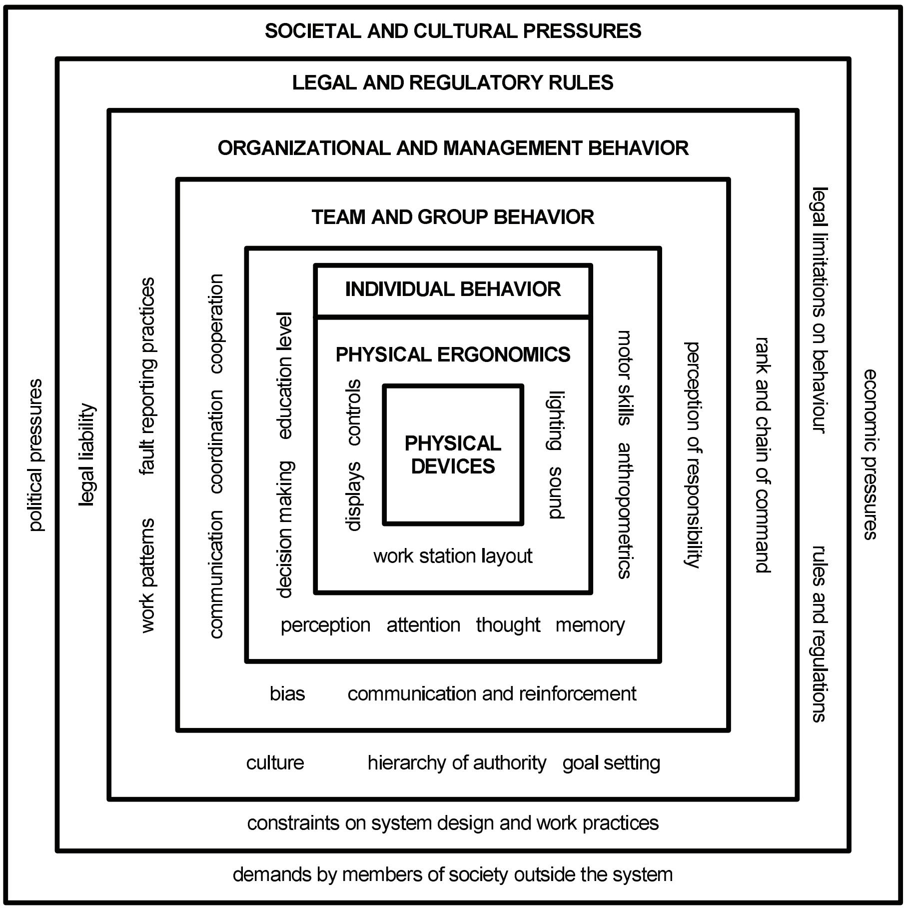


Figure 1. Ergonomics as the study and design of socio-technical systems (Moray, 2000)

Discussion

A key finding of the research has been that the "big picture" understanding is missing in the health care sector. The highest priority must be attached to remedying this without delay.

Mapping the "system" is a central focus for complex and intricate systems. As the interfaces between stakeholder groups become apparent, then so does the potential for error. Such mapping exercises have led to the development of a model to serve as a template for future systems design (see Cambridge, Surrey and RCA, 2003).

The need for risk assessment to include the intended user is essential, as is the need to learn from errors.

References available at http://www.scienceinparliament.org.uk/sip.asp

In discussion the following points were made:

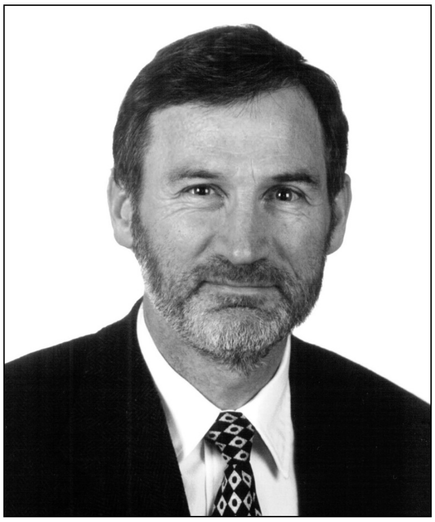
Litigation in general does not deter doctors, but is undoubtedly increasing pressure on the system. More emphasis is required on the need for better prescribing as many young doctors are uncertain about their ability to prescribe correctly due to the lack of sufficient training in this area. However the view was expressed that one should never train someone for a system which is intrinsically unsafe. The lack of a language requirement for NHS Doctors who were trained elsewhere in Europe was thought to introduce unnecessary risks of misunderstanding due to the lack of relevant skills with the English language. Good medical practice varies between hospitals, between wards and between shifts on wards and is therefore difficult to manage across the NHS. Regulation is needed to ensure standardisation of medical equipment, especially that which is used in life threatening circumstances, in order to reduce the risks of accidental misuse.

MATERIALS, MINERALS AND MINING – INNOVATION, CONSERVATION AND WEALTH CREATION

MEETING OF THE PARLIAMENTARY AND SCIENTIFIC COMMITTEE ON MONDAY 4TH DECEMBER

The recent surge in the value of primary raw materials, such as minerals and metals is partly due to increased industrialisation in emerging economies such as China and India. This has concentrated the focus on the finite availability of these commodities and the increasing difficulty in discovering new economic reserves in the near surface of our planet. Innovative research in the conservation of resources and in cost reduction has therefore also increased; these include recycling, the development of novel materials, using smart and nanotechnologies for example, and extended asset and material lifetimes through effective protection against degradation and corrosion. However, the attraction to young people of science and engineering is diminishing, despite attractive average lifetime career earnings for graduates. Thus, at a time when the demand for innovation in materials has never been higher, the number of students of materials science, and in mining and mineral engineering in our Universities is at an all-time low. It is true that almost all engineering and technological advances depend on new developments in the science and technology of materials. The list includes new, efficient light sources, electronic materials in computation, materials for the hydrogen economy, including batteries and fuel cells, and lightweight corrosion-resistant materials for transportation. Materials science is a key growth area that underpins the knowledge-based economy. The challenge now is to improve public perceptions so that our lead in this technology helps to create the next generation of materials scientists.

The Importance of Mining Engineering[1] in Providing Primary Raw Materials



Professor R J Pine FREng
Head of Camborne School of Mines, University of Exeter

In our everyday needs for materials and energy our resources are either grown or "mined". Historically the UK has played a leading role in the discovery and exploitation of mined resources including coal, iron, building products and a variety of metals and minerals. While the scale of UK mining and quarrying is not large by global standards it is still significant and likely to be more so with pressures to source raw materials locally. This will be driven by our responses to Climate Change and consequent reduction in energy usage. However, in the UK as a whole the importance of mining and quarrying is not fully appreciated and largely negative perceptions predominate. For example, obtaining planning permission for new or extended quarries, while not as demanding as for land fill or waste incineration sites, is very difficult and affected by the same societal attitudes. Other perceptions of mining and quarrying include bad environmental legacy from abandoned sites – unfortunately true – but the record is improving rapidly, and a rather low-tech uninspiring industry – completely untrue.

For the reasons summarised above, which occur in most of the developed world, there is a crisis in attracting young people to the extractive industries (oil and gas, mining, quarrying) and the age profile is highly skewed to 45-plus. It has been estimated by the major mining companies that they are short of 600 graduates per year, to replace retirees and other leavers, and this figure can easily be doubled by including the smaller operators. In addition many of the equipment suppliers to the industry, mining finance houses and consultants need large numbers of professionals with mining engineering skills. The industry leaders recognise that they have to solve this problem largely themselves and the solutions include better industry performance and consequent reputation; higher salaries; more attractive on-site packages (eg fly-in/fly-out patterns); better consideration of family issues; outreach to the public at large and to schools in particular.

However there is an underlying problem that is critical in the UK and very serious in many developed countries. The number of students in schools who are studying mathematics and science has declined rapidly and this has inevitable knock-on effects for universities. There have been some high profile examples recently in chemistry and physics, but the effects are felt throughout

[1] in the current context mining engineering also includes specialist disciplines such as mineral processing, applied geology and quarrying

science and engineering. There are now only two universities in the UK who offer mining engineering courses, Exeter (CSM) and Leeds. At the Camborne School of Mines we are currently pleased if we can attract 25 students per year into mining engineering. To do this we need good publicity, generous scholarships, an attractive package with good facilities and effective research and teaching. Our recent graduates typically can pick and choose between many job offers many of which are outside the mining industry. This is good for the graduates but not healthy for the industry. We need more applicants and the UK political/education system must address the underlying problems. There have been some encouraging initiatives in the past year but it requires a sustained effort to be effective.

Taking the global view, the mining industry has some important strategic considerations to address, in which mining engineering will play a key role.

The (shallow) easily mined world-class deposits of valuable metal and other ores have mostly been taken already, or have been located and mining has commenced. The industry must be increasingly innovative in finding and exploiting more marginal resources and in mining underground at depth, where it was previously possible to mine in large open pits. For example it is estimated that within 10 years the world supply of copper ore will be 90% from underground block caving operations, whereas currently it is 90% from open pits. This requires a step change in technology, a significant research effort, and retraining at all levels of operation. A short example of some of the computer modelling being developed in the UK for the simulation and design of block caving was demonstrated.

The impact of the rapidly growing economy of China has had a profound effect on the global flow of raw materials and their prices and on energy consumption (mostly coal-powered). The non-energy prices will probably moderate in due course but at the recent conference in London "Mines and Money 2006" it was predicted that the current high index value of base metal prices would continue to rise for a year or so, then decline to approximately current (late-2006) prices. These are historically very high. There are several consequences here – the increased prices will lead to more efficient usage (but not always immediately); there will be some substitution of cheaper alternatives; there will be concerns about security of supply of strategically important materials (including energy materials such as uranium) and recycling will become increasingly important (eg about 80% of lead comes from recycling, but not nearly as good for other valuable metals). Mining technology has a potentially critical role to play in reducing net CO_2 emissions in China and worldwide, with clean coal burning, in-situ gasification and sequestration. The UK has a significant capability in these areas and, in a related project, the planned Peterhead power station, will have CO_2 sequestered under the North Sea.

The impact of global warming and consequent need to reduce greenhouse gas emissions will affect the mining industry as much as others. The industry will increasingly need to reduce unit energy inputs per tonne mined, processed and shipped. For high value materials the market will remain global. For low value materials such as aggregates and some industrial minerals (gypsum, carbonates, potash) the energy cost of transport will increase pressure for local resourcing. In the UK this could mean opening currently abandoned quarries.

The global mining industry is rightly under increasing pressure to address the social, environmental and economic impacts of their operations on affected local communities. It is recognised by all responsible mining companies that they need a well-planned post-closure programme with adequate financing to meet future/unforeseeable needs, as a condition to have "permission to mine". This approach is now embedded in the Equator Principles to be applied by signatory financial institutions (eg World Bank) as conditions for approving project financing. Further, the Extractive Industries Transparency Initiative (EITI) is the (currently UK Government led) effort to address transparency and corruption.

The mining industry is truly global and has a direct impact on virtually every country in the world. The turnover of each of major companies (eg Anglo American, BHP Billiton, Rio Tinto, Xstrata) is typically in the tens of billions of dollars. The turnover of the whole industry is in the hundreds of billions of dollars. Typically the large mining companies and suppliers each have tens of thousands of direct employees and hundreds of thousands of closely dependent employees and their families.

The UK extractive industry is very significant if oil and gas are included, with an annual turnover of about £25 billion per year, of which over £20 billion is in oil and gas. Coal accounts for about £1 billion and quarrying for aggregates about £2.5 billion. There are small but significant mining and quarrying operations, which produce industrial minerals such as limestone, potash, gypsum, salt and clay. There are tens of thousands of employees. The UK quarrying industry, like others, has much international ownership. Although this may affect investment decisions within Europe, eg if UK becomes relatively difficult in which to operate, the energy saving agenda should favour local sources.

To conclude:

The global mining industry is key to future supplies of materials and minerals, which are essential for development. The industry has a major role to play in the transition to more sustainable patterns of development – and this needs top-quality skills. High prices and the need to reduce energy consumption at all stages will lead to profound changes in practice.

The UK has major roles to play in Mining Engineering domestically and globally. In the UK, reduced energy consumption should lead to more local sourcing of aggregates. Globally the community of UK-based mining finance specialists and technical consultants play major roles of importance to UK earnings and influence.

There is a serious global shortage of mining engineering professionals, which could get worse. UK universities are playing a small but significant role in meeting demands.

UK science and engineering university courses are undermined by the shortage of school students studying suitable subjects. Government policy and industry support are vital to redress the problem.

The Role of the Science of Corrosion in Extending the Useful Life of Materials

Dr Stuart Lyon
Corrosion & Protection Centre, School of Materials, University of Manchester

Introduction and History

The International Standards Organisation (ISO) definition of corrosion is "A physico-chemical interaction between a material and its environment which results in changes in the properties of the material and which may often lead to impairment of the function of the material, the environment, or the technical system of which these form a part". This is, essentially, a statement of the thermodynamic tendency for materials to react with their environment, an understanding of which has clearly been around since at least the Bronze and Iron Ages. However, the application of corrosion protection dates from Humphrey Davy (of the Miners' Lamp). Known as "Father of Electrochemistry", the Admiralty commissioned Davy in 1823 to investigate the corrosion of copper sheathing on the hulls of wooden vessels. In 1824 he instigated the first known application of cathodic protection (CP) by utilising iron or zinc ingots attached to the copper sheathing. Unfortunately, while this was a technical success, and effectively prevented the corrosion of copper, it was a practical failure as it eliminated the anti-fouling properties of the copper hull! Today, CP (using zinc or aluminium anodes) is the preferred method of protection of almost all marine (and many other) structures.

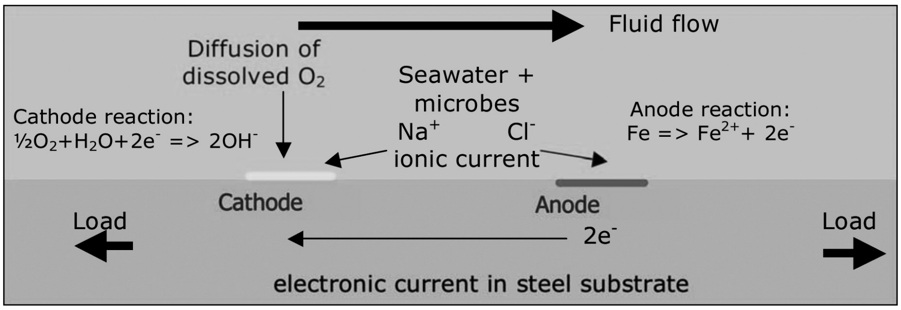


Figure 1.

Corrosion Processes

Following on from Davy, corrosion was first understood as (and proven to be) an electro¬chemical process by Ulick Evans (known as the "Father of Corrosion") in the Goldsmiths' Laboratory at The University of Cambridge in a research career lasting over 60 years from 1919 to 1980.

What Evans discovered was that corrosion consists of two reactions that happen at the same time, and at the same rate but not in the same place. These are exactly the same reactions that occur in a standard dry cell battery, where corrosion of zinc (at one terminal) is supported by an oxidant such manganese dioxide or oxygen from the air (at the other terminal) causing an electrical current to flow. Thus, all corrosion reactions involve the flow of electrical current and are affected by a range of materials and environmental influences, some of the complexity of which is indicated in the cartoon (Fig 1) showing steel corroding in seawater.

Corrosion is thus fundamentally multi- and inter-disciplinary that requires knowledge of:

Materials science (polymers, ceramics and metals), solid-state physics, organic chemistry, electrochemistry, mechanical chemical and civil engineering, microbiology, tribology, surface science, surface engineering, etc;

Engineering appreciation of applications and functions, etc;

Resource conservation, asset management, lifetime extension, recycling, etc.

With the key drivers being: engineering application, cost reduction, safety, legislation, etc, together with genuine scientific endeavour.

Costs of Corrosion

The costs of corrosion to industrialised economies are very significant. The Hoar Report, commissioned in 1969 by Tony Benn and reporting in 1971, put this cost to the UK economy at between 3.5-4.5% of GNP. A more recent UK survey, reporting in 2000, estimated the cost as somewhat less at between 2.5-3.5%. The significance of this amount is hard to grasp, so another way to consider it is that if the monies currently spent on maintenance and other repairs due to materials degradation were NOT spent, then the entire physical infrastructure of the country, (eg machinery and buildings, etc) would cease to function, or lose ALL economic value, in about 30-40 years. Similar surveys in USA, Japan and Germany, have come to essentially the same conclusions.

All such surveys have consistently estimated that 25-30% of corrosion losses could be eliminated by the application of effective corrosion control systems and procedures and that research in reducing such losses is highly cost-effective. The main outcomes of the Hoar Report were the establishment, at the former UMIST (now The University of Manchester), of The Corrosion and Protection Centre and, as a campus company CAPCIS Ltd. These currently comprise world-leading centres of excellence in, respectively, academic research into corrosion science and in the control of corrosion and in corrosion advice and consultancy to industry.

