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Global warming, cooperation and engagement

Nutrigenomics: the future of nurition?

Scientific advice in drugs classification

British Association for the Advancement of Science

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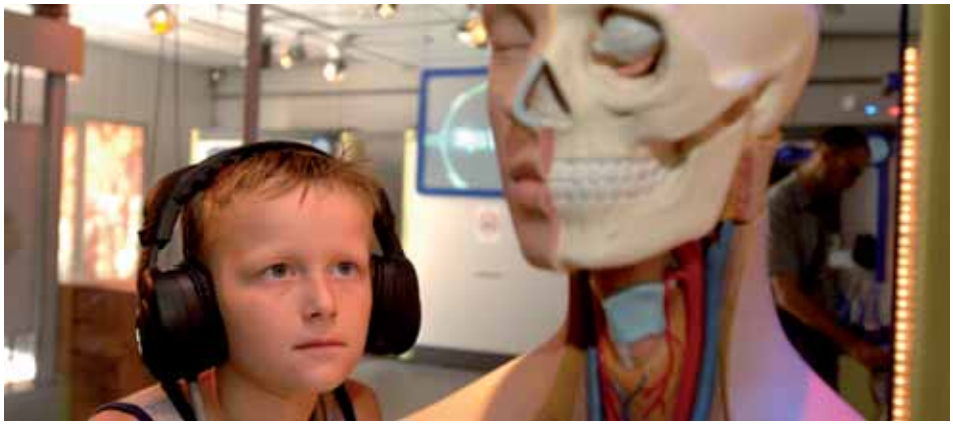

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Front cover picture: Publicising the challenge of climate change: see p.6 *Jon Challicom*

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Features

Energy, scientific advice and the future of diet

This issue looks forward to some of the subjects parliamentarians will be dealing with when they come back from their holidays in October.

Following the publication of the energy review, the white paper is expected around the turn of the year. Vanessa Spedding (p.8) delineates the battle lines between the nuclear and renewables camps, while Colin Axon and his colleagues (p.18) point to a little-remarked infrastructure problem. The UK grid was designed for a relatively small number of large power sources, not a large number of small distributed ones, they write, so it is not a straightforward matter to bring on-line large quantities of district- and domestic-scale generators. Nobody knows, they warn, how the grid will behave under those conditions.

Parliamentarians need scientific advice to legislate on these and other technical questions. November will see the Commons Science and Technology Select Committee publish its report, *Scientific advice, risk and evidence: how government handles them*. Already, the Committee has published the case studies on which the final report will be based. On drugs policy, Committee Chairman Phil Willis (p.17) is highly critical of the Advisory Council on the Misuse of Drugs, whose behaviour has 'created fertile ground for suspicion and conspiracy theories', as well as hindering public understanding of its role. Our new columnist, Tracey Brown (p.29), expands on the same theme, asking what constitutes scientific evidence in the first place. She argues that the status of scientific evidence is as important as its conclusions.

The problems parliamentarians face when they are advised by scientists are laid bare by John Bowis MEP (p.15). He took part in a Royal Society-sponsored scheme for MEPs and scientists to visit and observe each other at work. By chance, he visited Mark Enright (p.14) on the day when the MRSA deaths at Stoke Mandeville were hitting the headlines – an issue bang on Enright's expertise. Reflecting on scientific advice, Bowis explains how the precautionary principle has won out over the idea of proportionality of risk. If a parliamentary committee has accepted advice from a scientific advisory body, but some other scientist questions the advice, the parliamentarians will, he says, 'second guess the advice we have received and go... for tougher standards or restrictions than may be necessary.'

The UK is about to have a new body to see what is happening in science, engineering and technology, what might happen and how the political process should handle it. Ian Gibson (p.30) outlines plans for his new think-tank, called Newton's Apple. And amidst all this science and politics, the Conservative Party is re-thinking its science strategy, as Ian Taylor relates (p.16).

The SPATalk (p.4) argues out the merits and demerits of nutrigenomics, the effect of our entire diet on our genes, proteins and metabolism. Its enthusiasts hope it will lead to personalised nutrition, while its detractors maintain it will do nothing to help poorer people who are at higher risk of heart disease and diabetes.

Wendy Barnaby, Editor
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Nutrigenomics: the future of nutrition?

Siân Astley and Helen Wallace disagree

Nutrigenomics is about the effect of the whole diet on our genes, proteins and metabolism. Its enthusiasts hope it will lead to personalised nutrition: identifying a diet that has an optimal effect on these systems to maintain health and prevent disease in a population. This is different from nutrigenetics, which is about single-gene-single-food-compound relationships and individualised diets.

Keeping the doctor away: is nutrigenomics the answer?

Dear ***Siân***,
Nutrigenomics is being promoted as a solution to chronic diet-related diseases such as heart disease, cancers and diabetes. Commercial interest in this new science has two aims: developing new food products and personalising diets. Functional foods, such as cholesterol-lowering spreads and probiotic yoghurts, will be marketed as tailored to an individual's genes, and maybe other biological measurements, to 'optimise' a person's health.

However, personalised nutrition will not help to tackle the current epidemic of diseases linked with overeating. Genetic tests and functional foods are targeted at the wealthy and do nothing to help poorer people who are at higher risk of heart disease and diabetes.

The usefulness of targeting dietary advice based on genetic make-up is also limited because genes are poor predictors of an individual's risk. Your diet tailored to your genes is marketing, not science – driven by food and biotech companies that seek to personalise and privatise dietary advice.

Personalised nutrition could harm health by targeting the wrong dietary advice at the wrong people, confusing healthy eating messages, undermining public health approaches, promoting new expensive products instead of fruit and vegetables, and diverting research and public health resources.

Personalised nutrition is a false solution to the global epidemic of obesity.
Yours, **Helen**

Dear ***Helen,***
Nutrigenomics is a science, not a way of life, and personalised nutrition is not an alternative to public health policy but it does have much to contribute to the discussion.

Eating certain foods can protect us from a variety of age/ diet-related diseases, for example cancer and cardiovascular disease. But the risks are not the same for everyone; some people will develop these diseases earlier with more severe symptoms.

The issue is not just these tragically early deaths. It is also lives blighted by disability that impact not only individuals and their families but national economies as well, through increased healthcare costs for an ageing population.

Differences in response to diet have been evident for years, for example cholesterol and saturated fat intake. In the past, nutrition research has been limited to a few 'likely' dietary compounds, a handful of relevant biochemical pathways and latterly a small number of candidate genes. Nutrigenomics allows a more holistic approach; understanding how the whole body responds

to real foods at different life-stages.

Promotion of healthy eating and lifestyle are paramount and key messages are well established, but the 'one-size-fits-all' strategy is clearly not working. Consumers want something that meets their needs; personalising nutrition, as with other public health initiatives, may be more successful in achieving long-term change.
Yours, **Siân**

Personalising dietary advice means privatisating it, with different biotech and food companies selling different and potentially conflicting advice and supplements

Dear ***Siân,***
Personalising dietary advice means privatisating it, with different biotech and food companies selling different and potentially conflicting advice and associated supplements and new food products. Some unregulated genetic tests with misleading dietary advice are already being sold. This confuses healthy-eating messages, with potentially harmful consequences for public health.

With some exceptions, genetic differences appear to make only small and subtle differences to a person's risk of diet-related disease and hence very little difference to the foods they should eat. There is little evidence that individual variability in cholesterol levels is genetically determined, except in relatively rare cases, and the most studied gene – called APOE – has been found to be of little use in identifying people who respond best to low-fat diets. The biological response to dietary fats is highly complex and will be hard to predict for any individual, whether genetic tests or other biological measurements are used.

Too much saturated fat, sugar and salt is bad for everyone and there is an enormous and growing gulf between dietary guidelines and what people actually consume. Tinkering with individual diets and new ingredients will not solve this problem – what is needed is political commitment to change unhealthy food production systems and marketing practices.
Yours, **Helen**

Dear ***Helen,***
We have a long way to go in understanding how what we eat is absorbed, distributed, stored and used by our bodies; nutrigenomics gives us much broader and deeper insight, which in turn will enable experts to provide clearer, better nutritional and lifestyle advice for all.

Nutrigenomics will enable us to identify how much and how frequently existing foods should be consumed by, for example, 70 year olds, expectant mothers, toddlers and teenagers. It is here that the effects of individual genes may be relevant – tweaking an individual's requirements. Personalised, not individualised, information will meet the needs of consumers who struggle to apply existing dietary and lifestyle advice, creating the gulf between what they know and what they do.

Like it or not, food and biotech industries and retailers are part of this process, and excluding them will not protect consumers' health or pockets. Legislation against health fraud is paramount; failure to address ethical, legal and societal aspects of nutrigenomics will damage the public's trust in personalised nutrition, not the promises peddled by charlatans.
Yours, **Siân**

Dear ***Siân,***
You ignore the significant role that health inequalities and social and economic factors play in chronic diet-related disease, as well as how hard it will be to regulate these new health claims.

Today's epidemic of obesity is influenced by agricultural practices and the global marketing of unhealthy foods. In Argentina, for example, the diet of the poor has shifted since the 1960s, from a varied balanced one, to one which depends on only 22 basic products, selected to satisfy the appetite but high in fats and sugars. The food industry fosters this behaviour by targeting the poor with mass, low-quality products that are cheaper but less healthy.

These marketing practices also affect low-income families in Britain, who suffer from 'food poverty'. Poorer families tend to eat less healthily, consuming less fruit and vegetables and wholemeal bread and more white bread and processed meat products.

Personalised nutrition is a solution advocated by food manufacturers and biotech companies who want to sell both personalised nutritional advice and associated 'healthier' food products at a premium. Ignoring them is not an option, but nor is uncritical acceptance of their view that growth in expensive hi-tech 'personalised' foods will help to tackle the frightening global increase in diet-related diseases.
Yours, **Helen**

Dear ***Helen***
On the contrary, nutrigenomics takes into consideration not only the role of our genes, proteins and metabolism in our health but also life-stage and lifestyle. It will allow us to understand how the whole body responds to real foods, and the information that comes from nutrigenomics will enable consumers to make choices that suit them.

For some this will mean accessing new food products and genetic testing. For many it will mean applying sensible science-based dietary advice to their situation. The worried-wealthy-well will adopt these technologies sooner, despite the fact that arguably they least need the intervention because they are already diet and health conscious. But, the nature of our market economy means these new products will become available to all sectors of society with time.

Nutrigenomics will enable us to identify how much and how frequently existing foods should be consumed by toddlers and teenagers

Public health messages are, for a variety of reasons, failing to change people's behaviour and to counteract flashy advertising promoting cheap nutritionally-empty foods. But demonising the food industry will not overcome rising obesity rates or poor dietary and lifestyle choices. Enabling and encouraging people to make healthy choices for themselves, and supporting the science underpinning their decisions, just might.

In the end, humans are complex and so too are their diets, making nutrition science and questions about health fiendishly difficult. Nutrigenomics is the ideal, and perhaps, the only tool able to answer the ultimate question - what should I be eating?
Yours, **Siân**

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Global warming, cooperation and engagement

Frances Cairncross reflects on her time as President of the BA

Way back in September 1971, I recall trying to locate my parents to tell them that I had decided to marry a young journalist called Hamish McRae. I eventually ran them to earth in Swansea, where they were taking part in what was then called the Annual Meeting of the British Association for the Advancement of Science. Why there? Because my father, Alec Cairncross, the Master of St Peter's College, Oxford, was that year's President.

I would have loved to be able to tell my father, who sadly died eight years ago, that I am now also the head of an Oxford College (Exeter, which is older – and wealthier – than St Peter's). And this year, as President of what is now called the BA, and at an event now called the Festival of Science, I will deliver my own address on the other side of Britain, at Norwich in early September.

Like my father, I have found the presidency a fascinating and rewarding experience. It has been a chance to meet many people with a passionate interest in science. Two groups stand out: the interested lay-folk who thronged to the BA's last two Festivals, in Exeter in 2004 and Dublin last year; and the school students who exhibited their projects as part of the CREST Science Fair in the spring. Both groups showed how deep an interest there is in science, outside the academic and professional worlds of scientists.

But I have also been aware of how much more needs to be done to extend public engagement in science. Three issues have dominated my year, and the first two of them will be the themes of my presidential address.

Smiles all round at the BA CREST Science Fair

Predicting climate change is a task for natural scientists; changing people's behaviour is a job for analysis by social scientists

Global warming

The first issue has been the need for greater concern about global warming. I believe that the past year has seen a clear shift in public perceptions of the prospect of climate change. I say 'prospect' rather than, as I would have done five years ago, 'possibility', because the accumulation of evidence seems so powerful. Not only is the sort of temperature rise predicted by the best climate modelling already apparently under way. Last year was the second warmest on record.