Lifetime Extension of Materials

The science of corrosion is vital for the successful application of many modern engineering and technical systems. Such applications include those that use positive aspects of the corrosion process to develop (or engineer) particular desired functions on material surfaces. A well-known example of this is titanium, the surface of which can be treated using a corrosion process (anodising) to give attractive coloured finishes used in jewellery. Some other examples are tabled below (Fig 2).

An important example of the beneficial application of corrosion is in the surface treatment on the aluminium alloy. In aerospace and automotive applications, increasingly adhesive bonding of structures (as opposed to welding) is being carried out. This can be seen

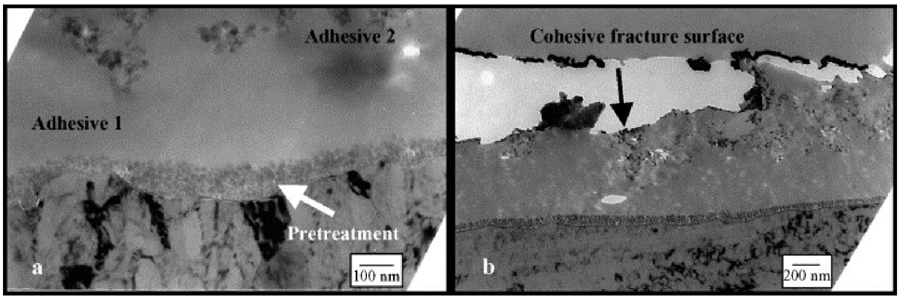


Figure 3.

in the electron micrographs (Fig 3), which provide visualisation of the position of joint failure (b), showing that the presence of the pre-treatment (a) has **prevented** failure, at the metal-adhesive interface.

Conventionally, the main reason for the application of corrosion control technology (of which protective coatings, including paints, are the most familiar) is to extend the economically useful life, or to increase the performance, of a material; hence, to reduce the cost of the technical system. Although, corrosion can never be completely stopped, it **can** be effectively controlled for a longer or shorter time by interfering with the material or environment in some way. In total, there four main methods of corrosion control:

Electrochemical modification (eg cathodic protection)

Chemical modification of the environment (eg inhibition of corrosion)

Application of a protective coating (eg paint, galvanising, etc)

Appropriate selection and design of material (eg selection of the correct type of stainless steel – there are probably over 100 different specifications).

Skills Training and Certification

One important message is that a significant fraction of corrosion costs (up to 25%) can be saved by correct application of current technologies. For example, modern paints, if correctly applied to properly blast-cleaned bare steel, can have lifetimes exceeding 20-25 years before re-coating is required. This compares with 5-7 years for conventional paints applied as touch-up over existing paint. For something like the Forth Bridge, where the painting proverbially never ends, a significantly longer life translates into tens of millions saved in maintenance costs over the coating lifetime. However, this can only be achieved with a properly trained and skilled workforce together with professional inspection of the finished coating. A new scheme, pioneered by the UK Institute of Corrosion, and developed with partners such as Network Rail and The Highways Agency, is intended to upgrade the status in the industry from painters (who handle commercial decorating) to industrial coaters (trained to apply correctly industrial coatings to structural steelwork). It would greatly assist this introduction if, as in some other countries, training in corrosion control was compulsory.

Challenges to Wealth Creation

Despite the undoubted economic importance of corrosion and the corrosion control industry to life extension and resource minimisation, the main challenge lies in the poor image that corrosion has. Nevertheless, images can and must be challenged and changed by education and upskilling of companies and individuals at all levels.

As a branch of materials science, we in the UK are world-leading in the science and engineering application of corrosion. We must acknowledge this lead and should not relinquish it to emerging or more vibrant economies. Thus, future wealth creation relies on technical, engineering and educational services predicated on retaining an indigenous talent and knowledge base. We must not "outsource" our strategic knowledge in a knowledge-based economy.

Beneficial Corrosion Process	Technological Application
Passivation of semiconductors	Micro-electronics
Surface treatment of aluminium	Adhesive bonding of structural alloys
High-temperature protective coatings	Efficient gas turbines (e.g. aero-engines)
Acid etching of aluminium	Lithographic printing plates
Corrosion of zinc	Dry cell batteries
etc.	etc.

Figure 2.

How Materials can help solve Major World Problems

Professor Colin J Humphreys CBE FREng
Department of Materials Science and Metallurgy, University of Cambridge

Introduction

It is no accident that the intelligent use of materials is one of the fundamental characteristics by which the development and impact of the human species on the planet is identified and described from archaeological records. Indeed it is this special ability to utilise materials that has made a relatively comfortable human existence in an otherwise hostile environment what it is today, to the extent that current living standards are widely accepted as an attainable norm for much of the human species. We are entirely dependent on materials to satisfy our desire for improved standards of living. The extra demand from growth in the human population and our increasing longevity don't make this any easier. There is also an urgent requirement to manage and minimise the detrimental impacts of increasing human activities on the global ecosystem.

Major world problems that are of particular concern relate to the improvements demanded in human health where elderly people have come to expect to be able to maintain healthy and active lifestyles for as long as feasibly possible. This inevitably contributes to demands for the provision of reliable and relatively inexpensive energy supplies that are required to underpin the economy and lifestyle of the human population. Fossil fuels are an essentially finite resource and unless managed in a more environmentally-friendly manner worldwide could precipitate a hostile global warming event never previously experienced by humanity. It is therefore essential to minimise the negative impacts of increased atmospheric concentrations of CO_2 and develop alternative fuels and energy sources. Hence an innovative range of new materials technologies using new materials will have a key role to play in providing a sustainable future for humanity in the planetary environment.

Biomaterials

The wide range in the application of biomaterials to human health is clearly demonstrated in Fig 1[1], where artificial hips enable the lame to walk and artificial arteries bring new life to the dying and thereby greatly improve the quality of life of many people. Many of these recent developments arise from UK successes in developing biomedical materials.

UK Successes in biomedical materials
Development of first successful joint replacements in 1960's
Ceramic coatings exported around the world
UK development of novel polymers and degradable materials
Artificial organ research UK led

Biomedical Implants
1970
Only joint replacements
1,000 operations per year
Implants
  Metal
  Polymer
Non-reactive materials
Artificial joint life – 10 years

Today
Soft and hard tissue replacement
External and internal systems
250,000 operations/year
Artificial bone materials
Joints perform longer and better
Corneal lenses - hydrogels
Skull – polymer/ceramic composites
Heart valves - polymers
Stents –shape memory alloys
Plates and screws – biodegradable polymers
Hips – ceramic coated metal
Knees – metal & polymer

Global Warming and the coming Energy Crisis

A portfolio of new materials science measures is now required:

- to improve the efficient use of the energy that we currently generate but utilise in a wasteful manner;
- to help with an innovative generation of safe and reliable nuclear reactors, such as the Pebble Bed Reactor, for example, which can be modularised and conveniently located within the community requiring electricity and heat from such a source; and
- to help increase the efficiency and reliability of electrical power from renewable sources, such as wind and wave. Materials science also has a key role to play in improving solar cells, fuel cells, and in developing nuclear fusion.

Next Generation Lighting

This is an example of an innovative project that I am involved in by application of materials science to next generation lighting. The project clearly demonstrates the urgent need for a new UK National Programme on next generation lighting which is entirely consistent with and underpins our national goals and targets for reduction of CO_2 from the generation of electricity.

Lighting is one of the biggest causes of greenhouse gas emissions, creating 1,900Mt of CO_2 emissions annually from power stations, which is 70% of the global CO_2 emissions of all cars and three times more than emissions from aviation (International Energy Agency Report, 2006). Currently the US consumes 30 times as much lighting per person as India and 1.6 billion people have no access to electric light. The projected global demand for lighting will be 80% higher by 2030 (IEA Report, 2006).

The Tungsten light bulb, which accounts for 79% of global lamp sales by volume, is only 5% efficient – 95% is lost as heat which stays near the ceiling. It has been suggested (Letters, The Times, 17 July 2006) that the sale of filament light bulbs be banned, hastening a changeover to the low-wattage, long-life fluorescent variety. However, compact fluorescent tubes are only 15% efficient and the efficiency of long fluorescent tubes is only 25%.

There is a need for ultra-efficient lighting: 20% of all electricity consumption in the UK is for lighting and in Thailand over 40% is for lighting. There is a new man-made material, Gallium Nitride, first used in 1993, which emits a bright light of any desired colour if mixed with Indium and UV light if mixed with Aluminium. The efficiency of GaN-based white LEDs in normal conditions is currently 25%, though in the lab we can achieve 40%, and the target is 50-80%. According to a US Department of Energy report if 50% of lighting in the USA is replaced by GaN-based LEDs (White) 41 GW of Electricity will be saved and 41 power stations can be closed.

Ultra-high efficiency white GaN-based lighting gives perfect colour rendering – like sunlight. Its use would reduce CO_2 emissions by over 10%, giving savings of £1.7 billion in annual energy costs. We could close about 8 power stations in the UK. It operates on a 4V circuit for lighting which is ultra-safe and cheap. In the developing world it can be powered by solar cell batteries. A single light lasts for 10 years continuously and for 60 years at 4 hours per day. There are national programmes in Solid State Lighting in Japan, China, Korea and the USA but there is no national programme in the UK.

Summary Overview of Materials in the UK

The UK undertakes world class research in many areas and manages world class industries in some areas. University-industry links are good and the organisational structure is good. However, there are manpower problems for industry and universities, and there are also funding problems for universities. I visited Rolls Royce Submarines last week. They employ 980 scientists and engineers, many of them materials scientists and engineers. They are mainly aged between 40 and 60 years and the MoD requires all their employees to be of UK origin. There are recruitment difficulties for industry, especially for the smaller SMEs, who find the supply chain has been sucked dry by the primary industries they are working to support. For example, Thomas Swan Scientific Equipment Ltd wishes to recruit 2 materials engineers for exports. They have found one from China but have been unable to find another after nine months.

Manpower problems also exist in universities. For example, one university in Singapore produces more materials graduates than all UK universities combined. All of my post-doctorate students are from overseas – with usually not a single UK applicant, while 80% of my first year research students are from overseas.

Conclusions

The HEFCE grant per undergraduate needs to be increased for Engineering and Physical Sciences students, if necessary by a redistribution of existing funds. Materials is a key subject for our wealth, health and for reducing global warming. It is a high priority topic in the USA, Japan, China, and needs higher priority in UK with increased funding for Materials allocated to EPSRC and the DTI.

[1] Full figure available at http://www.scienceinparliament.org.uk/sip.asp

In discussion the following points were made:

Depletion of the professional base results from the lack of a clear career prospect ahead of potential students of materials science. Graduates are increasingly seeking financial reward from their studies of metallurgy through employment in finance houses. The annual trawl around universities by companies seeking graduates for employment focuses on graduates with 2-3 years' experience, with less interest shown by companies in recent graduates due to the inherent costs involved in their training. Everyone wants experience, but no one is prepared to pay. Support for graduate apprentices should be restored. SMEs have the greatest difficulty in recruiting, as the defence-related industries that require UK nationals have had first pick. Students are not all hungry for money, but it is important. You cannot require someone to work as a post doc for 10 years without the prospect of permanent employment. No one wants to be a temporary worker for ever. Starting salaries should be raised and a reasonable career path should be offered. In some schools students are steered by their teachers into easier A levels to improve overall ratings. Universities must also play their part and recognise the importance of recruiting students taking hard subjects and cease seeking students with A grades from soft subjects just to improve their overall intake ratings. Every university makes a loss on training engineers and scientists due to the inadequacy of the current funding system when paying for laboratories as well as lecture halls. Finland, however spends 4% of GDP on research in science and engineering, compared with 2% in the UK, and boasts a world class company, Nokia, that provides high quality employment in materials science for Finnish scientists and engineers, based on the mobile phone, the original technology for which was developed in the UK.

"SIP" gives science a taste of public opinion

Dr Jekyll or Mr Hyde? In the public's mind, scientific research sometimes has a split personality. While people often have huge, sometimes unrealistic, expectations of the benefits science can bring, many also maintain a fundamental unease about what scientists are "getting up to". To promote a healthier relationship between science and society in general, the Engineering and Physical Sciences Research Council (EPSRC) has set up a new advisory body called SIP (the Societal Issues Panel).

Chaired by Professor Robert Winston, SIP aims to help EPSRC take more account of public thinking when deciding how to spend the £575 million a year it invests in research. Comprising eight members from wide-ranging backgrounds, SIP will provide advice on how to identify emerging social and ethical issues relevant to engineering and the physical sciences. It will also help EPSRC pinpoint areas where it needs to engage with the public more effectively, suggesting ways of doing this and helping to identify areas where further research might be needed.

Identifying the opportunities and concerns

There are a large number of areas where public optimism and enthusiasm can help to identify issues and drive opportunities to help shape tomorrow's technology. These include energy efficiency and the use of renewables, protection of the environment and the responsible use of data.

But advancing technology also produces understandable concerns. "ID cards are a good example of an area where the public have worries about technology's impact on civil liberties, as well as a false impression of science's ability to deliver a complete solution," says Professor Gloria Laycock, Director of the Jill Dando Institute of Crime Science and a SIP member. "It's vital that the research community is aware of these views, takes them on board and works to address them."

Other fields SIP is likely to focus on include crime, Information and Communications Technologies (ICT), nanotechnology and energy. In recent years, the last of these has seen negative public opinion contributing to restricted use of technologies as diverse as wind energy and nuclear power. Now, new Government proposals to expand the role of renewables and nuclear power to help combat climate change look set to prompt a range of "pro" and "anti" responses from the public.

"Science and engineering don't exist in a vacuum," Professor Laycock comments. "It may be going too far to say that the public should set the agenda for research, but society does at least need to feed into debates about how technologies are exploited. The scientific community has an obligation to guard against the danger of public cynicism, which could result from perceptions that science is remote and uncaring."

A change of culture

Looking at the bigger picture, SIP's real value as a highly visible new forum could extend far beyond individual issues. "By setting up the panel, EPSRC has made a profound statement that it aspires to change its whole way of working," says Professor Kathy Sykes, a SIP member well known for her work in making science accessible to a wider audience on television and radio. "The ultimate goal is to ensure that a serious regard for a broad range of – sometimes challenging – views and perspectives becomes embedded across the organisation and the whole research community."

In this context, SIP complements and reinforces the work of two other independent panels already established by EPSRC – the Technical Opportunities Panel (TOP), whose main role is to advise on new research opportunities, and the User Panel (UP), which advises on research needs from the viewpoint of technology users. Together, these three bodies provide a conduit enabling EPSRC to take external perspectives on board and so increase the tangible benefits its research ultimately delivers.

When formulating its advice to EPSRC, SIP will not only draw on the knowledge, experience and views of its members, but will also build on relevant work already undertaken in the UK and abroad. A particular priority is to identify examples of "good practice" trying to change the culture in organisations to incorporate ways of valuing and using public thinking, as well as engaging with the public on potentially sensitive issues and building mutual understanding between the public and the research community. One requirement is for SIP to provide input on the future shape of EPSRC's research portfolio, which is currently under review so that potential impacts on society are factored in and promising opportunities identified.

"Science has a huge amount to offer society," says Professor Winston. "By providing the basis for a better understanding between the two, SIP can help ensure that the benefits of research are felt as widely as possible in the years and decades ahead."

The current membership of SIP is as follows:

- **Professor Lord Robert Winston** (Chair): human fertility researcher, life peer, and former member of EPSRC's Strategic Advisory Team on Public Engagement.
- **Dr Donald Bruce**: Church of Scotland - head of society, religion and technology project.
- **Professor Derek Burke**: retired Vice Chancellor of East Anglia University; chaired the advisory committee on novel foods and processes from 1988 to 1997.
- **Mr David Jordan**: EPSRC Council member; retired Chairman and Managing Director of Philips Electronics UK Ltd.
- **Professor Gloria Laycock**: Director of the Jill Dando Institute of Crime Science; previously worked in the Home Office for over 30 years.
- **Baroness Onora O'Neill**: prominent political philosopher; President of the British Academy, Principal of Newnham College, Cambridge and a crossbench peer.
- **Professor Judith Petts**: Head of the School of Geography, Earth and Environmental Sciences at the University of Birmingham.
- **Professor Kathy Sykes**: Collier Chair of Public Engagement at Bristol University; former member of EPSRC's Strategic Advisory Team on Public Engagement.

Maximising the Benefit from Scientific Innovation

David Dent, International Agriculture and Technology Centre

The Oxford English Dictionary defines innovation as *the act of introducing something new* while the Department of Trade and Industry take things a stage further and considers innovation to mean *the successful exploitation of new ideas*. In economics, innovation is necessary to meet unsatisfied market needs and increase customer or producer value. In this context innovations are intended to make someone better off, and the succession of many innovations grows the whole economy. Scientific innovation is primarily used to solve scientific problems that constrain the development of human advancement rather than meeting an unsatisfied market need. There are many examples where a scientific innovation also leads to the development of new products and services which have market value. However, it is important to be clear that scientific innovation rarely by itself leads to economic innovation.

Science Innovation

In the UK, Government sponsored research has largely focused on a supply-led model of scientific innovation (science-led innovation) ie research undertaken in universities and national research institutes is monitored for commercial possibilities, intellectual property is protected, commercial partners sought and innovations licensed to industry to commercialise or spin-out companies are created.

There have been commitments to infrastructure and organisational investments to improve the effectiveness of this approach:

- Public scientific research organisations have created commercial teams whose role it is to identify and assess innovations, protect intellectual property (IP) and identify market opportunities and then facilitate/negotiate licensing agreements with relevant acquirers or to assist in the establishment of spin-out companies.
- Young scientists are provided with commercial/business/entrepreneurship training as part of their PhD studentship or Postdoctoral apprenticeship.
- Science Parks have been established involving businesses and science institutions in order to increase interchange of ideas, approaches and commercial opportunities.
- Knowledge transfer networks are being established in response to concern about general lack of pull-through of inventions. Knowledge Transfer Networks (KTN) "stimulate innovation in the UK's key technology sectors by promoting collaboration, best practice and knowledge sharing between industry and academia."

However, given a goal of generating wealth for UK plc, this whole system of science-led innovation represents a rather indirect, unfocused approach that relies too heavily on good fortune to match innovation against unsatisfied market need. This is not to say that science-led innovation does not have value but rather that it needs to be complemented by a more targeted and focused approach to scientific innovation, one where the market (demand) rather than science (supply) acts as the starting point.

Market-led Innovation

Market-led innovation starts with the needs of customers rather than in the laboratory with the interests of scientists. Market-led innovation provides the means by which scientific innovation is directed towards developing specific products and services. The market is assessed, specific product or service opportunities are identified, innovative approaches utilising science are sought to generate products and services which are developed for sale into a pre-defined market with an extant demand.

An extreme example of market-led innovation occurs during wartime when there is a very definite and focused demand for the specific products. In less demanding times however, scientists tend not to be deployed to solve particular needs of the market but rather to solve problems of scientific interest; their purpose, not the development of a product or service but rather the advancement of knowledge and the publication of scientific papers. There may be the vague notion of a market opportunity when research project applications are made but this is rarely properly defined in terms of the specifications required of a particular commercial product or service.

It is easy to preach market-led innovation, but it is more difficult to practice because it involves a change of mindset, organisation and behaviour at both an individual scientist and institutional level. Large companies such as Unilever and GSK can achieve a market-led approach through their in-house ability to combine and manage the link between market knowledge and scientific innovation. However, it is much more difficult to manage for small-to-medium enterprises with no in-house R&D capability, who at this time have to rely on science-led innovation for opportunities that may or may not meet market needs.

Achieving Market-led Innovation

I would not want to give the impression that there are no current market-led approaches to scientific innovation in the UK. The long standing relationship of Imperial College with industry stands out as exemplary and initiatives such as the LINK Programme seek to achieve the necessary integration of market and scientific innovation. However, these remain a relatively small drop in the ocean and if our goal is for the UK to become "the innovation engine of Europe" we need to take a more committed strategic step towards market-led innovation. One direct way of achieving this would be through Centres of Market-led Innovation that combine:

- Teams of market analysts with the ability to identify market gaps and opportunities in specific sectors relevant to industry, not as a grand centralised think tank but based on detailed specific sector knowledge at the level of potential individual products and services
- Access to the brightest and best innovators – scientists driven by the desire to develop solutions to problems that are a constraint to product and service development rather than purely by the science or engineering that might underpin a solution
- Mechanisms to reward science innovators on the basis of value to industry (number of patents and more importantly the number of licensing agreements or spin-outs created instead of papers published)
- Locations and facilities where there are clusters of scientific institutions, and relevant sector companies

In order to achieve this it would be necessary to re-focus existing science-led capacity in universities or national research institutes, or create completely new dedicated market-led innovation centres. Issues with regard to how much the capability should be centralised and or regionalised would also need to be addressed. However, whichever option is selected (or combination of options) market-led innovation centres would have the great advantage of being able, over time, to generate revenue from exploitation of their intellectual property and hence would not need to be as reliant on funds from central or regional sources as are conventional research establishments.

If this country really wishes to become the "innovation engine of Europe", then we need to be much better focused in our approach to scientific innovation and the most direct way of achieving this is through the support for market-led innovation.

Acknowledgements
I would like to thank Dr Brian Pettit for discussions and comment on an earlier draft of this paper.

Riding the wave of the latest Asian tiger: promoting UK/India science & innovation

Dr Rob Daniel, Head of S&I India, British High Commission, New Delhi

According to the think tank Demos, the geography of science is changing….rapidly.

"We used to expect new ideas to come from the universities and research laboratories of major companies in the US and Europe. Technology flowed from this innovative core to the technologically dependent periphery. No more. The core and periphery are being scrambled up. Places that were on the margins of innovation ten years ago – Bangalore and Pune in India, Daejon in Korea, Shanghai and Shenzhen in China – are now essential stopping-off points in the continuous flow of people, ideas and technologies around the world.

The rise of China, India and South Korea will remake the innovation landscape. US and European pre-eminence in science-based innovation cannot be taken for granted. The centre of gravity for innovation is starting to shift from west to east."

Charles Leadbeater: Demos report: *The Atlas of Ideas: How Asian innovation can benefit us all.*

India's economy is changing. The radical overhaul of the protectionist policies of the post independence era is paying dividends. Economic growth stands at 8% with no prospect of slowing down in the near future. India resembles China in having a huge population, but the similarity ends there. Unlike China whose phenomenal growth over the nineties we know all too well, India's economic growth is not based on low tech, mass manufacturing, but on knowledge. India's population is young (60% under 40), highly mobile and educated. It boasts 14 million graduates with less than 7 years' work experience, with 2.5 million additional science, engineering and technology (SET) graduates every year: one and a half times the number in China and twice that of the US. All in a country where the literacy rate hovers at around 50% with around 43% receiving no schooling whatsoever.

0.8% of GDP ($4.5billion) is currently spent on R&D. The Indian Government intends to increase this to 2% by 2020. Last year the Government R&D budget was raised by 30%. Again it is tempting to make comparisons with China's expansion, but it is only really the staggering growth figures that can or should be compared. Unlike China, Indian policy has always supported science. Nehru was convinced that India's problems would be solved by Indian brains and so he created a network of elite institutions such as the Indian Institutes of Science and the Indian Institutes of Technology, that are still world-class teaching and research establishments. India has indigenously developed nuclear technology and space-faring capability. In other words the additional money being pumped into Indian science is not being used to create a science base, but to build on existing, extremely firm foundations.

The Demos report points out that while Asian science is on the rise and will dramatically change the way we do things in the future, this represents an opportunity not a threat to the western developed economies. The FCO's Science and Innovation Network (SIN) in India and elsewhere ensures that the UK is in a position not only to benefit from this expansion but also to influence its direction. India has a long tradition of collaboration with the UK, indeed the UK was seminal in the set-up of a number of India's elite institutions. However over the years the UK's position has been overshadowed by the US and eroded by other countries such as France, Germany and Australia. The UK may be the partner of choice for most Indian researchers but, alas, it is no longer the partner in reality.

The SIN India team is involved in a number of initiatives designed to redress the balance and maximise opportunities. Gordon Brown recently announced the first six major awards and 23 standard awards under the UK–India Education and Research Initiative (UKIERI), for which there were over 350 applications. The SIN team is also working with the best of the unsuccessful applicants to help their proposed collaborations to go forward too. The UK-India Science and Innovation Council in June 2006 agreed to find ways to enhance collaboration in key areas. The SIN India team organises workshops, for example on optical fibres, next generation networking, earth observation and climate modelling. The team has also been working to put the UK at the forefront of Indian scientists' minds. Under the public diplomacy initiative: *"UK: Creating Tomorrow"* we have produced a series of six television programmes about innovative breakthroughs emanating from British science that will affect our lives in the year 2020. These programmes, entitled *Vision "2020"*, will be aired on Discovery India over the coming year and distributed as information packs.

The SIN team in India has a great deal of work ahead of it to redress the balance and maximise the opportunities. To do this it has recently been strengthened from four full-time staff to nine. This will help to ensure that it is able not only to survive the tidal wave of Indian expansion and influence but to surf the wave all the way to the beach.

PARLIAMENTARY AND SCIENTIFIC COMMITTEE VISIT TO IMPERIAL COLLEGE TUESDAY 17TH OCTOBER 2006

Report by Dr Douglas J Mills, Technical Secretary, Institute of Corrosion

On an Indian Summer day twenty-five members of the Committee made their way to Kensington and thence to Imperial College (full title Imperial College of Science, Technology and Medicine). It was founded after the Royal Exhibition of 1851 – Prince Albert donating the initial land. It became a stable University in 1907 and will be celebrating its centenary in 2007. After meeting in the large and imposing new reception area off Exhibition Road, we were escorted to the BioIncubator room in the Bessemer Building, where we were addressed initially by Dr Tidu Maini the Pro-Rector for Development and Corporate Affairs. He set the tone for a series of talks emphasising the business aspects of Imperial College's activities. He stressed the importance to the University of application of knowledge to Industry combined with world class scholarship. Interdisciplinary work has also always been encouraged and the University had produced 14 Nobel Prize Winners; it currently has a £500m turnover and a total research income of £250m. The three areas on which the programme concentrated on were: Health (advanced medical imaging); Environment (multiscale dynamics in bio systems); and Energy (improving the quality of life). The most exciting challenge facing IC at the moment is its bid for a $300m Energy BioSciences Institute in competition with MIT, Cambridge and Berkeley. It was anticipated that Imperial's strong financial management and world class Intellectual Property management would weigh in its favour.

Dr Maini's talk was followed by Susan Searle who is CEO of Imperial Innovations Ltd. Her remit is to take ideas "from the Lab to market". Each year she deals with 250 new ideas and helps file 50

patents. Business (MBA) students help identify the markets for technology in their dissertation work. A number of success stories were highlighted, including a body sensor which monitors pulse, temperature, glucose level, oxygen level etc, a smart surgical device such that after surgery such as laparoscopy there was no scar, and, on the physical sciences side, an "intelligent" refinery where wireless technology is used to monitor the thickness of pipework.

One "spun out" company was called Heliswirl which, starting from a theoretical mathematical analysis of how liquids flow, had produced a whole new concept in pipe design (as the name suggest in the form of helix) making flow of fluid through the pipe much more efficient. Despite all these successes, Susan stressed the continuing need for support – a major problem being a lack of readily available venture capital. Lord Jenkin commented that he had identified two equity gaps: the one mentioned by Susan and another in relation to lack of funding for people at Universities to assist in the commercialisation of research; there was also the worry that when companies reach a certain size they migrate from the high tax/high wage economy in UK to elsewhere.

This was followed by talks from three people involved in Imperial College Innovation Spin outs. The first was by Professor Steve Bloom, who talked about Thiakis which is developing products to treat obesity. This is a western problem at the moment (there are not many overweight people in India, China and Thailand) with some 35% of Sicilian children currently classified as obese; in the UK it will be 40% by 2010. After covering the importance of diet and exercise and various approaches to solve the problem (stomach stapling etc), he homed in on methods to chemically control appetite. Hormones in the gut tell the brain when to eat or not eat and one of these hormones (oxyntomodulin) had been identified and produced synthetically. Trials indicated that introducing this was very effective in combating weight gain either on its own or in conjunction with other appetite reducers. However, at the moment it is not user-friendly involving injections three times a day, and a better delivery method is being sought.

The second talk was by Professor John Hassard who described Delta Dot, a company developing instrumentation for analysis for pharmaceutical, defence and other applications. The testing required to bring a new drug to market can take up to 14 years. The Delta Dot "Raptor" range of machines are smaller (essentially bench top) and cheaper than those normally available, with high sensitivity and good resolution. An example was capillary electrophoresis which traditionally takes 35-90 minutes and has poor reproducibility but can be completed in 2-20 minutes using a Raptor machine which gives highly reproducible results. There are also applications in analysing wine and in forensics. The support for this had been DTI funding (genomics programme – helping turn crazy ideas into real products) and there was concern that this funding might be cut.

The final talk was by Professor Nigel Brandon who described Ceres Power – a fuel cell company developing systems for energy production. Fuel cells convert hydrogen (or methane) into electricity and hence they produce zero (or low) carbon emissions. A proton (H^+) exchange mechanism is needed and this can be achieved with a conducting polymer operating at 80-100ºC or a solid oxide (invented at Imperial College) which operates at 750-1000ºC. The former currently have low efficiency and the latter pose some technological challenges. The development that Ceres has been working on is the use of Stainless Steel as the catalyst which operates in the intermediate temperature range (400-500ºC) and is reasonably efficient. The company spun out in 2001 and now has 50 employees. The aim is to produce a micro Combined Light and Power (CHP) unit operating off the normal gas supply to domestic premises. Although the initial investment by the householder would be significant, there would be savings of at least 25% in terms of efficiency (compared with burning fossil fuels in a power station and transmitting the electricity to the home) and most importantly each home would save 1 to 2 tonnes of carbon per annum.

This talk was followed by a lively and wide-ranging question and answer session, concentrating initially on Imperial's situation and whether it could be a model for other universities. It was admitted that of 250 ideas a year only 10 companies emerged, 96% don't make it. It was also noted that 5% of academics have one idea per year or the average academic has one idea every twenty years! On broader topics there was discussion about whether the lack of Research and Development in industry (no GEC, BT or British Aerospace doing research) was holding the country back and whether the role had now been virtually fully taken over by Universities. Did big companies assume (or hope) that the research they needed would be done elsewhere? Should Universities be bigger?

This "seminar" was followed by a brief tour around the laboratories (particularly the Delta Dot instrumentation lab). The visit continued at the Rector's Lodge, a very impressive Queen Anne building on the campus, where we were welcomed for an excellent lunch by Professor Richard Sykes.

All those who took part thoroughly enjoyed the visit. Undoubtedly Imperial College is an excellent example of British entrepreneurship overcoming difficulties and bureaucracy and making a real effort to compete well in the global market.

PARLIAMENTARY AND SCIENTIFIC COMMITTEE VISIT TO NPL (NATIONAL PHYSICAL LABORATORY)

TUESDAY 28TH NOVEMBER 2006

Report by Dr Douglas J Mills, Technical Secretary, Institute of Corrosion

"When you can measure what you are speaking about, you know something about it" Attrib Lord Kelvin (William Thompson)

Sixteen members of the Committee took part in this informative and interesting visit to the National Physical Laboratory in Teddington.

We were welcomed by Steve McQuillan, the Managing Director who, together with Kamal Hossain, the Director of Science and Innovation, gave us an excellent overview of the activities at NPL. Founded in 1900 as the National Standards Institute, it has developed into one of the three top National Measurement Institutes in the world and employs over six hundred staff. However, it does much more than measurement: *inter alia* it can conduct state of the art failure analysis. In 1995 it became a GOCO (Government Owned Contractor Operated partnership) operated by SERCO and there is a secure commitment of funding of £400m over ten years. The operating turnover is £65m, of which about one third is from services for industrial and other users including big companies such as Rolls Royce, Agilent Technologies etc, and many SMEs.

Eighty per cent of traded goods are based on standards and regulations where measurements are required. NPL is at the heart of the National Measurement System providing the basic set of calibrations (some 5000 per annum) which go out to some 400 UKAS accredited labs which do about 1 million calibrations. One important aim of NPL is to assist UK Competitiveness and Steve gave an example from the Biopharmaceutical Industry. Contamination is a key challenge in the development of new drugs but drug companies do not want their secret production methods to be known by other companies. In this case NPL was able to act as broker.

NPL also helps with training and skills, running courses for measurement engineers in Rolls Royce and BAE. Assistance had also been given to an SME which had developed a "PowerMeter" to aid physiotherapists to deliver a safe and effective ultrasound treatment for muscle strain. NPL is involved in national security with the Cyclamen Programme (monitoring at all UK portals) where mathematical modelling and calibration of the neutron test sources has been needed and in a feasibility study on Biometric ID cards. In response to a question from Lord Jenkin of Roding, who asked if measurement of any one parameter was holding back development, Steve replied that progress was needed on several fronts. For example, if time could be measured to one part in 10^{18} (currently one part in 10^{15} was the best) GPS systems could operate to become accurate to nearly one cm.

The party then visited a lab where Alexandre Cuenat spoke on "Opportunities in Micro and Nanotechnology". He showed a "state of the art" AFM (Atomic Force Microscope) capable of atomic resolution without requiring high vacuum. He explained how nanoscattering by reducing friction could assist with the mixing of very small quantities of fluids as required for portable micro sensors which could monitor components in blood and indicate abnormalities. He also explained how nanotubes could be made into gas sensors using changes in the electrical properties of the polymer coating on the nanotube.