The speed of the rise seems to be exceeding expectations. There seems to be a growing and alarming possibility that it may trigger sudden and dangerous events such as an unexpected release of methane gas from warming soil. That would accelerate the rise. The prediction of the Met Office, which has done world-beating research on the subject, is that the temperatures we experienced in Europe during the blisteringly hot summer of 2003 will look normal by the 2040s and cool by the 2060s.

Cooperation between social and natural scientists

Predicting climate change is a task for natural scientists; changing people's behaviour is a job for analysis by social scientists. Few policy challenges are greater than persuading the main energy-consuming countries to work together to restrain their use of fossil fuels. All too often, natural scientists and social scientists work in separate spheres. The second issue that has dominated my year has been the importance of persuading natural scientists and social scientists to work more closely together.

In addition to being President of the BA, I chair the Council of the Economic and Social Research Council (ESRC). Throughout my presidential year, I have worked to persuade these two important organisations to work more closely with each other. I'm glad to say that neither needed much persuading. The social sciences have often seemed to me to be the poor relation of the natural sciences, and yet often the social scientists ask essential questions about how to turn scientific findings into public policy and how to analyse and understand their economic and social impacts.

Luckily for me, both Ian Diamond, the Chief

Executive of the ESRC, and Roland Jackson, Chief Executive of the BA, have been keen to explore ways for their two organisations to work together. For example, this year for the first time the ESRC became involved in the BA's CREST scheme, as part of its increased engagement with schools. That provided a chance to emphasise both the social and economic aspects and implications of work in the physical and natural sciences – but also the quantitative nature of much social science research.

BA collaboration with ESRC

In addition, a lot of joint planning went into ensuring that this year, the BA's flagship National Science Week (NSW) and the ESRC's Social Science Week (SSW) coincided. As a result, they were able to work together to publicise the challenge of climate change. In March, the BA and the ESRC got together with CRed (the Carbon Reduction Programme at the University of East Anglia) to mount a programme called Click for the Climate.[1] This allowed people to see by how much their pledge could reduce their carbon-dioxide emission and how much had been promised across the country. I pledged a contribution to Tree Aid, a charity that plants trees in developing countries. That seems a way not just to offset some of the emissions created by all the airplane trips I take, but also to give people in poorer countries a source of fuel, food and protection against soil erosion.

The BA and ESRC collaborated on a number of other projects and are now working together on the evaluation of the week. I very much hope that NSW and SSW will continue to run in parallel. As a consequence, there is now a more explicit acknowledgement of the role of the social sciences in terms of the BA's activities and also more opportunities for synergy between the social and the physical and life sciences. This is a wonderful and extremely encouraging result.

Publicise research results

The third issue with which I have been concerned is the need for scientists and social scientists to take seriously the publicising of the results of their research.

I have been a journalist for most of my life, mainly on *The Economist* magazine, and am conscious of the difficulties that academics often face in conveying the core of their research findings to a general audience without oversimplifying or caricaturing their results. But the dangers of failing to communicate emerged vividly from a radio programme that I did in June.

The programme was about Ignaz Semmelweis, a Hungarian obstetrician of the 1840s, who discovered the reason why women who gave birth in hospital attended by doctors were far more likely to die than those attended by midwives. Doctors came straight from dissecting cadavers to conducting internal examinations, with disastrous results. Semmelweis persuaded them to wash their hands in chloride of lime, and dramatically cut the death rate. But his intemperate personality and reluctance to write about his work meant that his findings were widely ignored, and thousands of mothers continued to die.

Many academics are still reluctant to publicise their work, though usually with less tragic consequences. But only by doing so can they intrigue young people and persuade them to pursue scientific studies or even careers. And unless people have some scientific literacy, they can hardly be expected to grasp the key arguments in scientific debates. In the past few years, some of the most important public debates have been on scientific issues: whether on genetic engineering of crops and other organisms; on the rights and wrongs of cloning; on the MMR vaccine; or on the need to generate more nuclear power.

Better maths teaching

At the very least, people need some understanding of risk. Many of the public policy issues that involve science boil down to questions about how willing people are to tolerate risk in exchange for various benefits. And understanding risk requires some sense of numeracy. People may be bad at arithmetic, but they need to realise that – say – a billion is a much larger number than a million, or that a substance measured as parts per thousand is likely to be more densely concentrated than one measurable only in parts per million. If such concepts mean nothing, how can people engage with science?

Semmelweis's intemperate personality and reluctance to write about his work meant that his findings were widely ignored

So at the very root of the task facing both the BA and the ESRC may be the need for better teaching in schools, and especially better teaching of maths. No subject opens more doors. When youngsters abandon maths early, or fail to take maths A-level, they exclude themselves from many of the most interesting and demanding degree courses and careers. And they also jeopardise their chances of understanding what scientists are really trying to say.

Engagement requires two parties, not one. But in one year, not everything is possible – and it will take another presidency to persuade more young people to study maths. My successor, Lord Browne, the head of BP, cares passionately about the education of engineers, and so I bequeath the task to him!

Reference

1. See http://www1.the-ba.net/climate/movie.html

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@ a glance...

There is a need for greater concern about global warming

Social scientists ask essential questions about how to turn scientific findings into public policy

Natural scientists and social scientists need to work more closely together

To further this aim, the Economic and Social Research Council and the BA cooperated this year to publicise the challenge of climate change

Both natural and social scientists need to be more serious about publicising the results of their research

Achieving a more scientifically literate population will need better maths teaching in schools

Shorts

In brief

Delivering on nanotech?
The Council for Science and Technology is reviewing the government's progress on the commitments outlined in its response to the Royal Society/Royal Academy of Engineering report, *Nanoscience and nanotechnologies: opportunities and uncertainties*. The review will assess if (and how quickly) it is delivering on these commitments and how its actions are affecting public perceptions and national competitiveness. Written submissions are accepted until 2 October. See www.cst.gov.uk/cst/business/nanoreview.shtml.

Seeking views on GM crop planting
The government has started a public consultation to help establish an acceptable basis for growing GM crops in the UK. Views are sought on how to address the proximity of GM to conventional or organic crops; possible compensation for farmers whose non-GM crops become contaminated with GM DNA; and the need for a GM crop register. The deadline for responses (www.defra.gov.uk/corporate/consult/gmnongm-coexist/index.htm) is 20 October 2006.

Artificial life under scrutiny
A coalition of 35 international organisations has called for public debate, regulation and policing of the rapidly advancing field of synthetic biology, which entails manipulating DNA to construct novel, artificial life forms. The coalition says that self-governance by the synthetic biologists themselves – as advocated at http://syntheticbiology.org – is inadequate for countering the possible social, environmental and bio-weapons implications. See www.etcgroup.org

Happy Birthday to the BA
The BA celebrates its 175th anniversary this September. Founded in 1831 to help reverse what Charles Babbage described as the 'decline in science' in the country at the time, its history is noted for having hosted meetings where the words 'scientist' and 'dinosaur' were coined and where the first demonstration of wireless transmission was given.

Energy review stuck at fork in the road

The white paper should clarify nuclear's future

Following the publication of the long-anticipated energy review in July, the battle for the high, carbon-free ground is now underway.

The review paves the way for low-carbon energy generation but is equivocal about which route to take; its proposals provide support for both nuclear and renewable technologies. They include: increasing the renewables obligation to 20 per cent; 'aggressive implementation' of the microgeneration strategy to remove barriers to household renewables; fundamental change to the planning system for all types of energy projects; measures to facilitate new nuclear power stations – including streamlining the licensing process and clarifying the strategy on decommissioning and waste; and strengthening the EU emissions trading scheme beyond 2012.

Decision time
The review will be followed by a white paper at the end of the year, by which time government policy and private investment, say the experts, will be pointing predominantly either to the nuclear or the renewables route but probably not to both.

The reason, explained Stephen Hale, director of the Green Alliance, is that the two methods of power generation are predicated on fundamentally different distribution structures. Nuclear needs a centralised system, remote from the area of demand, and renewables demands a decentralised network that generates power close to where it's needed. Investing in both sorts of structure is impractical, he said.

The infrastructure issue is one of the primary concerns voiced by the nuclear sceptics, after the problem of waste disposal. A commitment to nuclear, they say, will lock the country into centralised energy generation for decades and be unlikely to encourage efficiency measures.

Once in place, the fact that nuclear power generation relies on finite sources of uranium will mean that the energy supply crisis will only be postponed, not solved, they claim. They also express doubts as to whether nuclear power is financially viable without government subsidy.

Pro-nuclear optimism
John MacNamara of the Nuclear Industry Association told *SPA*: 'The industry is confident that major investors will come forward – providing they have some surety of timescales and that the planning and licensing processes will be streamlined. And security of uranium supply isn't an issue for the industry even if we do experience a global renaissance in nuclear. Uranium is used in very small quantities and is abundant enough for us to describe the supply as "virtually limitless".'

The review raised other issues. Dr Kevin Anderson, of the Tyndall Centre for Climate Change Research, pointed out that it does not address heating or transport, which between them account for 82 per cent of UK energy use. The Royal Society was similarly critical. Vice president Sir David Wallace said: 'The energy review has failed to deliver the bold decisions that we have been waiting for. ... [It] ... lacks urgency in taking action to put a cost on carbon dioxide emissions coming from road transport.'

Rewards for researchers who engage with the public

Engaged... scientists can look for rewards

Delegates at the Science Communication Conference organised by the BA and the Royal Society this summer were the first to hear of a significant new initiative to spur researchers to communicate about their work.

The proposal, still under discussion, has been mooted by the Higher Education Funding Council for England (HEFCE) with likely support from Research Councils UK (RCUK) and the Wellcome Trust. It will involve a national scheme with ring-fenced money behind it aimed at recognising and rewarding researchers involved in engagement. It will also take steps to catalyse a change in the culture that makes it hard for scientists to spend time on communication or engagement activities.

Centres of excellence

The first phase will involve establishing six centres of excellence within higher education establishments across the country. Kerry Leslie, head of RCUK's Science in Society unit, explained: 'This was prompted by the outcomes from a previous Science Communication Conference. The recent survey undertaken by RCUK, the Wellcome Trust and the Royal Society [on the attitudes of scientists to public engagement] also fed into the plans. The activities of the centres of excellence are still being fleshed out.'

The survey in question revealed that the 'research-driven' culture in British universities presents a barrier to scientists communicating their work with the public. Sixty four per cent of the scientists surveyed said the pressure to publish, attract funding and build careers on 'hard research' means public engagement work is not a priority for them.

Cash forthcoming

At the Science Communication Conference, Roger Grinyer, Head of Corporate Communications for HEFCE, took the bold step of announcing a plan – and the cash to fund it – with the aim of creating a culture in which public engagement is valued and its status raised.

HEFCE, he said, would provide up to £4 million over four years beginning in 2007-08, conditional on matched funding from RCUK, with the Wellcome Trust and the other UK higher education funding councils making contributions. The ensuing presentation from Professor Ian Diamond, chair of RCUK, suggested that they would do their bit to ensure the baseline amount of £8 million, although at this early stage details and figures were still tentative.

A formal announcement of the funding and a call for proposals is planned for September; it will apply to all research areas covered by the research councils, not just science.

Communicators pleased

The proposal was greeted with delight by the science communication community.

Kathy Sykes, Collier Professor of public engagement in science and engineering at Bristol University said: 'Finally, here's a scheme that will fund good practice, collaboration and consolidation. It won't deal with the issue – a cultural change is necessary for that, and a single measure can't be expected to instigate change overnight. But I do think it will help.'

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In brief

Exposing science teaching trends

The House of Lords Science and Technology Committee will report in autumn on its inquiry into school science teaching. It is investigating how to attract and retain science teachers, variations in the quality of teaching and the effects of curriculum changes and other factors. Meanwhile government is planning to rank schools according to their performance in GCSE science as well as in maths and English.

Web centre for maths teachers

The National Centre for Excellence in the Teaching of Mathematics (NCETM) is now up and running at www.ncetm.org.uk. Funded by the government to the tune of £15 million, the centre is described as a 'vital tool' that will provide mathematics teachers with support and professional development. It will also enable the creation of networked communities of teachers and local collaborations.

Could drugs and sport mix?

The House of Commons Science and Technology Committee is conducting an inquiry entitled 'Human Enhancement Technologies in Sport'. It will focus on the scientific and ethical case for allowing different human enhancement technologies (HETs), including drugs, genetic modification and technological devices, to be used to enhance sporting performance, as well as ways to minimise the use of illegal HETs at the 2012 Olympics.

Queries over Trident replacement

The House of Commons Defence Committee has reported on 'The Future of the UK's Strategic Nuclear Deterrent'. It concludes that the UK must examine the relevance of nuclear deterrence and must also consider the potential implications of any technical dependencies upon the US. The committee welcomed the government's promise of an open debate but expressed disappointment that the Ministry of Defence refused to participate in the inquiry.

Explaining ourselves

To regulate science we need to understand it, argues Monica Darnbrough

Teachers, writers and media presenters all have a pressing challenge. They need to be able to introduce scientific terms clearly enough so that we all have an accurate concept of their meaning.