From there we moved to see the Caesium Fountain clock. Krzysztof Szymaniec told us how this can be used to calibrate any other clocks in the world. Essentially it is an oscillator: laser light shining on caesium emits 10GHz radiation as a particular (very fast!) electronic transition. This enables time to be measured to an accuracy 10^{-15} second. The internationally agreed definition of the second is now related to this caesium transition.

Next it was across to Helen Margolis to explain how the next generation of clocks were being developed. These would use optical transitions rather than microwave, the oscillator being based on a narrow transition in a single trapped strontium or ytterbium ion. Technical challenges were gradually being overcome to enable orders of magnitude improvement over the accuracy of the Caesium fountain. This will enable improved satellite navigation systems, better tracking of deep space probes and more accurate measurements of fundamental physical constants.

The final lab visit to the Kaye building involved support for cancer treatment where Martyn Sené was our guide. Around 380,000 people are diagnosed with cancer in the UK annually and 40% of those are treated with radiotherapy. It is important that the radiation dose is delivered accurately. Cobalt-60 (^{60}Co) Sources (produces gamma-rays) need to be checked regularly as do the linear accelerators (producing high energy x-rays and high energy electron beams). Every hospital has a secondary standard ionisation chamber against which all doses are checked – and every 2/3 years these standards come back to NPL for calibration. The group is also working to enable emerging technologies for radiotherapy to reach their full potential, eg Tomotherapy and other conformal radiotherapy techniques that aim to deliver the exact radiation dose to just the tumour and nowhere else. There is also an active ultrasonics group at NPL who are helping to quantify a new high intensity ultrasound-based cancer treatment (HIFU).

There was an opportunity for members of the party to question NPL personnel over a buffet lunch, after which Glenis Tellett described Knowledge Transfer at NPL. Companies were benefiting to the extent of £700m per annum as a result of NPL's assistance with more active measurement. She emphasised the importance of Knowledge Transfer Networks (KTNs) with currently 5000 companies involved of which 400 were actively collaborating in research. NPL runs two KTNs, one specialised in Sensors and the other on Location. Several examples were given of successful knowledge transfer to (mainly) small companies, for example improving train brakes, dealing with "going-off" cheese and measurement of ulcers by use of a stereo camera system and digital imaging techniques.

Finally, there was a short question and answer session. We all came away impressed with what NPL are doing and certainly with more Physics knowledge than we started the day with! Let us hope we can all remember at least some of it!

BOOK REVIEW

Discarded Science – Ideas that seemed a good idea at the time

John Grant

Published by AAPPL Artists and Photographers Press Ltd, 2006 (£9.99)

When I was asked to review this book I expected it to be about ideas which people had regarding the future but which were found out to be wrong when later evidence came up. It is, however, more about the history of the various theories regarding the development of the earth and the universe (around 100 of the 335 pages) and the origins of the human species (around 50 pages).

Scientists these days do not get a good reception as witness the BSE discussions in the popular press. One reason is that the general public do not have a good understanding of the scientific method. If this book had been of the type I expected it might have gone some way to remedying this situation.

The 2002 study by Taleyarkhan on cold fusion, which is included, is one such example. I would have thought that this deserved further coverage and the inclusion of more similar examples.

As a psychologist/ergonomist I am perhaps reviewing under false pretences. In line with the views above I had expected examples of scientists who, having got an idea they believed in, continued to believe in it, even after evidence was found which contradicted the idea – perhaps even inventing data, and of rivalry between different scientists with one ignoring the evidence of the other because of the "not invented here" syndrome. There are examples of these but, again, not to the degree I would have expected.

Inventing data is mentioned briefly in regard to Cyril Burt's study on intelligence when he invented subjects which supported his theory; I am sure that there are many others. There is the recent work by Hwang in South Korea concerning cloning human stem cell research but that may have been discovered after the book went to press.

One example of the NIH syndrome which I would have thought merited a longitudinal study was the discovery by Semmelweis in the 1840s, with good evidence, that infections in hospitals could be drastically cut if medical staff washed their hands between seeing patients. The lesson was not learned then and he, in fact, got the sack for being radical. Even today there seems to be a reluctance to follow the rules of good hygiene.

Another example of scientific rivalry is covered by the differences of opinion in regard to Einstein's theory of relativity with Grant stating that many of the scientists involved in the debate did not really understand it!

Medicine is a good field to study the developments of ideas which are subsequently dropped and there are some examples of these in the book. Of course, when people are ill they will clutch on to straws to get better, especially with life-threatening situations, and physicians will react to that pressure to develop drugs and procedures to make them better, aided, of course, by the drug companies who see the prospect of handsome profits.

Grant quotes a number of procedures which he claims have been found to be less effective than believed at one time including ear grommets, tonsillectomy, mastectomy (as opposed to lumpectomy), prostate cancer treatments. There are many others. As he says, many illnesses will get better on their own without treatment. Of course, if patients really believe in their physician or the claims made for the drug or the treatment then the placebo effect takes place.

Another related area where there is belief by a large part of the public but often little evidence is that of complementary medicine. There is some mention of homeopathy and acupuncture and a review of some outdated medical theories such as physiognomy and phrenology.

There is considerable discussion of the role of faith-based views such as intelligent design and creationism in relation to the scientific theories such as Darwin's. The emphasis of the comparisons is on the extent of the evidence.

Also covered in the book are the evidence (or rather the lack of it) for the presence of UFOs and visiting aliens from outer space and the changing attitudes over time to sex.

As a final point I must take issue with the author on one statement. He states that it is hard sciences like physics and chemistry, amongst other things, that make the wheels of technology go round. Whilst this is obviously true it is nowhere near the whole truth. It is the softer sciences like psychology and ergonomics which ensure that the wheels start and continue to turn. Failure to consider organisational issues and the views of people may prevent any new system actually getting started and a failure to consider the capacities, limitations and needs (ergonomics) of those interacting with the system can result in catastrophic failure.

Reg Sell

House of Commons Select Committee on Science and Technology

Under the Standing Orders, the Committee's terms of reference are to examine "the expenditure, policy and administration of the Office of Science and Technology and its associated public bodies".

The new Committee was nominated on 19 July 2005. Members of the Committee are Adam Afriyie (Con, Windsor), Mr Jim Devine (Livingston), Mr Robert Flello (Lab, Stoke on Trent South), Dr Evan Harris (Lib Dem, Oxford West and Abingdon), Dr Brian Iddon (Lab, Bolton South East), Mr Brooks Newmark (Con, Braintree), Anne Snelgrove (Lab/Co op, South Swindon), Bob Spink (Con, Castle Point), Graham Stringer (Lab, Manchester, Blackley), Dr Desmond Turner (Lab, Brighton Kemptown), and Mr Phil Willis (Lib Dem, Harrogate and Knaresborough). Mr Phil Willis was elected Chairman of the Committee at its first meeting on 20 July 2005.

Oral Evidence

Science Question Time

The Committee hosted a "Science Question Time" with Lord Sainsbury of Turville on Wednesday 18 October. The topics covered included knowledge transfer, strategic science provision in universities, the EU Framework Seven Programme, and funding of science centres.

Classification of Illegal Drugs: Follow-up session

On Wednesday 22 November, the Committee took evidence from Mr Vernon Coaker MP, Parliamentary Under-Secretary of State for Policing, Security and Community Safety, Home Office, Professor Sir Michael Rawlins, Chairman of the Advisory Council on the Misuse of Drugs (ACMD), and Professor David Nutt, Chair of the Technical Committee, ACMD. This session was a follow-up to the Committee's Fifth Report of Session 2005-06, *Drug classification: making a hash of it? (HC 1031) and The Government Reply to the Fifth Report from the House of Commons Science and Technology Committee, Session 2005-06 HC 1031: Drug classification: making a hash of it? (Cm 6941).*

Current Inquiries

Human Enhancement Technologies in Sport

On 1 March 2006, the Committee announced a new inquiry focused on the use of human enhancement technologies (HETs) in sport, with particular reference to technologies which are likely to impact on the 2012 Olympics. The Committee is interested in the opportunities and problems presented by the increasing availability of technologies capable of enhancing sporting performance.

The Committee has heard oral evidence from the following: the Department for Culture, Media and Sport; UK Sport; the British Olympic Association; the World Anti-Doping Association; the International Olympic Committee Medical Commission; GlaxoSmithKline/Lucozade Sport; UK Athletics; Qinetiq, and the University of Glasgow. A Report is expected in spring 2007.

Research Council Institutes

The Committee announced its terms of reference on 22 March 2006. The inquiry is focusing on the Research Councils' strategies for providing support to their institutes and centres.

The Committee has heard oral evidence from the following: the Biotechnology and Biological Sciences Research Council; the Medical Research Council; the Natural Environment Research Council; the Department for Environment, Food and Rural Affairs; the Institute for Animal Health; Rothamsted Research; the Institute of Grassland and Environmental Research; the Centre for Ecology and Hydrology; the Tyndall Centre for Climate Change Research; the National Institute for Medical Research, and the Medical Research Council. A Report is expected in spring 2007.

Space Policy

On 19 July 2006, the Committee announced an inquiry into space policy in the UK. The inquiry is focusing upon the current levels of investment in the sector, the UK's relationship with the European Space Agency, the delivery of public benefits from the space-related activities of different Government departments, and the support for space-related research.

Oral evidence sessions began in December and the Committee has taken evidence from industrialists, the Particle Physics and Astronomy Research Council, the Council for the Central Laboratory of the Research Councils, and the British National Space Centre. Oral evidence sessions will continue in the spring.

Investigating the Oceans

The Committee is undertaking an inquiry into marine science. It will consider the organisation and funding of marine science, the role of the UK internationally in this field, support for marine science, the use of marine sites of special scientific interest, and the state of the UK research and skills base underpinning marine science.

The inquiry was launched on 27 November 2006 and the Committee is currently welcoming written evidence. Oral evidence sessions will commence in late spring.

Reports

Scientific Advice, Risk and Evidence Based Policy Making

The Committee published its Seventh Report of Session 2005-06, *Scientific Advice, Risk and Evidence Based Policy Making* (HC 900) on 8 November 2006. The Report was wide-ranging and considered the structures for scientific advice, evidence based policy making and the treatment of risk throughout Government. It recommended that the Government Chief Scientific Adviser be relocated from DTI to the Cabinet Office, that Departmental Chief Scientific Advisers be external appointments and that a scientific civil service be established. The Government will respond to this Report early in 2007.

Government Responses

Classification of Illegal Drugs

On 13 October 2006, the Government published *The Government Reply to the Fifth Report from the House of Commons Science and Technology Committee, Session 2005-06 HC 1031: Drug classification: making a hash of it?* (Cm 6941).

Identity Card Technologies

On 20 October 2006, the Government published *The Government Reply to the Sixth Report from the House of Commons Science and Technology Committee, Session 2005-06 HC 1032: Identity Card Technologies: Scientific Advice, Risk and Evidence* (Cm 6942).

Knowledge Transfer

The Committee published its Fifth Special Report of Session 2005-06, *Research Council Support for Knowledge Transfer: Government Response to the Committee's Third Report of Session 2005-06* (HC 1653) on 24 October 2006.

EU Physical Agents (Electromagnetic Fields) Directive

The Committee published its Sixth Special Report of Session 2005-06, *Watching the Directives: Scientific Advice on the EU Physical Agents (Electromagnetic Fields) Directive: Responses to the Committee's Fourth Report of Session 2005-06* (HC 1654) on 24 October 2006.

Further Information

Further information about the work of the Committee or its current inquires can be obtained from the Clerk of the Committee, Dr Lynn Gardner, the Second Clerk, Dr Celia Blacklock, or from the Committee Assistant, Ana Ferreira on 020 7219 2792/0859/2794; or by writing to: The Clerk of the Committee, Science and Technology Committee, House of Commons, 7 Millbank, London SW1P 3JA. Inquiries can also be emailed to scitechcom@parliament.uk. Anyone wishing to be included on the Committee's mailing list should contact the staff of the Committee.

Anyone wishing to submit evidence to the Committee is strongly recommended to obtain a copy of the guidance note first. Guidance on the submission of evidence can be found at http://www.parliament.uk/commons/selcom/witguide.htm.

The Committee has a new website address: www.parliament.uk/s&tcom. All recent publications (from May 1997 onwards), terms of reference for all inquiries and press notices are available at this address.

House of Commons Library Science and Environment Section

Research Papers

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 www.parliament.uk/parliamentary_publications_and_archives/research_papers.cfm

The Greater London Authority Bill

Parts 7 and 8 - Planning and Environmental Functions Research Paper 06/61

The Greater London Authority Bill would enable the Mayor of London to take over strategic planning applications from the London boroughs to determine them himself, instead of only being able to direct the boroughs to refuse applications, as is currently the case. The Mayor's powers over waste are also increased, but the Bill does not provide for a London-wide waste authority answerable to the Mayor.

The GLA will have a new duty to take action to mitigate the effects of climate change and help London adapt to its unavoidable impacts. The Bill will also place a duty on the Mayor to produce a statutory Climate Change Mitigation and Energy Strategy for London together with a statutory Climate Change Adaptation Strategy setting out how the capital should adapt to the effects of climate change.

House of Lords Science and Technology Select Committee

The members of the Committee (appointed 21 November 2006) are Lord Broers (Chairman), Lord Colwyn, Lord Haskel, Lord Howie of Troon, Lord May of Oxford, Lord O'Neill of Clackmannan, Lord Patel, Lord Paul, Baroness Perry of Southwark, Baroness Platt of Writtle, the Earl of Selborne, Baroness Sharp of Guildford, Lord Sutherland of Houndwood and Lord Taverne. Baroness Finlay of Llandaff was co-opted to the Committee on 12 December 2006.

Water Management

The Committee's report was published in June, and the Government response was received in August, followed by a debate in the House on Friday 13 October. A short follow-up report was published on 11 January 2007.

Science and Heritage

The Committee's report was published in November. It sets out a comprehensive vision for the future of what the Committee has termed "heritage science"—the diverse range of scientific research that underpins the conservation of our cultural heritage. Following the report's publication, the Committee held a private seminar, to offer key stakeholders, including a number of those who gave evidence, an opportunity to discuss the Committee's recommendations and provide feedback. The response at the seminar, which was held on 23 November, was overwhelmingly positive, with strong backing for the Committee's recommendations from English Heritage, the Research Councils, the Institute for Conservation and others. The Government's response is expected by the end of January 2007, and will be followed by a debate in the House of Lords.

Science Teaching in Schools

The Committee's report was published in November. Among other things, it called for dramatic action to recruit and retain more specialist physics and chemistry teachers; a wider baccalaureate-style examination system to replace A-levels; increased funding for school science laboratories; improved careers advice for students; and a proper career structure for school science technicians. The Government response is expected shortly and a debate in the House of Lords will follow thereafter.

New inquiry: Personal Internet Security

Sub-Committee II's inquiry into Personal Internet security was launched in November. The inquiry, which is being chaired by Lord Broers, will look at a broad range of security issues affecting private individuals when using communicating computer-based devices, either connecting directly to the Internet, or employing other forms of inter-connectivity. In late 2006 meetings were held with Government officials and with representatives of the financial services sector. In early 2007 meetings will be held on child safety, policing, online selling, Internet service provision, and other issues. The Committee will visit the United States in March, and aims to report in summer 2007.

New inquiry: Allergy

Sub-Committee I, chaired by Baroness Finlay of Llandaff, is carrying out an inquiry into allergy. The inquiry was launched in October and is looking at all types of allergy covering a full range of policy issues, but is not focusing primarily on allergy service provision, which was the subject of recent reports by the House of Commons Health Committee and the Department of Health. In November and December, oral evidence was heard from Government officials, academics and pharmaceutical companies. The Sub-Committee also visited the Evelina Children's Hospital to view the allergy treatment offered to children and investigate the research being undertaken by the MRC-Asthma UK Centre in Allergic Mechamisms of Asthma. In early 2007, meetings will be held on the impact of allergic diseases in the workplace, food allergy and anaphylaxis, the use of complementary and alternative medicine for allergic disorders and other issues. The Sub-Committee also plans to visit allergy centres in Germany and aims to report in summer 2007.

New inquiry: Radioactive Waste Management

The Select Committee has decided to hold a short follow-up inquiry, chaired by Lord Broers, into radioactive waste management. The inquiry will focus on the final report and recommendations of the Committee on Radioactive Waste Management (CoRWM), published in July 2006, and the Government's response to the report published in October 2006. The Committee will hear evidence from CoRWM, the Nuclear Decommissioning Authority, Government and others. The Committee's report on this inquiry is expected to be published around Easter.

Further information

The written and oral evidence to the Committee's inquiries mentioned above, as well as the Calls for Evidence on the Committee's new inquiries, can be found on the Committee's website www.parliament.uk/hlscience. Further information about the work of the Committee can be obtained from Cathleen Schulte, Committee Specialist (schultec@parliament.uk or 020 7219 2491). The Committee's email address is hlscience@parliament.uk.

Parliamentary Office of Science and Technology

Recent POST publications

Ambient air quality

November 2006 ***POSTnote 272***

Ambient air quality, the condition of the air in the outdoor environment, directly affects the health of humans and ecosystems. National and European regulation has delivered improvements in UK air quality (see POSTnote 188). Air pollution from major sources such as transport, power generation and industry, is now heavily regulated and declining. However, current air pollution levels continue to cause adverse impacts on human health and the environment, as summarised by this POSTnote.

Military uses of space

December 2006 ***POSTnote 273***

Space plays an increasing role in military activities. Over 800 satellites orbit the earth, many of which have military uses, from reconnaissance to guiding weapons systems. This POSTnote outlines national, EU level and wider military space activities. It discusses small satellite development in the UK and the growing debate over the role of space in European security and defence policy. It highlights concerns over the vulnerability of satellites to accidental damage or hostile acts.

Food security in developing countries

December 2006 ***POSTnote 274***

Food security and insecurity are terms used to describe whether or not people have access to a sufficient quality and quantity of food. They are affected by factors such as poverty, health, food production, political stability, infrastructure, access to markets and natural hazards. Improved food security is important for global reduction of hunger and poverty, and for economic development. One aim of the Millennium Development goals is to reduce by half the proportion of people suffering from hunger by 2015. Currently, 820 million people are so affected in developing countries and numbers are not falling quickly enough to achieve the goal, particularly in Africa and Southern Asia. This POSTnote examines food security in the developing world and options to improve it, including increasing access to food and higher agricultural production.

UK trees and forests

January 2007 ***POSTnote 275***

Trees and forests can provide a range of benefits that are often complementary. Some of these derive from availability of green space in general, but forests may also offer unique opportunities. The social and environmental value of woodland and forest in Great Britain has been estimated to be worth up to £1 billion a year. This POSTnote explores the issues surrounding the sustainable management of existing and new forest in the UK.

Current work

Biological Sciences and Health – Ethnicity and health, Alzheimer's disease and dementia, Strategic science, Prolonging life in newborns, Assisted reproduction technologies, Alternatives to custodial sentencing for young adult offenders.

Environment and Energy - Ecosystem services, Carbon balance of biofuels, Smart metering, Siting of nuclear power plants, Nuclear decommissioning.

Physical Sciences, IT and Communications – International migration of scientists and engineers, E-Science and the grid, Electronic waste, Internet governance, UK electricity infrastructure, Future nuclear technologies.

Seminars

In October POST, collaborating with the Royal Society, held a parliamentary event for the Presidents of all the African national Academies of Science, who were on a mission to the UK at the invitation of the Royal Society. Board member Anne Snelgrove MP discussed her experiences in participating in the Royal Society/MPs' pairing scheme.

Also in October POST, at the request of the Foreign and Commonwealth Office, held a seminar for locally-engaged staff in its Science and Innovation sections at UK embassies to explain the structure and operation of scientific inquiry and support at the UK Parliament, with presentations from the two select committees, the Science and Environment Division of the Commons Library and POST itself.

In November POST, jointly with the All Party Parliamentary Group on Assisted Reproduction, held a seminar to provide the terms of reference for a POST long report on the subject to be published in 2007.

Also in November POST and Ofcom hosted a seminar on Communications Convergence, the fifth in their joint series of parliamentary seminars on Digital Convergence, which was chaired by Board member, Dr Des Turner MP.

Fellows and interns at POST

Thomas Westgate (Manchester University) joined POST in September as a Royal Society of Chemistry Fellow to work on a POSTnote on Strategic science.

Sam Dolan (Cambridge University) joined POST in October as an Institute of Physics Fellow to work on a POSTnote on Electricity infrastructure.

Michael Hammond (Bristol University) joined POST in October as an Engineering and Physical Science Research Council Fellow to work on a POSTnote on Internet governance.

International activities

October

The Director visited the secretariat of the European Parliament (EP) in Luxembourg for discussions with former Directors of the EP's Science and Technology Options Assessments unit on establishing postgraduate scholarships at the EP.

The Chair, Board member Lord Oxburgh, the Director and Dr Baldwin attended the annual European Parliamentary Technology Assessment network (EPTA) Council and Conference in Oslo. The overall theme of the conference was European Energy Systems in Transition. The Chair made the key presentation in the session on nuclear power, while Lord Oxburgh was commentator in the session on clean fossil fuels.

POST Fellow Dr Walraj Gosal attended the 22nd Conference on Alzheimer's Disease in Berlin, one of the largest international conferences of its kind, in connection with the writing of the POSTnote on Alzheimer's disease and dementia.

POST Fellow Michael Hammond participated in the UN-sponsored Internet Governance Forum in Athens, in connection with writing a POSTnote on this subject.

Dr Peter Border represented POST at the INES Partners' Meeting and Final Conference in Brussels. POST has been a member of this European Commission-funded project since 2005.

At the invitation of the Japanese Government, the Director, was one of three international assessors for its Ministry of Education Culture, Sports, Science and Technology "Super-centres of Excellence" scheme, which funds innovative research at universities and public research institutes. While in Japan, he also visited the experimental flue gas carbon dioxide capture plant at the coal-fired Matsushima Power Station.

November

Dr Peter Border attended the 7th EMBL/EMBO Joint Conference on Science and Society: Genes, brain/mind and behaviour at the European Molecular Biology Laboratory in Heidelberg.

The Director visited the Canadian Parliamentary Centre in Ottawa for discussions on potential collaboration. The Chair and he also participated in the 2006 bilateral Canada-UK Colloquium, held at Lake Louise, Alberta, on the subject of Energy Security.

December

The Director visited Bonn for the annual planning meeting of the European Technology Assessment Group, while Dr Jofey Craig attended a planning meeting for a new project on genetically modified food and crops being conducted by members of the EPTA network..

LETTERS TO THE EDITOR

Sir,

The Royal Commission on Environmental Pollution

I was very interested to read the piece in the summer issue of Science in Parliament about the Past, Present and Future of the Royal Commission on Environmental Pollution.

It was indeed "created by Harold Wilson's Government," in the Department of Housing and Local Government when I was House of Lords Parliamentary Undersecretary there – ie subordinate minister. I had the rewarding experience of pushing it through in the face of considerable opposition from some of the civil servants, but with, of course, the support first of Dick Crossman and then of Tony Greenwood. The civil servants either didn't think environmental pollution important, or disliked the idea of a permanent Royal Commission in general.

This "permanence" in due course outdid Mrs Thatcher.

Lord Kennet

Sir,

Fly Ash - toxic waste or valuable by-product?

"The environmental advantages of using fly ash" was the crucial issue at stake at a workshop held by STEAG PowerMinerals Ltd on 21st November at The German House, Belgrave Square. Audiences and speakers from a wide range of sectors were brought together to debate issues of common interest concerning the after-use of fly ash derived from the combustion of coal in the course of electric power generation.

Fly ash is a combination of glassy, silica-rich mineral phases that were present, prior to combustion of the coal, as naturally occurring detrital mineral grains. These were washed by rivers into the sedimentary basins where the coal was formed and these mineral grains are now disseminated naturally throughout coal seams. The fly ash, also known as PFA (pulverised fly ash) is recovered from the flue gases, and also at the base of the furnace, and is not permitted to escape up the flue into the environment if the furnace is operated to agreed, internationally accepted standards. This is not always the case in some countries. Coals vary enormously in their natural mineral content and disposal of the ash thus generated is essential if power generation is to continue at the power station. The ash however has a very wide range of very useful applications as an inert bulk mineral, rather like silica sand. Indeed, in some EU countries the entire national production of fly ash is reused with nothing being sent to landfill and without contravening any EU-wide legislation on the topic.

However, in the UK the situation is handled rather differently, as the Environment Agency's several and conflicting interpretations of EU legislation may – or may not – stipulate that fly ash is a waste product. Where it does, there are clear implications concerning waste management and restrictions on after-use applications. The end result is that about half of the UK's fly ash goes to increasingly expensive and scarce landfill, when, based on the Continental EU example, it could be treated as an asset rather than a waste product. The difference in the interpretation of the same EU legislation between Member States thus results in considerable economic disadvantage to the UK, when compared with our EU competitors. It also contributes considerably to the excess energy wasted, and CO_2 generated, by landfill disposal. It would be far better to make a positive asset of the fly ash and use it as a high quality construction material with a wide range of commercial applications.

There is therefore ever-increasing pressure for fly ash to be reclassified in the UK as a by-product and not a waste-product. This will have the advantage of enabling the UK to handle the product cleanly and efficiently, while minimising local and national bureaucracy. This will allow commercial opportunities to present themselves as they have in other EU Member States.

Thomas Duve
Chief Executive Officer
STEAG PowerMinerals Ltd

Parliamentary and Scientific Committee News

We are delighted to welcome the following new members:

Scientific and Technical Organisations

The Association for the Study of Animal Behaviour represented by Dr Emma Cunningham

The Centre of Excellence for Life Sciences Ltd represented by Dr Ian Robson

The Foundation for Science Technology and Civilization represented by Professor Salim T S Al-Hassan, Chairman

The Royal Meteorological Society represented by Professor Paul Hardaker, Chief Executive

University

The University of Portsmouth represented by Professor John Turner, Pro-Vice-Chancellor

Industrial Member

PHARMAQ Ltd represented by Dr Lydia Brown, Managing Director

Publication of UK and European Digests

In order to release more pages for additional articles on relevant topics the editorial board of Science in Parliament has decided that from October 2006 UK and European Digests will no longer be published in the journal, Science in Parliament, but will be available on the website: www.scienceinparliament.org.uk. They can be found under Publications and can be accessed using the members' and subscribers' password (available from the secretariat).

In future the Digests will be published more frequently on the website (roughly every six weeks for the UK Digests and monthly for the European Digests) and the information contained will therefore be more up to date. It is hoped that our readers will find the new arrangements more useful. For those who do not have access to the internet paper copies of the digests can be supplied by post. Please contact the Committee secretariat.

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

Debates and Selected Parliamentary Questions & Answers

Following is a selection of Debates and Parliamentary 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 9th October to 8th November and from 15th November to 19th December 2006 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.

Crime

National DNA Database

Debate in House of Commons on Wednesday 15 November

Dr Ian Gibson (Norwich N): We can tell that the debate is serious because no one is in the Chamber except the Minister and me. That is a good omen that something will happen in the future, which is what I want from the debate. Forensic science made a great leap forward in 1985 when a British scientist, Alec – now Sir Alec – Jeffreys of Leicester University, discovered a new way of identifying people within a few hours using the molecule deoxyribonucleic acid, or DNA. Scene of crime identification – picking up the DNA and identifying the individual – can now be done in minutes. According to Sir Alec Jeffreys, 10 different genetic markers are used which should be extended to 16 to reduce the chance of mismatching. Only one bad mismatch would be needed to destroy the whole industry and culture of this technology. Hence pressure to place everyone on the National DNA database at the present stage of development should be resisted. There is a wide range of societal issues over the creation and application of the database that have never been openly discussed and debated, as pragmatism rather than policy appeared to dominate the process. Indeed the range of issues is ever increasing without the Government justifying and explaining how the database is managed now and what the plans are for the future. Hence the purpose of this debate is to raise the matter in such a way that the Government will be encouraged to present a much greater in-depth analysis and report of this increasingly important technology where the UK holds the lead internationally. The intention is to ensure clarity of purpose in future development of this vitally important technology for the benefit of society as a whole.

The Parliamentary Under-Secretary of State for the Home Department (Mr Vernon Coaker): Forensic science is now able to make a remarkable contribution to the prevention and detection of crime thanks in large part due to the key contribution made by the DNA database to the work of the police and criminal justice system. The Government believe that the current powers to take and retain DNA are proportionate and justified in the interests of preventing and detecting crime. As always, the debate is about individual liberty and public protection, and the balance between the two.

Since the legislation change in 2001 that allowed the police to retain DNA profiles of non-convicted persons, approximately 8500 profiles of such persons have been linked with other crime scene stains, including 114 murders, 55 attempted murders, 116 rapes, 68 sexual offences, and 119 aggravated burglaries. Would these crimes have still been detected if the police had not had available to them the match between the person's DNA profile and that found at the scene of the crime?

The proportion of white-skinned European and black and ethnic minority people's DNA profiles on the database closely mirrors the proportion of ethic groups reported at different stages of the criminal justice process in England and Wales. This suggests that the national DNA database reflects the police processes by which people are brought into the criminal justice system and lawfully sampled under suspicion or arrest for a recordable offence. The message that this Government want to send to offenders past, present, and future is that science and the law working together will bring more offenders to justice.

Education

Science in Higher Education

Debate in Westminster Hall on Tuesday 31 October 2006

Mr Rob Wilson (Reading E): The funding of science in higher education in England and Wales is becoming of concern to my constituents following the proposal to close the small but very capable physics department at Reading University, which is among the world's top 200, is extremely well run and has a strong reputation for research into atomic and molecular physics. That is why the university wanted to save it, if at all possible. The university has recently been stung by the new lecturer's pay settlement and changes to pension arrangements involving an additional £1m per year in extra pension contributions alone, and big rises in energy costs and an ever-growing backlog of maintenance to deal with. Many other UK universities are suffering similar financial crises with the axe falling fastest on the pure science subjects such as physics and chemistry. Since Labour came to power in 1997, 19 physics and 10 chemistry departments have closed, with about 80 science departments closing in the last six years. The Royal Society of Chemistry believes that in 10 years' time, only 40 chemistry departments will be left in England and Wales. The Institute of Physics report on 10 departments in English universities found that they were all in deficit, usually heavily. They were dependent on public funding and the metrics used to allocate it, with large fixed costs and outdated lab equipment requiring substantial investment. The necessary investment can only be made if large numbers of students are attracted, but this cannot be guaranteed.

This year Reading University is getting fewer than half the physics students that it had in 2002. The drop in numbers is thought to be due to a preference for easier subjects, such as combined science or media studies;

school league tables where science teachers, with one third holding a third-class degree or lower, push students towards less challenging subjects; and the lack of properly qualified teachers, with 80% of physics teachers without a degree in physics but having core skills in biology.

The Minister for Higher Education and Lifelong Learning (Bill Rammell) offered his congratulations on securing the debate, but nothing else, as he considered the foregoing remarks a travesty of the Government's record of investment in the higher education system over the past nine and a half years, particularly the investment in the scientific research and development base. The planned closure of Reading University's physics department was a matter for the university.

Bob Spink (Castle Point): The Minister will agree that the Government are planning to increase by 24,000 the number of physics and chemistry students by 2014, but what is the point of doing that if he allows departments that teach science in universities to close?

Bill Rammell did not think that there was any evidence that Government Departments dictating to universities which subjects they should deliver was the way to a sustainable future.

Mr Wilson: I want the Minister to deal with the point that I raised about whether he takes a view on how many physicists or departments we need in this country. Has any research been done on that?

Bill Rammell: I am happy to follow that up in writing. We certainly set out specific targets for the number of additional entrants for A-level qualifications that we wish to see by 2014. I think that we can make progress on that target, and if we can achieve it we will see the numbers flowing through to universities.

Universities Research Assessment Exercise

Debate in Westminster Hall on Wednesday 13 December

Dr Tony Wright (Cannock Chase): I want to concentrate on what I think I know and on what I have been told by distinguished academics in social science and the humanities. There are many disciplines on which I have no authority to speak – science, engineering and technology. It may be that they have no difficulties in the way that research is assessed, whether it is done in the present RAE form or in the form of the metrics that is planned to replace it. It is widely said that RAE designed for natural sciences is inappropriately applied to the humanities and the social sciences. In social science in particular, the RAE drives the profession in upon itself, cutting itself off from a wider public discourse. It is marooned in a private and impenetrable language, and it is consumed by its own publishing preoccupations. No thought is allowed to go unreferenced, and sentences become ugly aggregates of borrowed phrases. One only has to pick up a copy of a political science journal to find oneself immediately in the linguistic world of prefabricated henhouses. The Orwell mission of turning political writing into an art has no chance at all in this kind of academic environment. Journals are invented just to consume the products of the RAE and the more obscure and professionally introverted they are, the better. Public relevance is despised and devalued. In the disciplines that I know and care about, I want the perversities of the current arrangements to be rectified. I want the work of public intellectuals to be encouraged, the civic purpose of the university to be affirmed, policy-relevant research to be celebrated and valued, and the bias against teaching to be attended to.

The Parliamentary Under-Secretary of State foe Education and Skills (Mr Parmjit Dhanda): I hope you have heard the news about abolition of the RAE after 2008. Although the RAE has served the country well, the Government and higher education sector alike have continued to seek a simpler system. The Government have announced the move to a metrics based system after the 2008 RAE. The first assessment for SET subjects under the new system will take place in 2009 and it will begin to inform funding from the 2010-11 academic year. It will completely replace the RAE 2008 element in funding for SET subjects by 2014-15. For other subjects assessment under the new lighter-touch arrangements will be in academic year 2013, and it will inform funding from 2014-15. The detailed design of the process requires further work and the Higher Education Funding Council have been invited to lead that work and involve the sector closely. Our aim is to continue to reward research excellence but to reduce significantly the administrative burden on higher education institutions and their researchers.