Then we can all play a part with politicians to decide whether science and technology is used or not, and how its use is regulated in order to ensure public benefit and public safety.

Civil servants

My colleagues in the civil service were intelligent, widely read, witty people. Many had degrees in politics, philosophy and economics or law from prestigious universities. I was enormously impressed by the speed and facility with which they tackled issues, however complex or specialised. They quickly grasped specialist legal terms and concepts, City financial practices, obscure aspects of treaties. In a very short time they could write clear explanatory notes on the crucial points.

What surprised me was that the confidence, easy assimilation and skilled analysis seemed to evaporate when these consummate professionals were faced with scientific or technological issues. Specialised scientific terminology, which was no more conceptually difficult than legal or tax terminology, tended to be put into the too difficult pile, passed to a specialist, or dismissed as unimportant. It was as though there was a barrier or block which stopped them from dealing with these matters in their normal effective way.

Examples ranged from the earliest discussions of global warming (raised with us by Germany when Mrs. Thatcher was both Prime Minister and Minister for Science); international decisions about banning products like tallow or gelatin which might be linked to BSE; agreeing separation distances between fields of GM crops.

Medical ignorance

A patient with Parkinson's disease spoke in an easy-to-understand style on the radio about the causes and treatments. He described how two chemicals in the brain are out of balance and that dopamine levels are low. But, when he described compounds which are *agonists* (which bind to a receptor site and hence trigger an increase in production of the wanted dopamine) you could hear the interviewer losing the thread.

What we regulate

I am dismayed by the lack of knowledge, amongst generally well-informed friends, about the regulations that surround the mandatory testing of chemicals, pesticides, and novel drugs before products can be put onto the market in UK, US and Europe. Understanding the regulatory framework does not require knowledge of scientific terms: it is a civic matter. We should all know about the procedures which our societies have put in place to protect citizens.

It is not widely known that we no longer allow testing of cosmetics on animals to be done in the UK. There is little awareness of the way experiments on animals are regulated – the laboratories, the individual researcher and the experimental design all have to be authorised and licensed, and ethical committees are always involved in consideration of the research which is being planned.

There is also surprise that natural remedies and health foods have not had to undergo testing to demonstrate their efficacy in the way that drugs do.

The role of jargon

Why do scientists and the medical profession use unfamiliar words? It may seem as though they want to mystify or exclude 'outsiders'.

The use of special terms comes in part from the need to write up experimental methods in a precise way which will enable someone else to repeat the experiment exactly. Results must also be described precisely. When new observations are made, researchers 'invent' new words to describe them.

This new language is initially used only by the few specialist researchers working in the narrow field, but the research may be more widely presented. Most people want to understand something about their bodies and can understand that chemicals help to carry messages between nerves in the brain (neurotransmitters) but are baffled by terms such as 'anterior resection' on a consent form to describe the abdominal incision (sorry – the cut in the belly) needed for surgery on the gut.

Only when we understand the words and the concepts will we be able to consider how discoveries might be used and regulated in society. In the debate about whether to allow or encourage research using stem cells, we must distinguish between human embryonic stem cells (originally taken from a 'blastocyst' – a minute hollow ball of 'totipotent' cells which is the embryo after a few hours of development – and grown in 'cultures') and 'pluripotent' cells derived from umbilical cord blood or from bone marrow. See what I mean about needing to understand the words?

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We should know that traditional remedies are not regulated in the UK *Christine Gonsalves*

Open Science

Alan Cottey advocates openness from beginning to end

I advocate a radical kind of openness for science projects which has, I believe, never been tried.

The publication of polished results is, by itself, an insufficient basis for an adequate understanding of scientific practice. For this, it is necessary to know how the science is produced.

This would mean documenting, in real time, all stages of the project, including its passage through institutions' ethics and safety committees; the application for funding; review by the funding body; the funding body's terms for support; the institution's terms; log of the course of the project; reports; manuscripts submitted for formal publication; referees' comments; revisions and published papers.

The radically open kind of scientific project that I advocate is made technically feasible by current IT. An Open Science (OS) Project will have a definite starting point and full details of the work will be logged on a website and accessible to all in real time. This may sound like a science blog but there is an important difference, in that any OS Project will be a serious attempt to add to scientific knowledge. To do this on the web in real time will be *scary*.

Each experimental step should be open *Andrei Tchernov*

Current practice

That science should be open is a commonplace. On the other hand, private ownership now encroaches further into almost everything, including knowledge. Parts of the science commons are being enclosed. The BA has, throughout its history, been a player in this contest, its work for inclusiveness being a contribution to openness.

It is generally assumed that the essential requirement for science to be open is that the results be published and rigorously criticised. The most open kind of science that has been practised to date is however still far from fully open.

There always were problems with the traditional model of scientific practice. Is it as pure as the ideal would have? The norms of science – universalism, disinterestedness, communalism, scepticism – as identified by Thomas Merton are accurate as norms, that is, they describe scientists' values on how scientific knowledge should be produced.

Obviously actual practice does not meet these ideals fully. Parochialism, special-interest, privatisation and credulity do enter. Scientists are 'close' during the course of an investigation, until they and a few trusted colleagues have checked thoroughly for mistakes and omissions. They polish the presentation to make it persuasive.

This way of producing reliable and useful knowledge has worked remarkably well since it was developed in the 17th century. The aim of my Open Science proposal[1] is not to undermine this approach, which I see as having the potential to serve human survival and advancement for a long time to come. Rather, the proposal is for an addition to what has been tried to date.

Objections

One objection that I get in conversations with colleagues is that scientists will not expose themselves to the risk of someone else muscling in and getting credit by beating them to the finishing line. My answer to this is that for most of us the problem is the opposite – to be heard above the cacophony.

Another concern at the prospect of doing a radically open project is that all scientists know how muddy is the path to the clean published report. Scientists have reputations to lose, or hope to gain them. Fear of losing face is probably the principal obstacle to pursuing some research projects the OS way.

My answer to this objection is that most scientific research will not be best done according to a defined protocol for open science but it will be informative to do some projects in this radically open way. For reasons of practicality, the first OS Projects will be simple, small and not too controversial. The originality lies more in the OS method than in science path-breaking.

How to begin

The OS way sits especially well with inclusive science, for example involving a community or studying aspects of lifestyle. Environmental impact studies comprise a class of current importance. One such project I am considering is a comparison of machine dishwashing with manual dishwashing.

I believe however that OS Projects are possible in all areas of science. Even in big science, tiny elements of a complex project can be suitable.

A modest corpus of OS Projects may reveal aspects of the balance between the various levels of openness – in a group of web pages on Open Science[1] I call them secret, restricted, circumspect and open – that cannot be known without trying the open way. The full spectrum will then have been experienced.

Reference

1. For Open Science, see www.uea.ac.uk/~c013/open_science/open_science_front_page.html

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Does the push to publish lead to fraud?

Recent reports of scientific misconduct have fed impressions that fraud is increasing. In the UK, the demands of the Research Assessment Exercise and the intense competition for limited research funding are often blamed. Stephen Minger, Steve Fuller and Philip Campbell discuss.

Fraud is not on the rise

Science is still an honourable vocation, argues Stephen Minger

It is no wonder that, in today's research environment in which the drive to succeed and be the first to do so has reached unprecedented levels, people think there is increasing fraud in science.

This is so particularly in the aftermath of 'Hwang-gate', which exposed the seemingly-remarkable stem cell work of the South Korean scientist Professor Hwang as fraudulent.

However, from my perspective as a research scientist, I have no reason to believe that fraud in science is on the rise.

More caution, not less

I think that the motivation to cheat and to publish fraudulent data is as rare as in previous years. Almost any one engaged in scientific research is passionate about their particular field, and certainly most of us are driven to excel in a competitive and pressurised environment. We are scientists foremost because it is our vocation rather than our profession. But I think very few of us would ever consider risking a career that has taken years of hard effort and considerable personal struggle to achieve, all for that one 'killer' paper in *Science* or *Nature*.

In my own area of research, stem cell biology, the desire to translate our work from the laboratory into human clinical applications is often palpable and visceral. But the prospect of contributing to the generation of new novel therapies that one day will provide substantial improvement in the quality of life for a large number of individuals with chronic and debilitating disease actually makes us much more cautious in interpreting our results and publishing our work.

Peer review works

The peer review process in science does work. It is called reproducibility – another research team somewhere else in the world looks over our published work and replicates our research findings in their lab and with their researchers. Data and research findings that cannot be replicated become the subject of gossip on the scientific grapevine, and one can easily gain a reputation for publishing dubious data. But these are very rare research groups and certainly do not represent the mainstream of scientific research.

Stem cell research: latest casualty of fraud *Andrei Tchernov*

The problems that afflicted the research team in Seoul are a tragic lesson to everyone engaged in high-profile research, and one that we must all learn from. But science is still an honourable vocation, where the process of peer review, scrupulous dissection of one another's data, and the replication of experimental findings are still the *sine qua non* of the scientific method. It is for this reason that fraud in science will never become widespread and the vast majority of published work will hold up to such scrutiny.

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Fraud may be desirable

Steve Fuller isn't bothered

The push to publish undoubtedly leads to fraud, but so what?

An increasingly competitive research environment provides greater incentives to anticipate the results of research not yet done or to massage the data of results already in hand. But equally it provides more incentives to check for such transgressions of scientific propriety. Consequently, it is hard to say that there is now more fraud than in some supposedly less competitive past.

We might imagine the level of fraud to have been less in the past, given the lack of incentives. But there may have been more fraud, given the lack of check. In any case, there are no records. What most certainly does *not* follow is that the relative failure to detect fraud in the past means that less fraud occurred. Just as much, or even more fraud, may have been committed in the past, but more rides on science today than ever before. Arguably that is the real problem.

Citation clubs

The current fixation on research fraud hides more systemic problems with the scientific enterprise. Interest in fraud is typically limited to the misrepresentation of research outputs, not the inputs.

Here I mean the tendency – captured in the phrase 'citation clubs' – whereby a circle of researchers cite each others' work to ensure publication in key 'high impact' journals, regardless of their actual contribution to the intellectual basis of the research reported. As citations are increasingly used both to inform and to assess research performance, a subtly misleading picture is thus presented of the relative significance of particular researchers and their fields.

Plagiarism can restore undervalued work

Moreover, certain kinds of fraud might actually be desirable, especially given science's tendency to disown its past quickly.

Many plagiarism cases involve resurrecting work that was undervalued when first published but would unlikely appear credible now were it revealed to have been written many years earlier. In any case, much credible research can be – and has been – built on the back of frauds. Once that happens, the revelation of fraud may be reduced to a mere historical curiosity, as in the cases of Galileo and Mendel.

Truth to be told, science may flourish with a fair level of fraud, perhaps because reality is more tolerant of our representations of it than we might like to think. It may be that fraud goes undetected because it is 'wrong' only in misrepresenting one's own work, but not in misrepresenting how reality works.

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Fraud is only a symptom

We need to guard against the sociopaths, warns Philip Campbell

My answer to this question is: 'who knows?'

It's an unhelpful but honest answer: little has been systematically documented about the motivations of science fraudsters. But blaming the pressure to publish for fraud doesn't get you very far.

Publication is by far the most significant manifestation of scientific achievement, and the scientific impact of publications is the dominant measure of a researcher's value. The quality of the science ultimately counts for more than quantity.

However, it is an unhappy fact that in science you either come first or you may gain nothing from perhaps years of work. This pressure can be mitigated by the knowledge that work done more thoroughly has its own value – there is a place for people who aren't first but who nevertheless have deeper or broader tales to tell. But the medals and promotions tend to go to people who are first to report a clear discovery.

Misconduct

Current pressures are bound to increase the likelihood of misconduct. This is especially so with misconduct that is relatively easy to implement, such as the manipulation of images to make a result just that little bit more convincing, or using your senior position to put your name onto a paper even when you made a negligible contribution, or abusing your trusted position as a referee to steal an idea and quickly implement and publish it yourself.

Equally to be deplored are people who fabricate or plagiarize scientific results simply to cut corners. They believe they know the right answer, they are under one pressure or another to complete an experiment, and they act on a temptation to get there fast, believing that their actions will not be discovered.

Sociopaths in science

There are sociopaths in science as in other walks of life. When one looks at cases of fraud on a grand scale, involving the duplication or fabrication of data in papers that is almost certain to be detected ultimately, carried out by someone of high intelligence (the physicist Jan-Hendrik Schoen comes to mind), it is hard to avoid the conclusion that one is witnessing a pathological personality at work.

Instead of blaming pressures on researchers, it is more important simply to recognize that there are unethical scientists. Institutions, funding agencies and journals need to appreciate the damage that such people can do and enforce laboratory and refereeing practices that minimize their likelihood of success. After all, like it or loath it, the push to publish is here to stay.