Science: Skills

Question and Written Answer on Tuesday 19 December

Lord Stoddart of Swindon asked Her Majesty's Government: by what means and when since 1997 they have made or received estimates of likely shortfalls in the number of skilled or otherwise qualified personnel to fulfil the needs of science-related industries; and what steps they are taking to review and plan for any current or future deficit.

The Parliamentary Under-Secretary of State, Department of Trade and Industry (Lord Truscott): The recent Leitch review on skills supports the stance that estimating the exact number of skilled or otherwise qualified personnel to fulfil the needs of science-related industries is difficult and not advisable in a dynamic and rapidly changing economy. It does not believe that the Government should aim to predict the impact of future technological advances and attempt centrally to provide the skills they believe will be necessary.

The Government can and do analyse data on STEM (science, technology, engineering and mathematics) subjects, employment rates of science graduates, international comparisons of stocks and flows of science skills, and consider national employer skills surveys. Such analyses (for example, the DTI's economic paper No 16 *Science, Engineering and Technology Skills in the UK* March 2006, and DfES research report 775: *The Supply and Demand for Science, Technology, Engineering and Mathematics Skills in the UK Economy*) suggest that, at the broadest level, the supply of STEM skills is likely to meet demand over the next decade. However, we accept that there is the need for further action regarding the situation for specific science subjects, such as engineering and physical sciences. The falls in participation in mathematics and science A-levels are equally a cause for concern.

The Government have, therefore, made science education a high priority. The *Science and Innovation Investment Framework 2004-14: next steps* and STEM programme reports set out our commitment to improving STEM skills by increasing attainment of science and mathematics at GCSE level, increasing participation in science subjects post-16 and improving the quality and number of science teachers.

Energy

Energy Supply

Debate in House of Commons on Monday 30 October

The Secretary of State for Trade and Industry (Mr Alistair Darling) introduced this debate on the energy review published on July 1. This is also an opportunity to discuss the security of gas supplies due to the rapid decline in North sea gas production and also coincides with the publication of the report by Sir Nicholas Stern on the economic issues surrounding climate change. The review concludes that there is still time to avoid the worst environmental impacts if we act now and internationally. We need an economy that is both pro-growth and pro-green with an economic policy that is also an environmental policy, as indicated by the Chancellor.

The Secretary of State for DEFRA has also announced that a Climate Change Bill will be introduced so that we can become a leading low-carbon economy and which will provide a clear framework so that we can meet our long-term climate change targets to reduce CO_2 emissions by 60% by 2050, with real progress by 2020.

Mr Charles Walker (Broxbourne) indicated that reduction of carbon emissions must not be permitted to impact negatively on the UK's global competitiveness.

Mr Alistair Darling pointed out that one of the central findings of the Stern report is that there is an economic cost for doing nothing. It is far more efficient and effective to take action to tackle climate change, which will in turn help us to maintain our competitive position. Regarding security of gas supply and increased prices due to recent uncertainty, the Langeled pipeline between Norway and the UK has now been opened. The Balgzand to Bacton pipeline will bring in gas from the Netherlands. The Belgian interconnector has been completed and work continues on the Teesside offshore LNG importation project. Storage facilities at Rough and Humbly Grove are now both full up with gas. The Norwegian Ormen Lange field and the new LNG importation facilities at Milford Haven will start to provide us with gas in 2007.

The Minister for Energy (Malcolm Wicks) summarised the long debate by indicating that many of the things we need to do to save the planet in terms of climate change are the same things that we need to do in terms of energy security; yes, energy efficiency; yes, renewables; yes, clean coal technology, carbon capture and storage; and yes, a green light, if the market can come forward, for a new generation of nuclear reactors. However there is no one silver bullet or single answer. There is no uranium bullet. Diversity is the name of the game. We will return to these issues in the weeks and century to come.

Traffic Lights

Question and Written Answer on Thursday 14 December

Dr Iddon (Bolton SE): To ask the Secretary of State for Transport if he will estimate the *(a)* carbon dioxide emissions, *(b)* operational costs and *(c)* maintenance costs of a (i) light-emitting diode traffic light and (ii) normal traffic light.

Gillian Merron: The Department for Transport has estimated the amount of energy used by conventional traffic signals to be of the order of 17-24 MW/hr. Changing to light emitting diode traffic signals could potentially save 50-60% of this. Carbon dioxide emission reductions, operational costs and maintenance costs have not been estimated. Some of these depend on local energy agreements and maintenance practices and are for the local highway authority to determine.

Environment

Water Management (S&T Report)

Debate in House of Lords on Friday 13 October

The Earl of Selborne introduced the debate to take note of the report of the Science and Technology Committee on Water Management (8th Report, HL Paper 191). There was much public interest on publication of the report which coincided with regional hosepipe bans, water shortage warnings, publicity on leakage rates and water company profits, as well as a concern about house building proposals in water shortage areas. The realistic timescale for water resource development is 25 years, which does not match regional planning strategies. Furthermore any future EU legislation such as the current habitats, water framework and priority substance directives may also impact on development plans in the future.

The report focuses on the lack of transparency, openness and shared methodology for forecasting demand between Government and regulators. It is not clear what methodology has been adopted by Government in determining water supply for increased housing supply targets. Indeed an admission, "Look, this has not been an exercise in best practice in consultation" would have been appropriate. The so-called twin track approach reconciling demand and supply is anything but, as it is operated consecutively, thus delaying any future plans for increased supply from new infrastructure until all other options are exhausted. Water supply to vulnerable groups that cannot afford to pay is complicated by the fact that many who can afford to do so don't pay without suffering any negative consequences. Indeed South East Water has £15m of unpaid bills on a turnover of £100m. This combined with high leakage rates in some areas and a negative attitude to meter usage, creates an image of an industry suffering from a lack of inclusiveness and transparency. There may be a need therefore to bring the Environment Agency, Ofwat, the Government, consumers and others such as the Consumer Council for Water under statutory regional boards to promote compulsory consultation between the parties concerned.

Lord Oxburgh noted that in recent years the annual expenditure by water companies on research and development has been around £20m compared with an annual turnover of around £7b and an annual total of unpaid water bills of around £1b. The research expenditure is inadequate to deal with new technologies for leak prevention and sealing, the greater use of water purification technologies using membranes and improved water testing and analysis for chemical impurities and pathogens. Unfortunately neither the Government nor Ofwat appreciate the practical difficulties in setting up and conducting research of importance to the water industry which should be seen as an investment in the future rather than an in-year cost. Ofwat are encouraged to contact the Government's director general for research and innovation or the Chief Scientific Adviser for further advice on an appropriate funding structure.

Lord Broers emphasised the need for Government to show stronger leadership in informing the public about critical issues related to water management. He went on to criticise the monitoring of water usage and billing as primitive – years out of date by best practice standards in the western world. Meters should be provided for everyone, not the diminutive 28% who have them currently, and they should be accessible and prominent. Of all countries in the world, Britain should not be precipitating itself into a water crisis as all the problems can be solved by modifying behaviour with carefully planned increases in supply.

The Minister of State, Department for Environment, Food and Rural Affairs (Lord Rooker) responded on behalf of the Government and referred to the endemic lack of investment and infrastructure over decades and the general lack of welcome to the Government's response to the report. However any suggestion that the existing system of water management is dispersed and unclear was rejected as the water management measures introduced by the Government will secure a sustainable use of water both now and in the future. A long list of rather complicated and often obscure actions and decisions at various stages of completion were then listed, particularly in relation to the "200,000 homes for the south-east". Water metering was described as "a pathetic 28%" both of which appear at variance with the initial statement. An invitation to revisit the issue was offered in 18-24 months time to examine progress.

The Earl of Selborne accepted the Minister's invitation to revisit the issue.

Science Policy

Programme for Research: EUC Report

Debate in House of Lords on Friday 3 November

Lord Woolmer of Leeds introduced the debate to take note of the report of the European Union Committee on the Seventh Framework Programme for Research (33rd Report, HL Paper 182).

The budget for the seventh programme commencing on 1 January 2007 will be €54b – about €7.7b a year, which compares with about €5b a year in the sixth programme, a significant increase reflecting the importance attached to it by the Council of Ministers. There are four broad objectives: the first, with 60-65% of the budget, is to support co-operation between industry, universities, research centres and public bodies to gain leadership in key scientific and technological areas. The second, with 15-20% of the budget, is to promote and fund basic frontier research which will be the responsibility of the new European Research Council. The third, with 10% of the budget, is to train and provide mobility and careers development for researchers through the Marie Curie schemes. The fourth, with 10%, is to strengthen research and innovation capacity throughout Europe.

Baroness Sharp of Guildford expressed deep scepticism about Barossa's baby, namely the suggested European Institute of Technology; as a virtual institute is not the same as a physical place such as the Massachusetts Institute of Technology which has taken 150 years to develop. The whole idea about exchange and cross-fertilization of ideas by being able to rub shoulders with others is extremely important. We shall have to watch it fairly carefully.

Lord McKenzie of Luton responded for the Government in support of the further development of the European research area through FP7. UK research organisations have traditionally done well out of the framework programme. In FP6, UK organisations are involved in 48% of projects and have secured 14.5% of funding – in the region of $1.74b. The European Institute of Technology did not find favour today. The proposed EIT will support a series of autonomous partnerships – knowledge and innovation communities. The Government have been closely involved in discussions and are pleased that the Commission has taken our concerns on board. The Commission has proposed a budget of €2.4b for 2007-13, but it is unclear where the funding will come from, how market funding will be attracted, or how this will impact on other budgetary priorities. It is important that funds are found within existing EU resources and are not taken from existing programmes such as FP7.

Nanotechnology

Questions and Written Answers on Thursday 14 December

Dr Gibson (Norwich N): To ask the Secretary of State for Trade and Industry (1) what assessment he has made of the outcome of Government spending on nanotechnology research in the last five years;

(2) how much money the Government plans to spend on nanotechnology in the next five years; and how this funding programme will be structured.

Malcolm Wicks: The Government intend to provide continued funding for nanotechnologies over the next five years. Funding will be directed towards a programme of research to address the potential risks posed by engineered nanoscale materials. Further funding will help industry to maximise the potential benefits of nanotechnologies by contributing to research, knowledge sharing and infrastructure development.

Decisions on the amounts of funding have yet to be taken. However, the Government's first research report, published in November 2005, and a progress report in October 2006 set out current and proposed work and indicate what further research is needed to address the potential risks posed by engineered nanoscale materials. The new Technology Strategy Board will have responsibility for "science to business" collaborative research and development, and Knowledge Transfer Networks (one of which will build on the work of the Micro and Nano Technology Network). We will also be promoting the substantial funding opportunities within the EU framework programmes which we co-fund with other member states. We are working internationally to ensure that the UK funds research that complements, and does not duplicate, other research around the world.

The outcomes of nanotechnology research to address the potential risks posed by engineered nanoscale materials are assessed by the relevant Departments and agencies, with co-ordination by the Nanotechnology Research Co-ordination Group. It is too early to draw conclusions from the outcomes as few projects have been completed.

Euro-News

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

Determining the patterns of exposure to pesticides

Essential steps are being taken by the Europit project, funded under the Family and Psychological Services programme "Life Quality" to determine the pattern of human occupational exposure to immunotoxicants. Pesticides are widely used in agriculture for preventing or repelling pests, including insects, mammals, plant pathogens, weeds ands microbes that destroy crops and property. As a consequence, a great part of the population may be exposed to these compounds. Knowledge on the health risks associated with prolonged exposure to these compounds is rather poor and major uncertainties still exist. In the case of prolonged low-dose exposure, in particular, the association between pesticides and the occurrence of adverse effects on human health is often less clear and thus difficult to prove. In agricultural fields, workers are exposed to pesticides in numerous activities. Assessment of exposure is undertaken by determination of the presence of the main metabolite of these compounds, ethylenethiourea (ETU) in urinary excretions. Urinary ETU levels from a control group of unexposed subjects are set as a reference biological value for the general population at European level.

Protecting Europe's fish against endocrine disruptor compounds

The faster one can detect harmful levels of pollutants in water, the faster one can respond to protect the ecosystem's residents. Researchers in Italy exploited liquid chromatography-mass spectrometry (LC-MS) that allows for separation and quantification of several different chemical species simultaneously to provide concentration data for endocrine disruptors in a very short period of time. Endocrine disruptor compounds (EDCs) are man-made chemicals released into the environment that wreak havoc with organisms' endocrine systems, negatively impacting on their development and reproduction. The EESD programme brought together seven European universities to address the effects of EDCs on Europe's fish resources. The ACE project examined the effect of a specific type of EDC, oestrogenic chemicals in complex mixtures. Application areas for the technique include oestrogenic assays in polluted water or wastewater streams. The technique also works with saltwater samples.

Studying the effects of noise pollution on children's health

Noise pollution from aircraft and road traffic has caused children to be at high risk of adverse effects to their cognition and health. Some of these effects include annoyance, stress-related psycho-physiological effects, impaired cognitive function, raised blood pressure and sleep disorders.

Exploiting sugar waste for biomass production

Biomass constitutes one of the key sources of renewable energy and includes almost all plant or plant-derived material for generating fuels, power, chemicals, materials and other products. Of particular interest is its use for bioethanol, which can be used as an alternative liquid fuel. A pilot plant has been built that could be easily adapted to any modifications such as the extraction of natural products. The wastes generated could be used to provide the energy requirements of the process.

Modelling wind power

Wind power is increasingly introduced to electricity markets that are currently undergoing a process of market liberalisation. This has a strong impact on both the technical operation of the electricity system and also the electricity market. The integration of substantial amounts of intermitting renewable power production such as wind power in a liberalised electricity system causes chain reactions in technical and economical power systems performance. Technical instability can result from transmission bottlenecks between various regions due to increased wind power generation which have cost and price implications. The Wilmar planning tool offers a means for the analysis of wind power integration. Collaboration is now sought with research institutions and consultancy companies for further development and use of this tool.

EU regional policy supports research and innovation

EU regional policy was created to reduce the gaps in development among European regions and the disparities in terms of well-being among European citizens. European regional policy allocates more than a third of the total EU budget to help lagging regions to catch up, restructure declining industrial regions, diversify the economies of rural areas with declining agriculture and revitalise declining neighbourhoods in the cities. It sets job creation as its primary concern. In a word, it seeks to strengthen the economic, social, and territorial cohesion of the Union. The European Framework programme for research and technological development provides the context for all EU scientific activities. FP6, operating between 2002 and 2006 has a budget of €17.5b, FP7 covering the period 2007-13, will have a budget of €50.5b. The actions "Regions of Knowledge" are a good example of the synergies between European regional and research policies in the context of the Lisbon agenda that was established in March 2000 to enable the EU to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion.

European Union – Digest

Monthly digests of European legislation, taken from the Official Journal of the European Communities, 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.

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ABPI
Health Protection Agency
Society for General Microbiology

Water
AMSI
Campden & Chorleywood Food Research Association
Cefas
Freshwater Biological Association
Institution of Chemical Engineers
Institution of Civil Engineers
LGC
Royal Society of Chemistry
SCI
Society for General Microbiology

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

Association of the British Pharmaceutical Industry

Contact: Dr Philip Wright
Director of Science & Technology
12 Whitehall, London SW1A 2DY
Tel: 020 7747 1408
Fax: 020 7747 1417
E-mail: pwright@abpi.org.uk
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

Contact: Karen Gray, Secretary
Association of Marine Scientific Industries
4th Floor, 30 Great Guildford Street
London SE1 0HS
Tel: 020 7928 9199 Fax: 020 7928 6599
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.

Academy of Medical Sciences

Contact: Mrs Mary Manning, Executive Director
Academy of Medical Sciences
10 Carlton House Terrace
London SW1Y 5AH
Tel: 020 7969 5288
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 as quickly as possible into healthcare benefits for society. The Academy's Fellows are the United Kingdom's leading medical scientists 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
AIRTO Ltd: Association of Independent Research & Technology Organisations Limited
c/o CCFRA, 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 10,000 scientists and engineers with a turnover in the region of £1.5 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

Founded 1911

Contact: Dr Chris Kirk
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

Contact: Dr Richard Dyer, Chief Executive
Biosciences Federation
PO Box 502, Cambridge, CB1 0AL
Tel: 01223 400181
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 45 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.

Biotechnology and Biological Sciences Research Council

Contact: Dr Monica Winstanley
Head of External Relations
BBSRC, Polaris House, North Star Avenue
Swindon SN2 1UH. Tel: 01793 413204
E-mail: external.relations@bbsrc.ac.uk
Website: www.bbsrc.ac.uk

The BBSRC is the UK's leading funding agency for academic research in the non-medical life sciences and is funded principally through the Science Budget of the Office of Science and Innovation. It supports staff in universities and research institutes throughout the UK, and funds basic and strategic science in: agri-food, animal sciences, biomolecular sciences, biochemistry and cell biology, engineering and biological systems, genes and developmental biology, and plant and microbial sciences.