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Bringing scientists and parliamentarians together

The Royal Society's MEP-scientist pairing scheme enables Members of the European Parliament and scientists to visit and observe each other at work. It aims to make scientists more aware of policy-making at the European level, and to allow parliamentarians to gain more insight into the scientific process.

Formulating and approving policies

Mark Enright understands more

I was pleased to be paired with John Bowis, Conservative MEP for London, as only a small amount of background research revealed him to be very active in the area of public health policy in the European parliament and a former UK government health minister.

My laboratory group is trying to understand the mechanisms that produce increasingly aggressive and antibiotic-resistant types of MRSA and how these spread at hospital, national and international level.

Healthcare policy in this area has a direct and measurable effect on morbidity and mortality, yet many interventions in the area of infection control lack a strong scientific base. Many such studies are poorly designed or their results are poorly communicated, leaving their results open to misinterpretation.

Busy schedule

The draft timetable of my visit to Brussels appeared complex because, as well as spending time with the MEPs, myself and five other UK scientists were scheduled to meet with representatives of the European parliament, commission and council, NGOs and several other bodies.

The meetings were on the whole interesting and informative. I now have some understanding of how policies are formulated and approved by the European institutions – informed at several levels by inputs from the scientific community.

My visits to the European Parliament and with MEPs demonstrated the personal interest that the MEPs I met have in the policies that they help shape. John Bowis for example is currently helping develop new policies in the area of mental health and in the past his committee helped establish the new European Centre for Disease Control and food safety standards.

Consensus

Most MEPs, in common with most scientists, have a low public profile. However, in attending sessions of the Parliament, committees and press conferences I could see how busy their working lives are, as they go from meeting to meeting discussing policies and amendments, voting on them and then communicating them through the media.

My main impression of the political processes is of consensus – in my short time there I could see how MEPs of different countries and parties engaged in thorough debates informed, on occasion, by eminent scientists.

Framework Programme 7

Having spent a very busy week in Brussels in January 2005 evaluating grant applications under the European Framework programme 6 (FP6), I was interested in hearing about how the EU was going to allocate its research budget over the next five years under FP7.

In meetings with Directorate General Research officials, we were told of sizeable increases in the budget available to European scientists and for the first time the availability of funds based solely on the scientific merit of proposals. Previous programmes have had to satisfy other criteria such as capacity building and interactions with business; but this new initiative is designed to stimulate research at a globally competitive level.

More money is also being allocated to increase mobility of scientists between member states. I am a keen advocate of this, having had two successful visits from Marie-Curie visiting scientists.

MRSA research feeds into healthcare policy

More time

Informing policy makers and the public about the best science is important if government initiatives are to be successful and the Royal Society and other scientific bodies have a major role to play here.

The exchange was a worthwhile exercise from my point of view although I would have liked to have seen more of how MEPs work on a day to day basis. When John visits my laboratory at Imperial and when I meet him in his constituency I hope we can expand on the all too brief meetings we managed in Brussels.

I hope in future that such exchanges continue, as politicians and scientists should interact frequently to ensure that sound legislation can be based on the best and most recent scientific research.

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Making judgements about science

John Bowis enjoys a timely visit

My return visit to Mark's 'den' at Imperial College was fascinating.

By chance I was there on the day the shock-horror news was coming out on the MRSA deaths at Stoke Mandeville and the alarming rise in the national 2005 figures over 2004, showing more than 50,000 patients affected and a 17 per cent rise in one year. And so it was doubly interesting to sit in on a joint research discussion and planning meeting with two of Mark's colleagues from Birmingham and later to visit the laboratory and, suitably attired, to see the various specimens collected from various parts of the world and hear about the processes in this particular branch of scientific research.

Its topicality could not have been more dramatic. Nor could the layman's half-knowledge be more clearly exposed. Tabloid readers and schoolchildren and I know all about MRSA – the hospital superbug – or do we? First I doubt if many have even heard of the larger scale bacteria – *Clostridium difficile* – which was actually responsible for the 50,000 figure, while MRSA led to 7,000 cases. Secondly I learned for the first time about the less dramatic superbug cousin that exists outside hospitals.

Given that patient safety is one of the current key priorities for policymakers in Europe and in Britain, this meeting of science and politics showed in a microcosm exactly why the Royal Society's scheme is so valuable.

My visit also brought about another sort of reunion, when I discovered the professor heading up Mark's department, Brian Spratt, was at school with me. But those memories are for another day!

Committee responsibilities

As an MEP and former MP I know that I don't know enough about science. I also know that in my day to day legislative and scrutiny duties I rely on the advice of scientists. On the whole I do not know them or their working processes and nor, I suspect, do they know mine.

I am a member of the European Parliament's Committee on Environment, Public Health and Food Safety. The *raison d'être* of much of my Committee's work is the protection of human, animal and plantlife health from pollution in its many forms – air, water, soil and the waste and emissions from people, households, industries, agriculture, transport, electronics and so on.

Testing new chemicals: parliamentarians need scientific advice *Bayer*

The three areas of scientific advice on which I rely most often are probably those of the four agencies of my Committee (the European Food Safety Committee, European Centre for Disease Prevention and Control, European Environment Agency and the European Agency for the Evaluation of Medicinal Products). A fifth is about to be born: the Chemicals Agency that will flow from REACH (the Registration, Evaluation and Authorisation of Chemicals), if and when it completes its legislative passage (probably by the end of 2006).

Judging and regulation

In making a judgement, as we have to do, on whether a process or a substance should be phased out or a pollution reduction target met and by when, we have to rely on scientific advice as to the risk, its management and the alternatives. The committee establishes advisory committees of scientists to give this advice.

But how such advice is decided upon or how and by whom it has been agreed, is often unknown to us. It only takes another scientist to question the accepted advice of such a committee for parliamentarians to second guess the advice we have received and go for tougher standards or restrictions than may be necessary.

This is not very sensible governance but it stems from the blind adherence to the precautionary principle (if in doubt, play safe – or if there is a scintilla of doubt, condemn). The last Commission's attempt to underline that the principle must be one of proportionality as well as precaution was lost somewhere in translation!

Excellent concept

Mark Enright was a welcome but all too brief member of my office. He was able to sit in on my Development Committee, but was not able to come to Brussels early enough in the week to hear the debate on my Mental Health Report in the Environment Committee.

This perhaps suggests that future visits should be more tailored to the needs and interests of the two participants, rather than the organisers. That is not however to be critical of an excellent concept, well executed by the organisers, and a pilot that should be translated into a permanent scheme. I warmly welcomed the opportunity provided by the Royal Society to bring our two cultures together.

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The Conservative Party tackles science

Ian Taylor explores different funding priorities

The Conservative Party leader David Cameron's challenge to me to form and chair a policy task-force on Science, Technology, Engineering and Mathematics (STEM) was one I could not resist.

As a former Minister for Science and Technology, I know how significant the subjects are for the future prosperity and well-being of this country. Appropriately, the STEM task-force forms a key part of the work of the Party's Economic Competitiveness Policy Review Group.

Science central to economy

The Conservative Party has recently failed to take science and technology sufficiently into account in policy formation. Science was not mentioned at all in our last general election manifesto. By the time of the next general election we will have been out of office for more than a decade – a period of dramatic developments in both science and technology as well as in the global competitive climate. So an incoming Conservative government must ensure that the exploitation of STEM is central to the economic competitiveness of the UK and to our quality of life.

In the UK we cannot afford to be complacent about the resilience of our STEM base nor of the related knowledge and skills formation. Our accumulated expertise is at risk of being eroded by ever-increasing international challenge. Market incentives are moving highly skilled jobs abroad, where an exceedingly well-educated and qualified workforce can achieve a comparable or even better performance at a fraction of the UK labour cost. Universities are now competing in a global education and research environment.

Delicate future? The UK needs to retain experts in science and medicine *Medical Research Council*

Private and public funds

The purpose of the STEM Task-force is to recommend what main actions, in priority order, an incoming Conservative Government should take to maximise the contribution of STEM to the economic competitiveness of the UK. In this, we have taken as a core principle that in the modern economy it is in the national interest for taxpayers' money to be invested in stimulating STEM innovation.

We also maintain that one of the objectives of government funding is to leverage into STEM as much private capital and activity as possible – and to avoid bureaucratic rules and regulations which act as deterrents. For example, the plethora of government input schemes are still often disjointed, confusing and uncoordinated between agencies. Awards are both too thinly spread yet require massive documentation and compliance. How can better investment risk-taking emerge from the shadow of the National Audit Office?

Whilst we are obviously aware of the government's priorities and agenda we do not intend to let this stifle our thoughts or policy review. Re-prioritising science funding could not all happen overnight so there will be some continuity if there were to be a change of government. But there may be a radical shift in emphasis nevertheless. Without engaging in a bidding war for more money, there are certainly ways in which improvements can be made.

Our subjects

We are looking constructively at several related themes:

- the scope of a national strategy for STEM
- the relative importance of applied science and 'blue skies' research
- the actual stimulus provided by the Research Assessment Exercise
- the key research areas that need to be developed and/or retained
- the achievement and exploitation of STEM in a global market
- the most added-value mechanisms for the successful exploitation of STEM
- the relative effectiveness of input funding versus government procurement
- the methods and mechanisms of attracting and retaining students/leading experts
- the role of public sector research establishments
- the remit, organisation and management of the Research Councils
- the impact of EU and international research collaboration in STEM.

Educating future scientists

A fellow task-force on higher education and skills will look at personal skills development and transfer. This will include reviewing policy for attracting students, the state of vocational training and the comparative decline in student numbers in several STEM disciplines – a crucial concern if we are to maximise our future potential.

I have participated in a Conservative seminar on the curriculum and teaching of science in schools, as improving these are crucial if we are to have the students with skills to exploit the policies we put forward for STEM.

The task-force I have assembled consists of individuals from different backgrounds but with a broad range of experience and skills both from academia and industry. We will publish our interim report around the end of this year. There is plenty to do, but I am certain we will stimulate a wider political debate about STEM which can only be in the national interest.

For further details on the STEM task-force, visit www.competitivechallenge.com or email chilmans@parliament.uk

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Scientific advice in drugs classification

Phil Willis finds serious shortcomings

The term 'evidence-based policy' is regularly bandied about by politicians seeking to give their policies greater credibility. In a wide-ranging inquiry, the Science and Technology Committee has been exploring the reality behind the rhetoric by examining the role that scientific advice and evidence have played in the formulation of various key areas of government policy.

One of three case studies undertaken within the inquiry addressed the classification of illegal drugs.

The current ABC system purports to classify drugs on the basis of harm, in order to make penalties for possession and trafficking proportional to the harm associated with their misuse. Most of the classifications of individual drugs were determined in the Misuse of Drugs Act 1971 but there have been changes made since then – most controversially, the reclassification of cannabis from Class B to Class C which came into effect in 2004.

The Misuse of Drugs Act also established a scientific committee, the Advisory Council on the Misuse of Drugs (ACMD), to advise the government on drugs policy. The Home Secretary is obliged to consult the ACMD prior to making any changes to the classification of a drug, although he is not bound by this advice.

Reclassification of cannabis: clear information needed

Conspiracy theories

We were concerned to find a number of deficiencies in the operation of the ACMD. We recognised that the Council made a vital contribution to policy making but found that it had given insufficient attention to transparency and public communication.

Scientific advisory committees have a public duty to be as transparent as possible in their approach – the ACMD's deficiencies in this area have created fertile ground for suspicion and conspiracy theories, as well as hindering public understanding of the role of the Council.

We were also disappointed to find that the ACMD had focussed disproportionately on the provision of advice to the Home Office. The Department of Health and Department for Education and Skills clearly have pivotal roles to play in delivering the government's drug policy targets and it is essential that approaches to treatment and prevention are firmly rooted in evidence. We concluded that the Council needed to be much more proactive in supporting policy making in these departments.

Concerns all round

In order to examine the incorporation of advice in policy, we looked at the part played by scientific advice and evidence in the classification of cannabis; amphetamines, including ecstasy and methylamphetamine; and magic mushrooms. In each case, we found cause for concern.

The widespread confusion that accompanied the reclassification of cannabis emphasised the need for clear and effective information campaigns to ensure that the police, users and the general public understand the implications of any changes.

In the case of ecstasy, we found the ACMD's failure to review its classification – despite accumulating evidence that it did not merit its Class A status – surprising and disappointing.

We were also critical of the fact that the ACMD took it upon itself to make a political judgement in advising the Home Secretary against moving methylamphetamine from Class B to Class A on the grounds that it might stimulate interest in the drug amongst potential users. The Council's subsequent change of mind gave the impression that it had either realised its error, or succumbed to outside pressure.

Finally, in respect of magic mushrooms, we were critical of both the Government for using a 'clarification of the law' to place fresh magic mushrooms in Class A (which bypassed the need to consult the ACMD), and the ACMD for not speaking out against the government's decision, despite a lack of evidence to suggest that magic mushrooms should be placed in Class A.