British Association for the Advancement of Science - the BA

Contact: Sir Roland Jackson Bt, Chief Executive
The BA, Wellcome Wolfson Building,
165 Queen's Gate, London SW7 5HD.
E-mail: Roland.Jackson@the-BA.net
Website: www.the-BA.net

The BA (British Association for the Advancement of Science) is a charity which exists to advance the public understanding, accessibility and accountability of the sciences and engineering. The BA aims to promote openness about science in society and to engage and inspire people directly with science and technology and their implications.
Established in 1831, the BA organises major initiatives across the UK, including the annual BA Festival of Science, National Science Week, programmes of regional and local events, and an extensive programme for young people in schools and colleges.

British Ecological Society

Contact: Nick Dusic, Science Policy Manager
British Ecological Society
26 Blades Court, Deodar Road, Putney,
London, SW15 2NU
Tel: 020 8871 9797 Fax : 020 8871 9779
E-mail: nick@BritishEcologicalSociety.org
Website: www.BritishEcologicalSociety.org

The British Ecological Society promotes the science of ecology worldwide. The Society has 4,000 members who are active in advancing the science and application of ecology.
The BES publishes four internationally renowned scientific journals and organises the largest scientific meeting for ecologists in Europe. The BES also supports ecologists in developing countries and fieldwork in schools through its grants.
The BES informs and advises Parliament and Government on ecological issues and welcomes requests for assistance from parliamentarians.

British Nutrition Foundation

Contact: Professor Robert Pickard, Director-General
52-54 High Holborn, London WC1V 6RQ
Tel: 020 7404 6504
Fax: 020 7404 6747
Email: r.pickard@nutrition.org.uk
Website: www.nutrition.org.uk

2007 is the 40th Anniversary of the British Nutrition Foundation. This scientific and educational charity 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.

British Pharmacological Society

Today's science, tomorrow's medicines

Contact: Sarah-Jane Stagg
British Pharmacological Society
16 Angel Gate, City Road
London EC1V 2SG
Tel: 020 7417 0113
Fax: 020 7417 0114
Email: sjs@bps.ac.uk
Website: www.bps.ac.uk

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

The British Psychological Society

Contact: Christine O'Rourke
Parliamentary Officer
The British Psychological Society
St Andrews House, 48 Princess Road East
Leicester LE1 7DR
Tel: 0116 252 9917
Fax: 0116 252 9929
E mail: christine.orourke@bps.org.uk
Website: www.bps.org.uk

The British Psychological Society is an organisation of over 42,000 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

Contact: Tracey Guest, Executive Officer
British Society for Antimicrobial Chemotherapy
11 The Wharf, 16 Bridge Street,
Birmingham B1 2JS.
Tel: 0121 633 0410
Fax: 0121 643 9497
E-mail: tguest@bsac.org.uk
Website: 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.

British Veterinary Association

BVA

Contact:Chrissie Nicholls
7 Mansfield Street, London W1G 9NQ
Tel: 020 7636 6541
Fax: 020 7637 4769
E-mail:chrissien@bva.co.uk
www.bva.co.uk

BVA's chief interests are:

* Standards of animal health
* Veterinary surgeons' working practices
* Professional standards and quality of service
* Relationships with external bodies, particulary government

BVA carries out three main functions which are:

* Policy development in areas affecting the profession
* Protecting and promoting the profession in matters propounded by government and other external bodies
* Provision of services to members

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 brings together and applies scientific information and expertise to improve people's lives. Founded in 1910, CABI is owned by over 40 member countries. Today CABI publishes books, journals and scientific outputs, carries out scientific research and consultancies to find sustainable solutions to agricultural and environmental issues and develops innovative ways to communicate science to many different audiences. Activities range from assisting national policy makers, informing worldwide research, to supporting farmers in the field.

Campden & Chorleywood Food Research Association

Contact: Prof Colin Dennis, Director-General
CCFRA, Chipping Campden,
Gloucestershire GL55 6LD.
Tel: 01386 842000 Fax: 01386 842100
E-mail: info@campden.co.uk
Website: www.campden.co.uk

An independent, membership-based industrial research association providing substantial R&D, processing, analytical, hygiene, best practice, training, auditing and HACCP services for the food chain worldwide.
Members include growers, processors, retailers, caterers, distributors, machinery manufacturers, government departments and enforcement authorities.
Employs over 300; serves over 2,000 member sites; and has a subsidiary company in Hungary. Activities focus on safety, quality, efficiency and innovation. Participates in DTI's Faraday Partnerships and collaborates with universities on LINK projects and studentships, transferring practical knowledge between industry and academia.

Cavendish Laboratory

University of Cambridge

The Administrative Secretary, The Cavendish Laboratory,
J J Thomson Avenue, Cambridge CB3 0HE, UK.
E-mail: dhp24@phy.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: LEP, SPS & future 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.

Cefas

Centre for Environment, Fisheries & Aquaculture Science

Contact: Anne McClarnon, Communications Manager
Pakefield Road, Lowestoft, Suffolk NR33 0HT
Tel: 01502 56 2244
Fax: 01502 51 3865
E-mail: anne.mcclarnon@cefas.co.uk
Website: www.cefas.co.uk

Cefas offers multidisciplinary scientific research and consultancy for fisheries management and aquaculture, plus environmental monitoring and assessments. Government at all levels, international institutions (EU, UN, World Bank) and clients worldwide have used Cefas services for over 100 years. Three laboratories with the latest facilities, plus Cefas' own ocean-going research vessel, underpin the delivery of high-quality science and advice to policy-makers.

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 agents to obtain international protection.

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

Council for the Central Laboratory of the Research Councils

Contact: Natalie Bealing
CCLRC Rutherford Appleton Laboratory
Chilton, Oxfordshire, OX11 0QX
CCLRC Daresbury Laboratory
Daresbury, Cheshire, WA4 4AD
Tel: 01235 445484 Fax: 01235 446665
E-mail: enquiries@cclrc.ac.uk
Website: www.cclrc.ac.uk

The CCLRC is the UK's strategic agency for scientific research facilities. It also supports leading-edge science and technology by providing world-class, large-scale experimental facilities. These advanced technological capabilities, backed by a pool of expertise and skills across a broad range of disciplines, are exploited by more than 600 government, academic, industrial and other research organisations around the world each year. The annual budget of the CCLRC is c. £150 million.

Economic and Social Research Council

Contact: Lesley Lilley, Senior Policy Manager, Knowledge Transfer,
Economic and Social Research Council,
Polaris House, North Star Avenue,
Swindon SN2 1UJ
Tel: 01793 413033 Fax 01793 413130
lesley.lilley@esrc.ac.uk
http://www.esrc.ac.uk

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 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.

Eli Lilly and Company Limited

Answers That Matter.

Contact: Paul Johnson PhD,
Managing Director
Eli Lilly & Company, Erl Wood Manor,
Windlesham, Surrey, GU20 6PH
Tel: 01256 315000
Fax: 01276 483307
E-mail:p.johnson@lilly.com
Website:www.lilly.com or www.lilly.co.uk

Eli Lilly and Company Limited 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 and many other diseases.

Engineering and Physical Sciences Research Council

Contact: Dr Claire Graves,
Public Affairs Mamager,
EPSRC, Polaris House,
North Star Avenue, Swindon SN2 1ET
Tel: 01793 444459 Fax: 01793 444005
E-mail: claire.graves@epsrc.ac.uk
Website:www.epsrc.ac.uk

EPSRC invests more than £500 million a year in research and postgraduate training in the physical sciences and engineering, to help the nation handle the next generation of technological change. The areas covered range from mathematics to materials science, and information technology to structural engineering.

We also actively promote public engagement with science and engineering, and we collaborate with a wide range of organisations in this area.

Freshwater Biological Association

Contact: Dr Roger Sweeting,
Chief Executive.
The Freshwater Biological Association, The Ferry House, Far Sawrey, Ambleside,
Cumbria LA22 0LP.
Tel: 015394 42468 Fax: 015394 46914
E-mail: info@fba.org.uk
Website: www.fba.org.uk

The Freshwater Biological Association is an independent organisation and a registered Charity, founded in 1929. It aims to promote freshwater science through an innovative research programme, an active membership organisation and by providing sound independent opinion. It publishes a variety of specialist volumes and houses one of the finest freshwater libraries in the world.

Health Protection Agency

Contact: Professor Pat Troop, Chief Executive
Health Protection Agency Central Office
7th Floor, Holborn Gate, 330 High Holborn
London WC1V 7PP
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 uses 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 and 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

Contact: Tim Whitaker
21 Bloomsbury St
London WC1B 3HF
Tel: 020 7291 8200
Fax: 020 7291 8201
Email: tim.whitaker@hfea.gov.uk
Website: www.hfea.gov.uk

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

Institute of Biology

Contact: Prof Alan Malcolm, Chief Executive
9 Red Lion Court, London EC4A 3EF
Tel: 020 7936 5900
Fax: 020 7936 5901
E-mail: a.malcolm@iob.org
Website: www.iob.org

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

Contact: Public Relations Department
76 Portland Place, London W1B 1NT
Tel: 020 7470 4800
E-mail: public.relations@iop.org
Website: www.iop.org

The Institute of Physics supports the physics community and promotes physics to government, legislators and policy makers.

It is an international learned society and professional body with over 35,000 members worldwide, working in all branches of physics and a wide variety of jobs and professions – including fundamental resarch, technology-based industries, medicine, finance – and newer jobs such as computer games design. The Institute is active in school and higher education and awards professional qualifications. It provides policy advice and opportunities for public debate on areas of physics such as energy and climate change that affect us all.

Institute of Physics and Engineering in Medicine

Contact: Robert Neilson, General Secretary
Fairmount House, 230 Tadcaster Road, York, YO24 1ES
Tel: 01904 610821 Fax: 01904 612279
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 27,000 members.

Contact: Andrew Furlong, Director
t: +44 (0)1788 534484
f: +44 (0)1788 560833
e: afurlong@icheme.org
www.icheme.org

Institution of Civil Engineers

Contact: Nicola Bates, Senior Public Affairs Executive
One Great George Street, Westminster, London SW1P 3AA, UK
Tel: 020 7665 2265
Fax: 020 7222 0973
E-mail: nicola.bates@ice.org.uk
Website: www.ice.org.uk

ICE aims to be a leader in shaping the engineering profession. With over 75,000 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 and comment, on a wide range of subjects from energy generation and supply, to sustainability and the environment.

Institution of Engineering and Technology

Contact: Tony Henderson
Institution of Engineering and Technology
Savoy Place, London WC2R 0BL
Tel: 020 7344 8403
E-mail: tonyhenderson@theiet.org
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.

LGC

Queens Road, Teddington
Middlesex, TW11 0LY
Tel: +44 (0)20 8943 7000
Fax: +44 (0)20 8943 2767
E-mail: info@lgc.co.uk
Website: www.lgc.co.uk

Setting standards in analytical science

LGC, a science service company, is Europe's leading independent provider of analytical and diagnostic services and reference standards. LGC's market-led divisions - LGC Forensics, Life and Food Sciences, Pharmaceutical and Chemical Services and LGC Promochem (for Reference Materials) - operate in a diverse range of sectors for both public and private sector customers.

Under arrangements for the office and function of Government Chemist, LGC fulfils specific statutory duties 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 based in Teddington, Middlesex, with other UK operations in Runcorn, Edinburgh, Culham, Risley and Tamworth and facilities in France, Germany, Italy, Poland, Spain, Sweden and India.

London Metropolitan Polymer Centre

Contact: Alison Green,
London Metropolitan University
166-220 Holloway Road, London N7 8DB
Tel: 020 7133 2189
Fax: 020 7133 2184
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. A programme of industrial short courses and customised courses, together with distance learning and other flexible delivery methods, lead to qualifications ranging from technician to Masters level, alongside the full-time courses for Polymer Engineering and Product Design. Recent successes include a WRAP sponsored programme to develop new commercial applications for recycled PET and several technology transfer projects with companies.

Marks & Spencer Plc

Contact:
David Gregory
Waterside House
35 North Wharf Road
London W2 1NW.
Tel: 020 8718 8247
E-mail: david.gregory@marks-and-spencer.com

Main Business Activities

Retailer – Clothing, Food, Financial Services and Home

We have over 450 stores in 31 territories worldwide, employing 65,000 people.

We offer our customers quality, value, service and trust in our brand by applying science and technology to develop innovative products and services.

Medical Research Council

Contact: Simon Wilde
20 Park Crescent, London W1B 1AL.
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.

Merck Sharp & Dohme Research Laboratories

Contact: Professor Ray Hill, FMedSci
Licensing & External Research, Europe
Hertford Road
Hoddesdon
Herts EN11 9BU
Tel: 01992 452836
Fax: 01992 441907
e-mail: ray_hill@merck.com
www.merck.com

Merck Sharp & Dohme is a UK subsidiary of Merck & Co Inc a global research-driven pharmaceutical company dedicated to putting patients first. Merck discovers, develops, manufactures and markets vaccines and medicines in over 20 therapeutic categories directly and through its joint ventures. 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

Contact: Nicola Kane
Media and Public Affairs Assistant
1 Plough Place
London EC4A 1DE
Tel: 020 7438 2500
Fax: 020 7438 2501
Email: nicola.kane@nesta.org.uk
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

National Physical Laboratory
Hampton Road, Teddington
Middlesex TW11 0LW
Tel: 020 8943 6880 Fax: 020 8943 6458
E-mail: enquiry@npl.co.uk
Website: www.npl.co.uk

The National Physical Laboratory (NPL) is the United Kingdom's national standards laboratory, 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

Contact: Dr Tom Tew
Director Science and Evidence
Natural England
Northminster House
Peterborough
PE1 1UA
Tel: 01733 455056
Fax: 01733 568834
Email: tom.tew@naturalengland.org.uk
Website: www.naturalengland.org.uk

Natural England is the Government's conservation agency working throughout England; we conserve, enhance and manage the natural environment for the benefit of current and future generations. We commission research and publish papers which underpin the development of our policies and programmes.

Natural Environment Research Council

Contact: Sheila Anderson
Head of Communications
Polaris House, North Star Avenue
Swindon SN2 1EU
Tel: 01793 411646 Fax: 01793 411510
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

Newcastle University

Contact: Dr Douglas Robertson
Newcastle upon Tyne NE1 7RU
Tel: 0191 222 5347 Fax: 0191 222 5219
E-mail: business@ncl.ac.uk
Website: www.ncl.ac.uk

Newcastle University is a member of the Russell Group of research intensive universities. Newcastle's focus is Excellence with a Purpose. The University has a well balanced portfolio of research funding and a very significant portfolio of FP6 EU activity (with over 100 projects involving more than 1800 partners) with a strong interdisciplinary approach to research. The University was a winner in the 2006 EPSRC Knowledge Transfer awards. The University is taking its commitment further through the development of Newcastle Science City in partnership with the City Council and RDA.

The Nutrition Society

Contact: Frederick Wentworth-Bowyer,
Chief Executive, The Nutrition Society,
10 Cambridge Court, 210 Shepherds Bush Road
London W6 7NJ
Tel: +44 (0)20 7602 0228
Fax: +44 (0)20 7602 1756
Email: f.wentworth-bowyer@nutsoc.org.uk

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

PHARMAQ Ltd

Contact: Dr Lydia A Brown
PHARMAQ Ltd
Unit 15 Sandleheath Industrial Estate, Fordingbridge
Hants SP6 1PA.
Tel: 01425 656081
Fax: 01425 655309
E-mail: lydia.brown@pharmaq.no
Website: www.pharmaq.no

Veterinary pharmaceuticals specia-lising in aquatic veterinary products. Fish vaccines, anaesthetics, antibiotics and other products.

Society for General Microbiology

Contact: Public Affairs Administrator
Marlborough House, Basingstoke Road,
Spencers Wood, Reading RG7 1AG.
Tel: 0118 988 1843 Fax: 0118 988 5656
E-mail: pa@sgm.ac.uk
Website: http//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 Chemical Industry

SCI where science meets business

Contact: Andrew Ladds,
Chief Executive
SCI International Headquarters
14-15 Belgrave Square, London SW1X 8PS
Tel: 020 7598 1500 Fax: 020 7598 1545
E-mail: secretariat@soci.org
Website: www.soci.org

SCI is an interdisciplinary network for science, commerce and industry. SCI attracts forward-looking people in process and materials technologies and in the biotechnology, energy, water, agriculture, food, pharmaceuticals, construction, and environmental protection sectors worldwide. Members exchange ideas and gain new perspectives on markets, technologies, strategies and people, through electronic and physical specialist conferences and debates, and publish journals, books and the respected magazine *Chemistry & Industry.*

Society of Cosmetic Scientists

FOUNDED 1948 SCS SOCIETY OF COSMETIC SCIENTISTS

Contact: Lorna Weston,
Secretary General
Society of Cosmetic Scientists
G T House, 24-26 Rothesay Road, Luton, Beds LU1 1QX
Tel: 01582 726661
Fax: 01582 405217
E-mail: ifscc.scs@btconnect.com
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
Wheathampstead, Herts. AL4 8AN.
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.