Decouple classification from penalties

Drugs education must be evidence-based if it is to be credible. Yet in our inquiry we found glaring anomalies in the classification system and no convincing evidence for the deterrent effect which is widely seen as underpinning the government's drug policy.

Decoupling the classification system from penalties would facilitate the development of a more scientifically-based scale of harm which could be far more responsive to changes in the evidence base. A decoupled scale could also include tobacco and alcohol to give a better sense of the relative harms associated with abuse of various drugs.

At the beginning of 2006, the government promised to undertake a root and branch review of the classification system but this has failed to materialise. Our inquiry has shown conclusively that this review is urgently needed.

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See also Tracey Brown's article on page 29.

Renewables in gridlock

Colin Axon, Gary Taylor, and Malcolm Irving forecast sparks ahead

An important factor has been overlooked in the current energy debate – it is not a straightforward matter to 'bring on-line' large quantities of renewable generation.

The commonest barriers to the deployment of renewable energy sources, whether large- or small-scale, include the aesthetic impact on the landscape or skyline (as David Cameron found with his ultimately successful planning application to mount a small wind turbine on his house in a conservation area), and doubts that they will supply enough energy.

A more significant impediment is the configuration and performance of the present UK electricity grid infrastructure. The UK network consists of two separate (but linked) systems – the high voltage transmission grid, characterised by the pylon network, and the lower voltage distribution grid for the UK's 22 million domestic and commercial consumers.

This network was designed for a relatively small number of large power sources, not a large number of small distributed ones. The difficulties of integrating large-scale sources (wind farms, wave or tidal generators and so on) into the transmission system are related, but different, to those of adding domestic scale 'embedded generation' into the distribution system.

Transmission issues

The transmission grid consists of approximately 180 large power stations and 10,000 sub-stations, connections and so on. As there is no cost-effective way of storing electrical energy, the demands made by consumers must be generated and managed minute by minute; this is one of the most complicated control problems imaginable.

By using statistical analysis of usage patterns, it is possible to predict and cope with short-term peaks and troughs from daily patterns, in addition to the slowly altering seasonal demand. What is much more difficult to deal with is inherently unpredictable variability.

The intermittent nature of renewables, particularly wind turbines, will make control of the transmission grid especially difficult because all generators in the system have to be synchronised. Furthermore, the system must be actively controlled and balanced to exacting standards for frequency and voltage, set and regulated by Ofgem, the body which regulates the electricity and gas markets in Great Britain.

Will the UK grid cope with generation from small-scale renewable sources? ***Solar Century***

It is widely accepted that the transmission grid will remain stable and reliable with a rise in renewable generation from the present three per cent to the Government's desired ten per cent. However, it is not known what percentage of renewables might adversely affect the grid's behaviour. This figure is likely to be above 50 per cent of operating capacity, though if the strategies to decrease power demand and to grow the number of large-scale renewable sources are successful, we might get to that figure faster than anticipated. Grid engineers have been very resourceful in meeting demands, but we are at only the start of the grid-connected renewables learning curve.

Down your street

The greatest concern is how the distribution grid will behave once embedded with many district- and domestic-scale generators.

We do not know whether the behaviour of such a complex network could exhibit unpredictable characteristics and even unexpected emergent behaviour. The proportion or number of distributed generators that the system can comfortably tolerate is simply not known. The interaction between the transmission and distribution grids is currently straightforward, but once the distribution grid also becomes a 'generating' grid, this interaction will cease to be simple.

Complex networks can be very sensitive to small changes. In 2003, north-eastern USA and Canada experienced a widespread blackout as the result of a single cable failure. This uncontrollable cascading outage affected around 50 million people. The UK system, presently able to meet expected demands, will need to be flexible in future to cope with increased levels of intermittent generation and more variable loads.

One possible solution is to reconfigure the distribution grid into so-called micro-grids based on localised areas such as housing estates or neighbourhoods. Any micro-grid will need to be finely balanced between generators and users, meaning that there must be a mix of domestic, public (for example, schools), and commercial users. There is much current research and development to work out how these schemes would function, but practical experience to date is very limited.

What now?

The transmission and distribution network operators need clear support and firm policy implementation from government. Given the current situation the renewables targets are at best over optimistic, and at worst arbitrary. The government's recent energy review acknowledges many of the transmissions issues, but seems to assume that the distribution grid will cope with all eventualities.

The government can set whatever targets it chooses, but unless there is a very large investment in infrastructure and research, there is little possibility of properly harnessing the obvious advantages of renewables.

Further reading

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The Energy Challenge, The Department of Trade and Industry Energy Review, July 2006: London www.dti.gov.uk

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The new GCSE science curriculum

Teachers are getting ready, reports Dominique Driver

For many science teachers this year will prove particularly demanding, as they get ready to teach the new GCSE science courses for the first time.

All schools will have to adopt a new GCSE science curriculum, although they will have the choice between a number of programmes on offer. Each exam board has created a suite of new GCSEs, in line with revised criteria from the Qualifications and Curriculum Authority. The courses offer a more contemporary approach to science teaching with greater flexibility and choice for students, in recognition of the fact that only a minority go on to study science at a higher level.

The most widely known, and perhaps diverse of these new programmes is Oxford Cambridge and RSA (OCR) Examinations Board's Twenty First Century Science, developed in collaboration with the University of York and Nuffield Curriculum Centre, with funding from the Salters' Institute, Nuffield Foundation, and Wellcome Trust.

Controversial course

The move has been criticised by many independent schools, who believe that it is 'dumbing down' classroom science. Janet Pickering, Headmistress of Withington Girls School in Manchester explains: 'Everyone was very concerned that it was all very touchy-feely, let's appeal to very low ability students and we were thinking, well how's that going to work for us?' Talking to the *Independent*, Dr Martin Stephen, High Master of St Paul's School for boys in London, said the GCSE had 'a terrifying absence of proper science...it is no preparation for A-level.'

A firm supporter of the new course, Jonathan Gray, Head of Physics at Gosford Hill School in Kidlington, Oxfordshire, believes that such criticisms are unfounded. 'I think if you know how to learn something you can learn it and that's always got to be addressed first. If we can equip them with the skills to be able to learn things when they leave school then that's great.' He is heading the changeover to Twenty First Century Science in his school, describing it as 'much less content driven and more about how science works.'

Pilot experience

Meanwhile, in a different part of Oxfordshire, the new scheme is already in full swing. Wheatley Park School in Holton is one of 80 schools that has been piloting Twenty First Century Science over the last three years, with OCR being the only examining body to have run a pilot scheme.

> 'If we can equip them with the skills to be able to learn things when they leave school then that's great.'

Ben Green, Head of Science at Wheatley Park, says that students have generally received the new programme positively, whilst the teachers have actively noticed a difference in their attitudes towards science. He describes a perfect example of this. 'A few years ago I was teaching a class in year 11 and we were doing plant hormones and it was about March time, just before their exams. They were sitting there going 'oh what's the point of all this' and actually I had to agree with them, the point was pretty unrelated to what they were going to experience.'

Piloting the new course at Settle College, North Yorkshire

And now? 'With the equivalent group in the current year 11 it was nothing like that at all – they were still engaged and interested. I think that any course that does that has got to be good news.'

Ethics

However there are some areas where he feels the new course may be trying too hard to please.

'It deals with some quite difficult ideas, like ethics, and we were wondering whether this is actually a useful thing for them to know about. The MMR vaccine for example, most people when they become citizens want to know whether to have the vaccine for their child or not. They don't want to be weighing up the evidence for and against, necessarily. We were wondering whether it overplays the ethical questions.'

But Jonathan Gray disagrees. 'There are going to be results that contradict each other – the government says that your child should have the MMR vaccine but then people hear on the news the next day a trial's been done and there could be a problem with it. If you don't understand the ethical perspective and you don't understand how scientists have got their results, then who do you believe? Part of what we're hoping to teach is that science is often not a case of black and white.'

In general though, Ben Green describes the switchover as 'most definitely' a positive one: 'We do a lot more discussion and group work, getting kids to express their own opinions a lot more.'

For science teachers one message is clear: some major changes and challenges are on the horizon.

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Short, crisp quotes

Ainsley Newson discovers how the media works

Ever wondered what it's like to be a journalist, reporting the latest developments in science? Questioned why stem cell research is such a 'sexy' subject yet theoretical physics is seemingly ignored? So did I. Last year, I was given the chance to find out – as a BA Media Fellow.

The BA Media Fellowships scheme aims to create a greater understanding of the workings of the media among academics like me. Ten of us were placed with national press organisations, including the BBC and the *Times* (where I worked with Science Editor Mark Henderson). For around four weeks we were immersed in this strange world and treated like journalists – suggesting and writing our own pieces and meeting deadlines that would make most academics recoil in fear.

But why did I want to give up my summer for this? Like many academics, despite good intentions and hours of training, previous forays into the media hadn't been entirely successful. I'd been misunderstood, mis-quoted and embarrassed. So my usual reaction whenever a big story broke in my field, medical ethics, was to go into hiding until it was all over.

Yet it was clear I was missing out on something. I wanted my voice to be heard in debates over genetic testing, IVF and cloning. I wanted to learn what my colleagues were doing right that I wasn't. Could it be possible that engaging with the media could be... enjoyable? And useful?

Working at the *Times*

On my first day at the *Times*, I entered a vast, open-plan newsroom humming with ringing phones and TV sets spouting the latest headlines. I browsed the papers, checked newsfeeds, and followed Mark to the news desk for a grilling from the news editors about possible stories before the morning news conference. The morning was spent researching and writing, with most stories taking shape in time for the afternoon news conference. Final copy was filed by 6pm.

Most of my days at the *Times* went like this, although I soon began to write my own pieces. My first piece explored ethics and paternity testing. I had two hours to write 400 authoritative words that thousands of people would read the next day – scary, but it certainly focuses the mind!

The next morning, the impact of those words became clear. It seemed everyone wanted to speak to me: BBC News, Sky News, LBC London Radio... A surreal day on which I overcame my fear of becoming tongue-tied whilst the nation watched. But news is transient: the next day everyone had moved on to the next story. This cycle of writing, publishing and starting again continued for the next four weeks.

Controlling journalists

And what did Fellows learn? 'I am now much more confident to market my own science to a wider audience,' said Dr Vikki Burns, a 2005 Fellow. Dr Alison Ross, another 2005 Fellow, agrees: 'It was a great opportunity to do something entirely out of my comfort zone and the best way to understand the constraints under which journalists work.'

As for me, I now appreciate that journalists love short crisp quotes and don't like being bugged on a Friday afternoon. I realise that 'we are their research' – they want simple facts, without nuances or qualifications. I know how to write 'back to front' stories (the conclusion goes at the beginning) and explain difficult scientific concepts using simple language.

The Fellowship also de-mystifies the media, and with this knowledge comes control. 'I now understand how to "handle" journalists, so that they get a good story, and we get accurate, informative coverage of our research,' Vikki said.

Transferable skills

My admiration for journalists has also increased: they display incredible skill in quickly coming to terms with complex issues and distinguishing core facts. But news is also a huge juggling act, in which compromises have to be made and sometimes hard-toiled science gives way to the 'sexy story'.

And the skills you'll gain will have benefits across your work: 'The experience has certainly improved my communication skills, recently helping me write a clearer, more concise research proposal to try and acquire my own funding for the first time,' Alison said.

So if you are interested in finding out more about how the media works, then a BA Media Fellowship to see how two very different worlds collide is a fantastic opportunity. Vikki sums it up: 'The media fellowship is one of the best things I have done as an academic.'

Distinguishing core facts: journalists at the Festival of Science

For more information on the BA Media Fellowships scheme, visit: www.the-ba.net/the-ba/ScienceinSociety/Schemes_and_awards/MediaFellowships/

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Plant genetic resources for agriculture

Good news from Madrid, proclaims Emile Frison

The first meeting of the Governing Body of the International Treaty on Plant Genetic Resources for Food and Agriculture does not sound like a source of cliff-hanger thrills – but it was.

Not until five in the morning on the last day, after an all-night negotiating session, did delegates in Madrid finally agree the text of a contract that will govern the movement of samples of plant genetic resources. With that in place, the way is clear for farmers and plant breeders to get access to biodiversity they need to adapt agriculture to meet unforeseen future challenges.

The Treaty is the first international instrument that deals with the needs of agriculture. It covers the incredibly rich diversity hidden within the plants we depend on for food. These are the genetic resources that, for example, enable one variety of rice to grow in five metres of water while another thrives in relative drought. Farmers and breeders use genetic resources to create new varieties that meet current challenges.

Swollen shoot disease of cacao, palm leafhopper, banana bacterial wilt, Asian soybean rust, clover-root weevil, UG99 strain of wheat rust; newly virulent pests and diseases are battering at humanity's food supply. Developed nations can choose to afford plant protection chemicals, if they are available and effective. For poor farmers in developing countries, genetic resources are one of the few assets they can use to secure their food supply.

Accessing resources

Historically, the world has depended, and continues to depend, on genetic resources from elsewhere. In the 1920s a Russian relative of wheat donated resistance to a fungal disease that threatened the entire US harvest. A new virulent strain of that disease recently emerged and the solution will also almost certainly be found in varieties from somewhere else.

In recent years the flow of material among breeders and farmers has dwindled considerably. The Treaty loosens the regulatory log-jam by establishing a multi-lateral system for access and benefit-sharing. A single variety may have hundreds of ancestors from scores of countries in its pedigree. Rather than having to sign scores of bilateral agreements,

Breeding rice sprouts: genes crucial to agriculture

contracting parties sign up to the Treaty. That gives them facilitated access to the plant genetic resources held by all the other contracting parties.

Possibly the most important of these plant genetic resources are held in the genebanks of the Centres of the Consultative Group on International Agricultural Research. There are more than 650,000 samples with a preponderance of the farmers' varieties and wild relatives that are such a rich source of sought-after traits. The Standard Material Transfer Agreement (SMTA), agreed early that Friday morning, sets the terms and conditions for the use of these and other materials under the Treaty.

Most notably, the SMTA establishes that any variety that uses any material derived from the multilateral system is, by definition, a 'product'. If that product is commercialized, a payment of 1.1 per cent of net sales goes into the Treaty's fund, to support conservation and research in developing countries. The payment is compulsory if the new variety is not available for further use in research and breeding and voluntary if it is available.

Enforcement

An important and innovative aspect of the Treaty is the recognition of a third-party beneficiary with an interest in the enforcement of the SMTA. The SMTA is an agreement between provider and recipient of the material, not among the contracting parties of the Treaty, but the monetary benefits flow to an international fund. FAO (the Food and Agriculture Organization of the United Nations), acting as the third-party beneficiary, has the right to bring legal action on behalf of the Treaty parties in cases of suspected infringement.

Infringement will itself be easier to police, thanks to the simple definition of a product and to the plans for an integrated information system that will not only accumulate and share information about the resources – one of the non-monetary benefits envisaged by the Treaty – but will also make it easier to track which samples were distributed to whom.

Cause for hope

The meeting was a huge success. Negotiators were willing to compromise on the level of payments, for example, and each side moved to meet the other. The seed industry, which some sceptics were saying before the meeting would scupper any chance of agreement, proved very constructive. So there is cause to be hopeful, and we need it.

With the International Treaty now in place, plant genetic resources will once again be able to play a central role in improving agriculture and securing our food supply for the future.

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Controlling infectious diseases

Martin Ince forecasts benefits for Africa

Infectious diseases are humanity's oldest and most durable enemy. Some have been on the scene for hundreds of years.

Influenza killed millions during the 20th century and is still emerging in new varieties, as the arrival of Avian Influenza shows. Other infections, such as HIV, have appeared recently as human diseases after existing for many years in other species.

Yet other infectious diseases threaten not human life but human livelihoods. By attacking crops and animals, they can cause famine and poverty. Phythophthora infestans, the virus responsible for the Irish Potato Famine in the 1850s, still causes millions of pounds' worth of damage to potato crops around the world each year. There are estimates that infectious disease destroys 10-15 per cent of world crop production.

Africa needs better control of infectious diseases *© EC/ECHO/François Goermans*

Foresight findgings

A new analysis of the problem shows that we could make a better job of managing risks from new and existing infectious diseases with future detection, identification, and monitoring (DIM) systems – provided these are linked to effective control measures. The study has been carried out by the Office of Science and Innovation's (OSI) Foresight directorate.

That is good news for us all, particularly in Africa, a focus of the project, where infectious diseases continue to be a major barrier to achieving the Millennium Development Goals.[1]

Effects of technology

Foresight's international *Detection and Identification of Infectious Diseases* (DIID) project drew on the knowledge of over 400 scientists and experts, from over 30 countries. They agreed that although advancing technology has much to offer, it could also exacerbate the problem of infectious disease. For example, people can now cross the world in 24 hours, less than the incubation period of many diseases. So they can arrive in a new country with an infection whose symptoms have not yet appeared.

Modern travel and tourism have been especially important in the spread of HIV/Aids. In addition, the growth in international trade and travel allows disease-bearing organisms, ranging from infected plants to malarial mosquitoes, to travel in bigger numbers than before.

Some infectious diseases of humans, such as smallpox, have been conquered by vaccination and other means. Among the animal diseases, the impact of rinderpest, once a scourge of cattle in east Africa, has been much reduced although it is yet to be eradicated because of the large reservoir of the infection in wild animals.

The control of future infectious diseases will be affected by economic and social change such as the urbanisation of the developing world. Our increased ability to model complex systems means that it is getting more feasible to anticipate the effects of such change.

The project also found that new technology has much to offer in the struggle against infectious disease.

Detection, identification, monitoring

We can now describe the genome of a new infection in a few days. Equipment under development may make it possible to detect an outbreak of infection more rapidly than before. The 2001 outbreak of Foot and Mouth Disease in UK cattle cost £2.3 billion, so there are financial as well as human reasons to speed such innovation.

Such developments might make it simpler to identify infection at key points such as in hospitals, ports and airports. However, they might be even more valuable in the developing world. Africa has the biggest load of infectious disease and the least well-developed systems for coping with it.

Detection systems that were designed to cope with African conditions, for example by not requiring power or refrigeration, could allow diseases to be controlled but could also have commercial benefits. Their use might reassure trade partners that they were buying products which did not pose a threat of infection.

Another key technology is satellite-based monitoring of weather, plant health and other conditions on the ground. This could allow vulnerable areas for plant and animal infection to be spotted more quickly so that vaccination programmes and other measures can get going more rapidly. All experience shows that speedier response is key to cutting the impact of an outbreak of infection.

The lesson of the project is that on a 10 – 25 year view, the potential benefits of DIM systems will only be accrued if the new systems are linked to effective control measures, and we become more joined up across plants, animals and humans, at national and international levels.

Reference

1 See www.un.org/millenniumgoals

The DIID project's reports are all available at www.foresight.gov.uk and paper copies can be ordered online from the site.

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Communicating science through theatre

Mark Dyball and Angela Sharpe test the power of performance

Three disparate people find themselves stranded on a deserted platform of an underground station.

Vijay is caught in an eternal moment of remembering a crime he'd sooner forget. Maya is slowly descending into a world of chaos, her memory crumbling away, piece by jigsaw piece. Dino's fractured psyche is soothed only by the drugs he takes and thoughts of escape. They are ministered to by Silas, the lone kiosk attendant, self-styled healer and purveyor of Kit Kats and crisps. Together on platform 2B these four minds are compelled to confront the devastating nature of Alzheimer's disease, the agony that is post traumatic stress and just what it is that could drive someone to kill at random...

Mind the Gap, developed and produced by Y Touring Theatre Company, explores the implications of memory and brain research. It challenges conventional ways of science learning; its aim is to present the shades of grey in the argument and leave the audience (usually school students) wanting to find out more. The centrepiece is the performance, which consists of a play and subsequent debate.

'We always believed that strong drama could not only affect people emotionally but help them to understand new ideas and think about complex issues,' said Nigel Townsend, Artistic Director of Y-Touring. A key objective for Y-Touring was to 'stimulate and inform debate about the ethics of brain research' amongst the students.

An anguished moment from Mind the Gap *Y Touring*

People Science & Policy Ltd evaluated the project using pre- and post-performance questionnaires for students.

'Ethical committee'

The students role-played being members of an ethical committee which had to consider a series of questions and come to a decision.

They were supported by the characters from the play who had personal experience of the issues in question. The facilitator would pose each question and ask for an immediate vote, discuss the question in some depth and then take a further vote.

The questions that were posed to the 'ethical committee' included:

- If there was a pill that improved memory, who should be allowed to take it?
- If we had a pill that could target and make us forget specific memories, who should be allowed to take it?
- If there was a drug that could cure addiction, who should take it?
- If there was a brain scan that could show doctors if young people have a disorder that made them predisposed to commit acts of violence, who should be scanned?

Stimulating and informing

Nigel is adamant that the performance must work as a dramatic event: 'If it is not good theatre that grips the audience...all we have is a school hall full of bored teenagers.'

As a piece of drama, *Mind the Gap* was highly successful in engaging and enthusing both students and teachers alike. The great majority of students (86 per cent) said that they enjoyed the play. Similarly, over two thirds (69 per cent) said they had enjoyed the debate. Over half of the students (55 per cent) agreed with the statement, *I felt included in the debate*, and only 16 per cent actively disagreed.

As to informing debate, the students' responses to the post-performance questionnaire showed that they better understood Alzheimer's disease, and whether they might develop a brain disorder, after the performance than before it. Over 70 per cent of the students agreed that *The play taught me things that I would not normally learn in class.*

Lasting influence

Y-Touring's aim is 'to highlight important, often difficult, current issues and empower its audiences of young people and adults to generate change in themselves, others and society.' Informing and stimulating debate is a part of this, but does the influence of a performance like *Mind the Gap* persist? This is the next question for Nigel Townsend. 'Now we know what we always believed, that we make a difference, we really want to know whether that difference lives on in the minds of the students. Finding that out is our next goal,' he said.

Mind the Gap is the fourth in a series of 'Creating the Debate' projects. They have been funded by the Wellcome Trust.

Details of *Mind the Gap* and other Y-Touring activities can be found at www.ytouring.org.uk

The People Science and Policy report can be downloaded from www.peoplescienceandpolicy.com

Another Y-Touring play, *Every Breath*, is currently touring the UK. It explores the social, moral, scientific and political questions raised by the use of animals in medical research. There will be two performances at the BA Festival of Science on 8 September, at 9.30am and 2.30pm.

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Dissecting tsunamis

Jon Copley eyes the sea floor

'Nothing in the world is softer and weaker than water' wrote the Chinese sage Lao Tze in the 6th century BC, 'yet nothing is better at attacking the hard and the strong.'

Tsunamis are the most destructive manifestation of this power. Although they are often no taller than normal wind-driven waves – the Hollywood image of a skyscraper-sized wall of water is misleading – tsunamis are devastating because the water continues to surge relentlessly when it hits the shore, rather than receding.

The Indian Ocean tsunami on 26 December 2004 was one of the worst disasters in modern history, leaving more than 229,000 dead in its wake. Although scientists cannot predict exactly when the earthquakes that trigger tsunamis will occur, science should be able to predict the impact of such events and help authorities to plan for them. But this science is still in its infancy.

The Boxing Day tsunami was three times larger than predicted from the size of the earthquake alone. So as aid agencies swung into action to help survivors, scientists also mobilised to investigate the earthquake zone off the coast of Sumatra where the tsunami originated. And thanks to some unconventional sources of support, we were able to respond more rapidly than the usual processes of grant application and peer-review allow.

Earthquake on the ocean floor

Tsunamis are the product of events beneath the ocean floor, where the movement of plates of the Earth's crust translates into movements of the seabed, which in turn disturb the ocean surface. Seismologists can estimate the size of earthquakes from instruments around the globe and the Indian Ocean earthquake measured more than magnitude 9.0, making it one of the largest ever recorded. But the subsequent chain of events that generates a tsunami can be complex.

The ocean floor either side of the fault where the earthquake occurs can lift up or drop down by several metres. An earthquake can also trigger underwater landslides, for example, which disturb the ocean surface and contribute to the wave. So the key to understanding the birth of a tsunami is to understand how the earthquake has changed the ocean floor.

Investigations

One of the first scientific efforts on the scene of the Boxing Day earthquake was the Royal Navy's survey ship HMS *Scott*, which was made available to scientists at short notice in response to the disaster. HMS *Scott* is equipped with a sonar system that can map the seabed in great detail. My colleagues Tim Henstock and Lisa McNeill of the National Oceanography Centre, Southampton, used HMS *Scott*'s sonar to identify seabed features such as underwater landslides that could have been formed during the earthquake.