Science Diary

The Parliamentary and Scientific Committee

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

Tuesday 20 February 08.30-10.30
Breakfast Briefing: Large Hadron Collider
Speakers: Dr Lyn Evans, CERN
Dr Tara Shears, Royal Society Research Fellow, University of Liverpool

Thursday 15 March 09.45-14.00
National Science and Engineering Week Seminar with the DTI
Innovative Scientific and Engineering Solutions for the Management of Climate Change
Jointly chaired by Malcolm Wicks MP and Dr Doug Naysmith MP
Speakers: Prof Martin Blunt, Imperial College
Dr Steve Koonin, Chief Scientist, BP
R J Budge, Powerfuel
Robert Hawley, Vice-Chancellor, World Nuclear University
Maria McCaffery, CEO, British Wind Energy Association

The Royal Institution

Due to refurbishment, all Ri events are to be held at external venues until late 2007. See www.rigb.org or telephone 020 7409 2992 for full details and to book tickets.

Friday 23 February 19.30
Therapeutic potential of human stem cells: promise and pitfalls
Dr Chris Mason
University College London

Wednesday 28 February 19.00
Middle world: the restless heart of matter and life
Dr Mark Haw and Dr Nick McCormick
National Physical Laboratory

Friday 2 March 19.30
Synchrotron light: from Einstein's theories into a brilliant future
Prof Gerhard Materlik
University College London

Monday 5 March 18.00
The trouble with physics: the rise of string theory, the fall of a science, and what comes next
Prof Michael Duff, Prof Lee Smolin and Prof Nancy Cartwright
The RSA

Friday 9 March 19.30
Solar explosions: will we ever have an accurate space weather forecast?
Prof Louise Harra
University College London

Thursday 15 March 18.00
At the extremes of existence
Dr Mike Grocott and Prof Jean-Paul Richalet
Institut Français Cultural Centre

Friday 16 March 19.30
Molecules by the million
Prof Graham Richards
University College London

Wednesday 21 March 19.00
The last man who knew everything
Andrew Robinson
The Royal College of Surgeons of England

Friday 23 March 19.30
All flesh is glass: using light to look into the body
Prof Dave Delpy
University College London

Monday 26 March 09.15
Alternative energy, health and the environment: UK 2100
Speakers include Dr Alan Bond, Prof Ian Fells and Prof Sir Chris Llewellyn-Smith
Magdalen College School, Oxford

Tuesday 27 March 09.15
Alternative energy, health and the environment: Africa now!
Speakers include Dr John Mugabe, Prof Gabriel Ogunmola and Prof Terence Ryan
Magdalen College School, Oxford

Tuesday 3 April 14.00
Ri and U3A out and about
Prof Bill McGuire, Prof Salvador Moncada and Vivienne Parry
Friends Meeting House, Euston Road, London

Tuesday 10 April 19.30
The curious incident of the never-ending numbers
Prof Marcus du Sautoy
Royal Museum and Museum of Scotland, Edinburgh

Wednesday 18 April 19.00
Science's most successful failure
Dr John Whitfield
The Royal College of Surgeons of England

Thursday 19 April 19.00
Moving forward: energy efficient transport for the future
Prof Nigel Brandon
University of Plymouth

Monday 23 April 19.00
Autism nation
Prof Simon Baron-Cohen, Dr Michael Fitzpatrick, Marti Leimbach and Kamran Nazeer
The Institute of Contemporary Arts

Tuesday 15 May 18.00
Wonderland: when science, design and culture collide
Prof Tony Ryan and Helen Storey
London College of Fashion

Wednesday 16 May 19.00
What happened to the polymaths?
Oliver Morton, Andrew Robinson and Dr John Whitfield
The Royal College of Surgeons of England

Tuesday 22 May 19.00
Seed to seed
Dr Nicholas Harberd
Royal Botanic Gardens, Kew

The Royal Society

6-9 Carlton House Terrace
London SW1Y 5AG
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:

Thursday 1 and Friday 2 March (all day)
The science of climate change:
a Royal Society showcase of the IPCC 4th Assessment Working Group 1 Report

Please see www.royalsoc.ac.uk/events for the full events programme, more details about the above highlights and web casts of past events.

The BA (British Association for the Advancement of Science)

Monday 14 – Tuesday 15 May
The Science Communication Conference
At The Institution of Engineering and Technology
For further information visit www.the-ba.net

Association of Marine Scientific Industries

www.oceanbusiness2007.com
Tel: 01453 839228

Tuesday 27 March - Thursday 29 March
Ocean Business 2007 Event showcasing the latest in marine science
National Oceanography Centre, Southampton

Institution of Mechanical Engineers

1 Birdcage Walk, London SW1H 9JJ

Wednesday 28 February – Thursday 1 March
Rail Accident Investigation
Contact Sian Clayton 020 7973 1245
s_clayton@imeche.org

Tuesday 6 March
Clean Zero Emission Geo-Pressure Energy
Contact Dunni Akinola 020 7973 1243
d_akinola@imeche.org

Wednesday 4 April
Risk Education for Engineers
Contact Michelle O'Brien 020 7973 1309
m_obrien@imeche.org

Tuesday 17 April
Carbon Capture: Technology Options and making Plant Carbon Capture Ready
Contact Shelley Quinn 020 7973 1260
s_quinn@imeche.org

Thursday 19 April – Saturday 21 April
Engineers and Surgeons: Joined at the Hip
Contact Alison Payton 020 7304 6829
a_payton@imeche.org

SCI

14/15 Belgrave Square
London SW1X 8PS
Contact: conferences@soci.org
or 020 7598 1562
Unless otherwise stated events are at SCI

Tuesday 6 March
Continuous Processing as a Pharmaceutical Development Tool

Thursday 15 March
The Road to Extended Pavement Life

Tuesday 20 – Wednesday 21 March
Optimising Farm Inputs
At Robinson College, Cambridge and
Edible Oils And Fats - Trends In Raw Materials, Processing And Applications At InterContinental Hotel Citystars, Cairo
At InterContinental Hotel Citystars, Cairo

Tuesday 3 April
Frontiers of Research 2007 Medal Award Meeting

Monday 16 – Wednesday 18 April
Molecular Mechanisms of Resistance to Antibiotics, Drugs and Pesticides
At Churchill College, Cambridge

Wednesday 18 – Thursday 19 April
Optimum Frying for Health and Quality
At Reading University

Tuesday 24 April
Designer Molecules for Interfacial Activity

Wednesday 25 April
Young Chemist in Industry XVI

Thursday 26 April
C-H Activation Present and Future
At AstraZeneca, Charnwood

Tuesday 15 May
Secrets of Formulation – Part II

Royal Pharmaceutical Society of Great Britain

Contact: science@rpsgb.org
www.rpsgb.org

Monday 12 - Wednesday 14 March
The Development and Manufacture of Parenteral Dosage Forms – quality and regulatory issues
RPSGB, London

Thursday 22 March
The role of Materials Characterisation in Pharmaceutical Quality by Design & Manufacture
School of Pharmacy, London

Wednesday 2 May
Analytical Support for Clinical Trials
RPSGB London

Tuesday 20 – Thursday 24 May
Ninth Advanced Level Workshop on Pharmacokinetic and Pharmacodynamic Data Analysis
Madingley Hall, Cambridge

Officers of the Parliamentary & Scientific Committee

Science in Parliament
3 Birdcage Walk, London SW1H 9JJ
Tel: 020 7222 7085 Fax: 020 7222 7189
Editor: Professor Peter Simpson
Editorial Assistant: Mrs Annabel Lloyd

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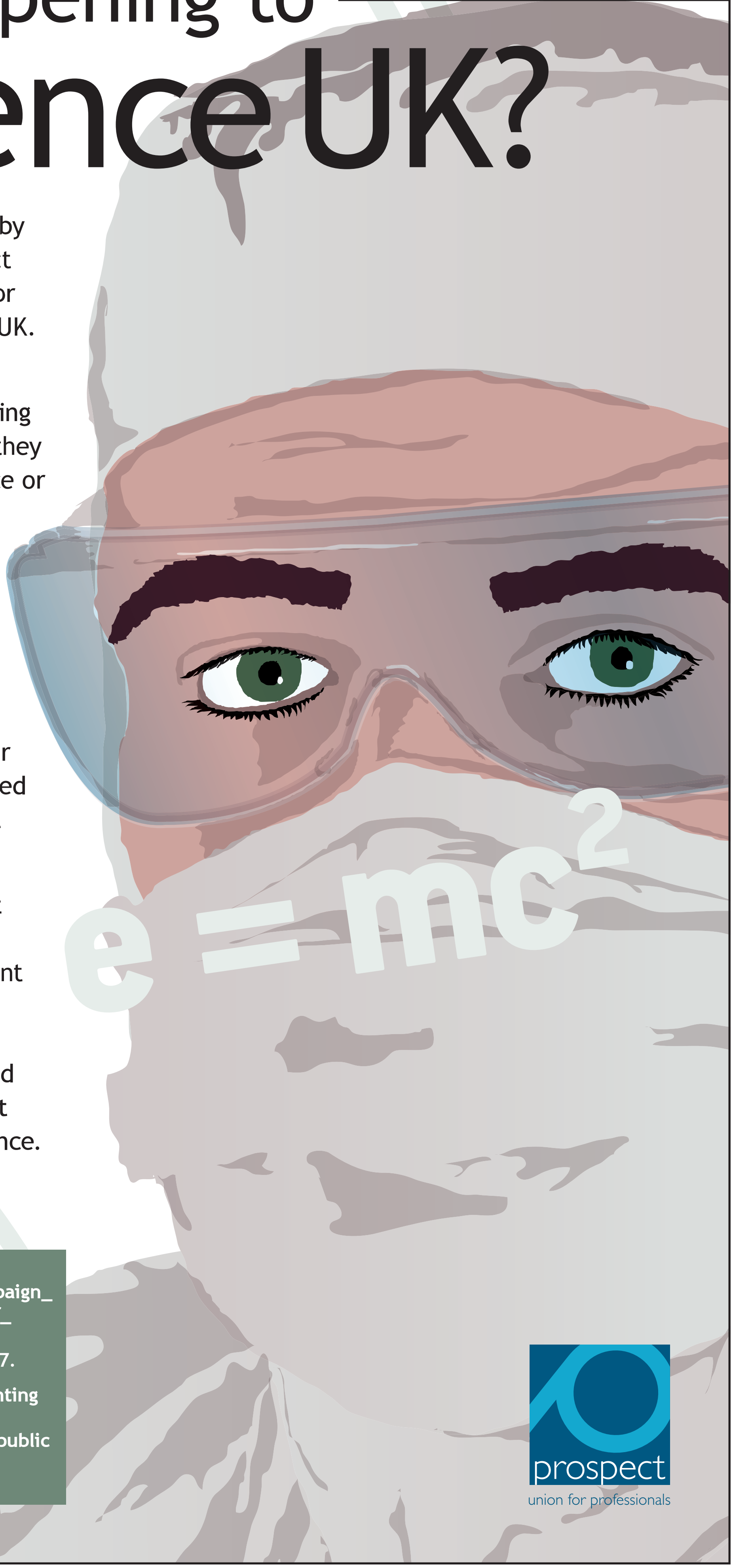
What's happening to science UK?

A recent survey undertaken by the scientists' union Prospect revealed worrying findings for the future of science in the UK. The results show that:

- More than four in 10 working scientists are either unsure they will be able to stay in science or certain that they will leave
- One in every four of respondents have been asked to tailor their research findings or advice
- Two out of every three respondents report that their team's work has been affected by funding cuts over the last five years.

Prospect is calling for urgent action to avert a brain drain in UK science including decent pay and careers for staff, a halt to 'cost-driven' lab closures and privatisation and the introduction of a Cabinet minister responsible for science.



To view the full report visit www.prospect.org.uk/doclib/campaign_materials/public_science/state_of_science_2006 or contact Prospect communications on 020 7902 6607.

Prospect is a trade union representing 102,000 scientific, technical, managerial and specialist staff in public service, related bodies and major companies.

prospect
union for professionals

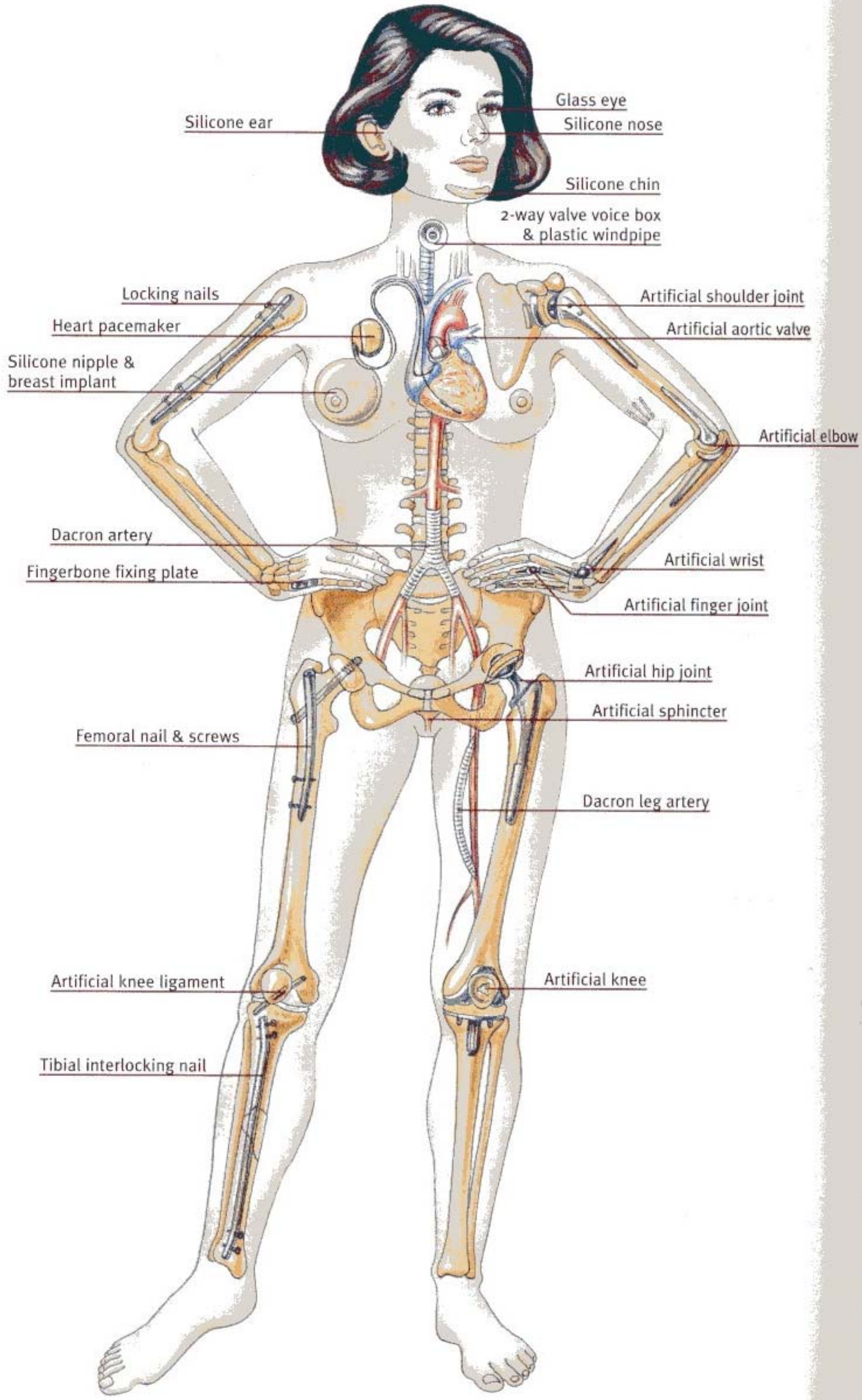
Biomedical implants

1970

- Only joint replacements
- 1,000 operations per year
- Implants
  - Metal
  - Polymer
- Non-reactive materials
- Artificial joint life – 10 years

Today

- Soft and hard tissue replacement
- External and internal systems
- 250,000 operations/year
- Artificial bone materials
- Joints perform longer and better
- Corneal lenses – hydrogels
- Skull – polymer/ceramic composites
- Heart valves – polymers
- Stents – shape memory alloys
- Plates and screws – biodegradable polymers
- Hips – ceramic coated metal
- Knees – metal & polymer



UK successes in biomedical materials

- Development of first successful joint replacements in 1960's
- Ceramic coatings exported around the world
- UK development of novel polymers and degradable materials
- Artificial organ research-UK led

Science in Parliament Spring Issue 2007
Paient Safety, Systems Design and Ergonomics
Professor Peter Buckle

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Science in Parliament Spring issue 2007 – figure referred to on page 24
Are Patients Safe with the NHS?
Bill Murray