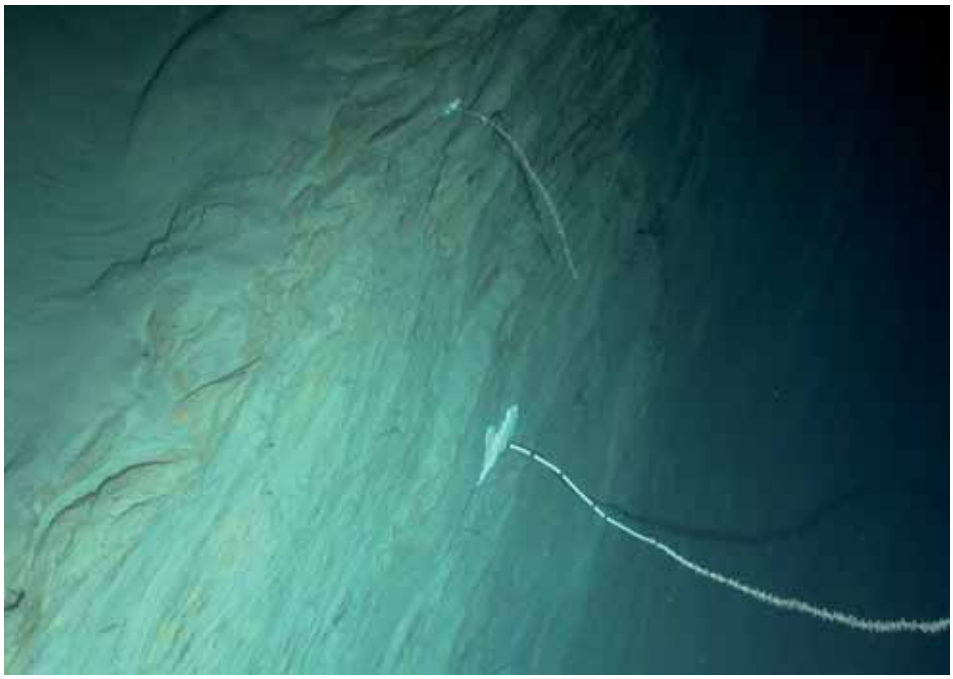
But sonar can only tell you so much. To really understand what happened, you have to inspect the seabed close-up. So five months after the earthquake, I joined a team of geologists, geophysicists, wave modellers and biologists from the UK, US, Canada, France and India for another expedition to the same area. We used a remotely-operated vehicle from a commercial survey ship to dive to the ocean floor and examine some of the features identified by HMS *Scott*.

Perhaps surprisingly, this is where biologists like me could contribute to the investigation. Possible recent underwater landslides identified by HMS *Scott* turned out to be home to deep-sea creatures such as bamboo corals that were much too old to have grown since the earthquake. But at one site, nicknamed 'the ditch', there were no obvious signs of life, consistent with recent disturbance of the seafloor during an earthquake.

Our goal is to obtain a better understanding of how earthquakes generate tsunamis. This should help local authorities produce effective emergency plans for the next tsunami whenever and wherever it arrives. And with 60 per cent of the world's population living on or near a coast, it is 'when' and not 'if'.

Funding footnote

Piecing together the events that generated the tsunami has a forensic feel and a colleague nicknamed our efforts *CSI: Deep Sea* in reference to TV's popular *Crime Scene Investigation* series. Our expedition was actually funded by the BBC and Discovery Channel to make a documentary. We could not have got out there so quickly if the TV companies had not made it happen, as the carefully considered peer-review of research proposals usually takes months and itineraries for research ships are often fixed years in advance. Thankfully science often offers a compelling narrative to match that of a detective story – and perhaps we should trade more on this asset for support.



Bamboo coral grows from the side of an underwater cliff, proving that the cliff was not formed by seabed movement during the Boxing Day earthquake *SEATOS Scientific Party*

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The causes of childhood leukaemia

Ken Okona-Mensah asks whether staying indoors could contribute

The UK and other industrialised countries may be witnessing an increased incidence of the most common form of childhood cancer – leukaemia.

Around 400–450 new cases of leukaemia occur in UK children each year; the most common type being Acute Lymphocytic Leukaemia (ALL).

Despite huge medical advances, leukaemia remains a devastating childhood cancer, with cure rates varying from 10 to 90 per cent. The biggest obstacle in research is identifying the causative factors. As it is a biologically diverse disease, there are many factors which may be responsible, which further complicates research. To help raise money for further research, a national campaign called 'Leukaemia Research Awareness Week' will take place during the last week of September.

Environmental factors

Currently one out of every 2000 children living in the UK will develop ALL. The risk, which is higher in industrialised, developed countries, suggests that environmental exposures may play a role.

Many investigators have attempted to link environmental risk factors with the development of ALL, but the evidence has not been strong for any one particular factor. Aside from certain genetic diseases, the strongest evidence points to urban-rural population-mixing, and a delay in exposure to common infections during infancy in susceptible children (who are possibly exposed to DNA-damaging environmental agents before birth).

UK review

In 2004, the UK Department of Health's independent expert scientific advisory committee, the Committee on Carcinogenicity (COC) examined the available scientific literature to determine whether exposure to chemicals in the environment could be associated with the development of childhood leukaemia.

Several scientific studies in the past have suggested that exposure to pesticides, cigarette smoke, and parental exposure to occupational solvents may play a role. However, the COC considered that there was no strong evidence from these studies that chemicals were involved in childhood leukaemia. It did decide, though, to carry out a detailed review of recent reports that residence near to busy roads, petrol stations and garages can lead to high levels of exposure to traffic exhaust and petrol fumes, and that these might play a role.

Traffic exhaust and petrol fumes contain chemicals known or suspected to cause cancer. Benzene is well known to cause leukaemia in adults exposed to high air levels at work. For children, exposure to petrol fumes and traffic exhaust occurs mainly from travelling in cars, during visits to petrol service stations and also from staying indoors (in high traffic areas with large numbers of parked cars and indoor garages).

Exposure indoors

The COC found that there was no basis on which to conclude that living close to petrol stations, garages and road traffic leads to an increased risk of a child developing leukaemia but suggested that children's exposure to sources of petrol vapour and benzene inside the home warranted further investigation.[1]

Research shows that levels of benzene indoors can be considerably higher than that outdoors, particularly in homes with an attached garage. Around 22 per cent of UK houses have an attached (integral) garage, usually sharing a common wall or interconnecting door to the living area with the vehicle owner's home. A room located directly above the garage can have benzene air levels 2.5 times the ambient air standard. However, other sources such as building and furnishing materials, environmental tobacco-smoke, particle-board furniture, floor adhesives, paints and wood panelling contribute to air levels of benzene inside the home.

A recent study estimated that children staying in their homes absorb the highest levels of petrol vapour, due to the amount of time they spend indoors. The study also found that (on a body-weight basis) children absorb more than six times the amount of benzene indoors compared to adults.

The European Union has reduced the maximum level of benzene permitted in petrol from five to one per cent. Current UK air quality legislation sets an ambient air objective for benzene (by the end of 2010) of 5 $\mu g/m^3$ in England and Wales, and 3.25 $\mu g/m^3$ in Scotland and Northern Ireland.

Raising awareness of leukaemia
Leukaemia Research Fund

Understanding causes

Leukaemia Research, the national research charity responsible for co-ordinating the Leukaemia Research Awareness Week, is devoted to funding research almost exclusively into leukaemia and other related diseases of the blood.[2]

Analysis of cancer research activity in 2002 by the National Cancer Research Institute showed that only 16 per cent of funding goes towards efforts to understand the causes of most cancers (compared to 41 per cent allocated toward understanding the biology of cancer). An understanding of the causes of childhood leukaemia would help the development of prevention strategies and ultimately help reduce the risk of leukaemia in children.

References

1. See http://www.advisorybodies.doh.gov.uk/coc/childleukaemia.htm
2. See www.lrf.org.uk

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This article represents the view of the author only and is not intended to represent the views of the Department of Health or Imperial College.

Alternative medicine

Lionel Milgrom considers ridicule and integration

The Whole Story: Alternative Medicine on Trial? by Toby Murcott(Macmillan, hardback 2005, paperback 2006)

It seems hardly a day goes by without a gaggle of emeritus professors haranguing some poor newspaper editor about the alleged waste of NHS resources on 'useless' complementary and alternative medical (CAM) therapies.

Columnists (some scientifically literate) ridicule 'wacky' CAM therapies, those who practise and those who partake of them. 'Where's the evidence CAMs actually work?' they smirk. And herein lies the difficulty: for CAMs, such as acupuncture, osteopathy and homeopathy, are notoriously difficult to research using conventional science's tried and tested methods. So how does one find out if CAM therapies actually work or not?

This, in essence, is the subject of Toby Murcott's brilliantly researched and bravely written little book. A biochemist by training and science writer by occupation, Murcott journeys into the rapidly expanding world of CAM research in *The Whole Story*. And what a seething cauldron of believers, sceptics and truth-seekers it turns out to be. Those of a more fundamentalist persuasion might well feel alarmed at how science's current monopoly on what constitutes evidence is being seriously challenged by the CAM research community.

Increasingly popular

Murcott rightly proclaims the successes of modern medicine. By eradicating the traditional big killers, for example infectious diseases and wound sepsis, it has delivered better health and longer life-spans in the developed world.

However, he points out, this apparent progress has to be viewed against a backdrop of rising chronic lifestyle complaints. These include cancer, heart disease, diabetes, and Alzheimer's, while not forgetting the huge increase in immune-system problems, such as asthma and rheumatoid arthritis, that doctors are increasingly unable to cope with. Consequently, many people world wide are turning to CAMs for succour for their ills.

The figures are quite staggering. Roughly half the populations of the UK, US and Australia have availed themselves of CAM therapies. Even more interesting is the number of conventional doctors all over the world who are prepared to work alongside CAM practitioners or use CAM themselves as an adjunct to their ordinary medical practice.

The evidence, albeit anecdotal, seems to be that CAMs work. The problem is only a small number of these therapies have been tested scientifically, leading some to vituperate against what they see as a gullible public being conned by 'hocus pocus'.

Methods and results

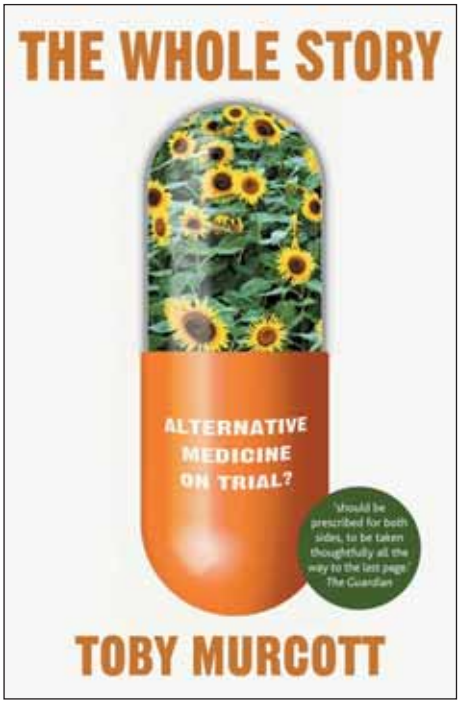
But hold on, Murcott warns. This isn't the whole story. For one thing, most doctors and CAM practitioners are more concerned with trying to make their patients better than understanding how a particular therapy might work. There are many serious-minded practitioners researching CAMs and different ways of acquiring evidence that do not necessarily chime with the demands of orthodox medicine's clinical trials methodology. So, what happens when the daily experience of practitioners' own eyes, in terms of satisfied, relieved clients, clashes with the results of clinical trials telling them their CAM therapy doesn't work?

And then there is the placebo effect.

Placebo and evidence

Clinical trials, Murcott points out, use placebo as a mark of failure. So if a CAM modality works no better than a sugar pill, it is deemed ineffective. But the placebo effect has always been part of every doctor's kitbag, and is even enshrined in the Hippocratic Oath. Also, many CAM practitioners say their therapies work by encouraging the body to heal itself (in other words, a placebo effect), and suggest a far more humane appreciation than the rather pejorative meaning usually attached to this phrase. Ranged against this pragmatism, however, are the growing demands of evidence-based medicine (EBM).

In essence, EBM emphasises a particular kind of evidence: that gathered from clinical trials and sifted through systematic reviews, over the hard-won skill and experience gathered during practitioners' lifetimes. Hailed as a 'paradigm shift', staunch supporters of EBM are even calling for the 'ex-communication' of those who do not follow its precepts, even though many of the drugs and procedures currently used in orthodox medicine have yet to be clinically confirmed by EBM.



'Brilliantly researched and bravely written' ***Macmillan***

Humility all round

Dispassionately reviewing all the evidence, Murcott asks some penetrating questions. Could it be that CAMs are actually pointing the way towards more successful ways of treating chronic conditions? And if so, could it be that what a chronically ailing public really needs is properly integrated health care, not persistent and damaging trench warfare between the proponents of CAM and EBM?

Quoting from one of the UK's most respected and senior medical researchers, Professor Sir Iain Chalmers, Murcott finally concludes, 'The most important resource required to promote the concept of integrated healthcare is likely to be humility among those whose practices will be put to the test, within both orthodox and complementary medicine.'

For all our sakes, may peace break out soon.

Dr Lionel Milgrom
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Public good or private gain?

Denis Murphy is worried about plant science research

Dear Editor,
There has often been an uneasy relationship between taxpayer-funded research for public-good applications versus its development for profit in the private sector.

The upsetting of this balance in the UK may be at the core of many of our current concerns, from GM crops to the funding mechanisms of scientific research in general.

Plant science research and its application for crop improvement illustrate my point (see 'Cuddling, calculating and commercialising the biosciences', Monica Winstanley, *SPA* March 2006, p 16). It can be argued that, in these areas, the UK is respectively a world leader and a global casualty.

Public funding

Over the past century, the UK and USA were important global powerhouses of plant science research and its application for crop improvement.

This paradigm of publicly-funded plant science research designed to be exploited both as a public good and, in some circumstances (such as the US hybrid maize) for private profit, started to unravel in the 1970s as plant breeders' rights were introduced.

During the 1980s, the UK went further in privatising or closing many of its leading crop-related research centres, culminating in the sale of PBI to Unilever in 1989. Since then, the dwindling band of remaining research institutes have tended to focus more on basic aspects of plant science and, with a few notable exceptions, there is almost no practical plant breeding research in the UK public sector.

One of the consequences has been a loss in our capacity to exploit basic research for long-term use as public goods, especially in developing countries. Instead, new technologies like GM crops have been exclusively captured by the private sector and used for short-term commercial gain, for example to produce herbicide-tolerant crops.

Benefits lost

In the UK, the 1980s privatisation agenda proved to be deeply flawed when applied to plant breeding, where relatively immature markets were unable to assimilate the new developments. Instead of creating a vigorous commercial plant-breeding sector, we now have a situation where virtually all of the companies have abandoned the UK.

Since we have also destroyed our public-sector breeding capacity, the UK is now in the strange situation of being a world-class producer of basic plant research that has lost the wherewithal to apply the benefits of such knowledge for crop improvement.

The remaining UK plant research centres tend to focus on model plants like Arabidopsis, rather than crops, and on short-term (1-3 year) government contracts. Such contracts often address current public concerns, such as GM crop segregation, rather than more considered longer-term projects aimed at topics like crop improvement for the growing amount of saline or arid soils where public-good research could really make a difference.

Reasons for concern

Does any of this matter? I think it does.

Firstly, UK taxpayers might question why they are funding basic research in plant science while the country has lost its capacity to exploit its future benefits.

GM brassicas: the UK's basic plant research doesn't translate into crop improvement *Denis Murphy*

Secondly, we will still have to feed ourselves in the coming uncertain decades of possible climate change, but we have largely lost our ability to breed new crops for this purpose.

Thirdly, the public sector needs to 'recapture' technologies like genetic engineering for use in public-good programmes that are of little interest to commercial companies. Such initiatives are now under way in the US and Australia, but not so far in the UK.

As with previous crop improvement technologies, the key to the future success of GM might lie in its application as a public good rather than exclusively for private profit.

Denis J Murphy
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Not science

SPA undermines the BA's mission, complains Richard Weber

Dear Editor,
Sir William Stewart, Chairman of the Government's Health Protection Agency, is quoted as urging caution about 'undiscovered effects of mobile phones' on children ('Mobile phones and children', Phil Willis, *SPA* June 2006, p22).

Fear of 'unknown unknowns' is not science. While it may serve some vested interests, generating and using fear as the means to guide development of public policy is not good government.

Much of the public concern about nuclear power, GM crops, and some medical practices is fueled by fear and rumors about unknowable risks. For *SPA* to tacitly endorse the idea of using emotive speculation rather than evidence-based methods as a basis for guiding public policy seems to undermine a central part of the BA's mission.

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We state very clearly on page 2 of SPA that 'the views expressed in this publication do not necessarily reflect those of the editorial committee or the BA.' – Ed

Opposing animal extremists

David Priestman has had enough

When animal rights extremists started using violence and intimidation in the early 1980s, scientists became more and more shy about speaking openly about their work. This grew into a 'climate of fear' which still exists to such an extent that most people involved in medical research are so intimidated and in fear of personal assault that they dare not speak out. This includes NHS doctors and nurses who see the benefits of medical research developed using animals each and every day.

Although I've always been happy to explain to people I meet about research I've been involved in here in Oxford (diabetes, obesity, genetic diseases in children and epilepsy), the reality of intimidation by the animal activists didn't hit until the new animal lab started being built. SPEAK (formerly 'Stop Primate Experiments at Cambridge', now 'a voice for the animals') then began regular demonstrations very close to the labs in the science area where I work. After a while, threats of violence and intimidation resulted in the building contractors pulling out, delaying work for over a year.

It's ironic that anti-vivisectionist extremists managed to delay the completion of a building specifically designed to provide the best possible conditions for the animals and also for the research which will take place there. Ideas of the new labs being a 'monkey death camp' are an illogical and morbid fantasy propagated by the likes of SPEAK who promoted a similar campaign leading to the cancellation of a laboratory project in Cambridge. The reality is that the new labs in Oxford are being built to replace antiquated labs in several departments in the science area. They are for ongoing research, more than 95 per cent of which uses rodents amphibians or fish.

Insulting proclamation

Because scientists have been cowed into not talking about their work publicly, the anti-vivisectionist minority, including organisations such as the British Union for the Abolition of Vivisection (BUAV), Europeans for Medical Progress (EMP) and SPEAK have had free rein to spread lies, rumour and junk science which simply don't hold up to scrutiny.

One of the things that insults me most is their proclamation that animal research is somehow 'unscientific', yet they are not scientists themselves. Unfortunately, much of what they say is believed by a gullible minority and that is why it is time for scientists to talk openly and publicly ourselves. Our work is not an embarrassing secret, and the time is long overdue for all of us to be proud of what we do and not be afraid to be frank and explain the absolute need to use animals in medical research.

Pro-Test: standing up for science ***Andrew Singer photography***

Although scientists and doctors regularly present their work at meetings and conferences and publish their findings in learned journals, they don't often have to communicate directly with the lay public. Without animal research, medical treatments which we take for granted would not exist. This needs to be emphasised and it's time for us to speak out more effectively about our work to the general public. They have a right to know and we have a duty to tell them.

Pro-Test

I was astonished and somewhat embarrassed that it took a bold, sixteen year-old student, Laurie Pycroft, to stand up to the protestors in January this year. Together with a group of Oxford students, Laurie founded Pro-Test, a movement formed explicitly to support the completion of the new lab, to dispel the 'climate of fear' and to promote the use of animals in medical research in rational debate.

Soon afterwards, Pro-Test held a march in Oxford which drew a crowd of over one thousand people, many of them University students who had been told by animal extremists that they were 'legitimate targets' for action. When I heard about Pro-Test and the march, I was delighted that, at last, people were beginning to refuse to feel threatened and declare their support for medical progress. Having been asked to join the committee, I was able to help in the organisation of a second march early in June which included speeches from politicians, scientists and writers. The march drew fewer students than in January, but was attended by many more academics who were prepared to stand up to the extremists.

In summary, I'm amazed that a small group of 'animal rights' people have been able to dictate to the majority for so long. I'm tired of their lies. I've never been intimidated and refuse to be so. I really hope that my putting my own name and photo in the public domain (on the Pro-Test website) will encourage more scientists here in Oxford and elsewhere to be proud of what they do and to discuss their work without fear.

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Scientific advice in government

Tracey Brown asks what constitutes evidence

The Commons Science and Technology Select Committee will publish its report, *Scientific advice, risk and evidence: how government handles them*, in November.

Never mind how the government uses evidence, let's wind back a stage and ask, exactly what is scientific evidence in the policy world? Because, in practice, we seem to be confronted by a wide range of interpretations of that authority-bestowing word.

MRI case study

In July, the Science and Technology Select Committee released the first case study in its forthcoming report on scientific advice. It looked at how we have nearly reached the point of introducing EC occupational health rules on exposure to magnetic resonance imaging, without evidence to support them. Such data as does exist has been described by every scientific body as outdated. The protestations of the scientists and clinicians were just brushed off.

This report is among the most critical ever produced by the Committee, taking in the failings of Commission officials, advisory boards and the UK's Health and Safety Executive, all of whom seemed to say different things about the evidence.

Other issues

Aside from MRI restrictions, the Select Committee has looked at drugs policy and identity cards. It might equally have considered regulation of transport safety, guidelines on sun exposure, the Human Tissue Bill or banning full fat milk in schools. The treatment of evidence varies from policy initiative to regulation, from department to agency.

The Food Standards Agency, set up amid calls for independent scientific evidence, is now citing a consumer survey as 'evidence' in a row about the health benefits of sticking coloured 'traffic light' labels on foods. The Highways Agency will doubtless be pleased to learn that people find traffic lights 'a simple system'. Whether sticking them on food will reflect nutritional needs or change behaviour... well, scientists are interested but the agency doesn't appear to want this kind of evidence.

Is it peer-reviewed? Is it a chap reporting earth-shattering results from experiments conducted alone, in his garage, ten years ago and still not published?

Despite the Office for Science and Innovation's introduction of departmental chief scientists, the problems are wide-ranging and defy easy translation into rules that Sir Humphrey can police. But the Select Committee's report might prompt a start. Here are some suggestions:

Rules of engagement

Rule One: the status of scientific evidence is as important as its conclusions. This does not mean the unusual or untested is ignored – as the experience of badgers and bovine TB shows, sometimes you have to look beyond what exists and seek new evidence. But regard for status does mean that you should know what you are looking at. Is it peer reviewed and published in a journal recognised in the field? Have findings been cited? Repeated? How stable is the science? What do citations say? Is it a big study? A case report? Is it a chap reporting earth-shattering results from experiments conducted alone, in his garage, ten years ago and still not published? I might be sending it up there, but leaf through the referenced submissions of recent enquiries and you'll see why more of these questions would be worthwhile.

Rule Two: there are no rules except Rule One. That is, there is no box to tick, no one-size-fits-all 'good evidence' form to fill. It's a question of judgement and, ultimately, responsibility. This is difficult for government and it is what will make it so hard to respond effectively to the Select Committee report. Few are anxious to be in that accountable seat. Too frequently we have policy initiatives dressed as evidence, so responsibility lies everywhere and nowhere.

Evidence to fit policy

Government is also not going to be able to respond to the report's conclusions while evidence is treated as that thing you find to fit the policy, sometimes when the policy announcement is emerging from the printer. The now Lord Waldegrave, whose BSE experience informed the first Chief Scientist's guidelines, warned against the pressure for quick answers. But a pragmatic approach to the facts is being encouraged by a speed of policy development that precludes appreciation of evidence.

Science, by contrast, makes a pretty good job of dispassionate review, through critical exposure to peers, self-questioning and a humility before evidence that doesn't suit the policy world. Nor should it, but that doesn't remove the need to know which questions to answer scientifically, when officials would do well to mimic the critical scrutiny of science.

Scrutiny

As a matter of accountable judgement, we can't have a standards committee for evidence; we can only examine the way that questions are pursued in particular cases.

The Select Committee has promised to revisit some of its cases next year, to review progress. Perhaps this kind of challenging scrutiny of judgement is the best way forward where rules won't do.

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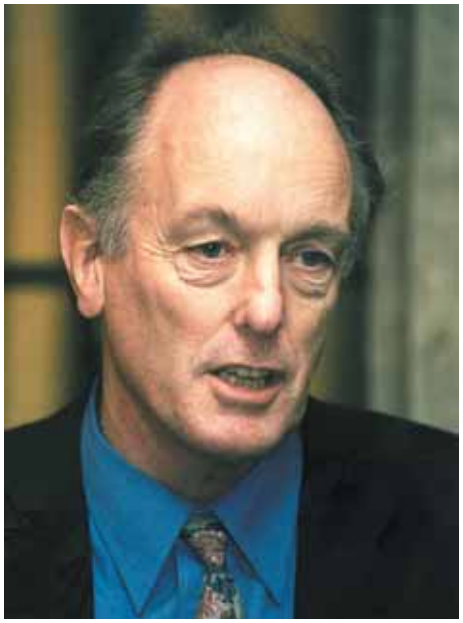
A new science think-tank

Ian Gibson takes a bite of the future



I am looking at a diagram produced on innovation spend in the UK which is rumoured to have emerged from the Treasury. It is awesome.

Government departments, universities, charities, EU frameworks, development agencies and so on make up an amazing bureaucracy. It can only confuse and baffle.

Since science and technology underpin such large sectors, how do our young people undertaking creative research see their future? And how can they believe their interests will see the light of day in the world of innovation – so beloved of Ministers, advisors and government? (The word 'innovation' appears frequently in Parliament, in debates, statements and the media. Like 'science and technology' it emerges as a showstopper when the going gets tough.) The world of the diagram is very fragmented, and arrows between the sections cover up the weaknesses.

Enthusing the disenchanted

In the last few weeks I have met many young scientists: some in forensic science, others still working in the university system, and bioentrepreneurs who take science and form it into products, with the support of the DTI and the Foreign Office. Somehow, they have come through the weak primary and secondary science curriculum. But we know many are left behind, bored, confused and unimpressed by the 'career' prospects and the lack of societal value for scientists, engineers and technologists. So how do we change it?

Although I have views about science education from primary school to research degree, as well as on research and its organisation, scientific communication and the need for a total overhaul of UK's future science, I am starting with the launch of a science think-tank.

Newton's Apple

A steering committee has evolved the name 'Newton's Apple'. We have trustees and support is coming in. It includes a cross section of scientists and age groups and at the launch on 16 October at the Science Media Centre we will outline our first investigation into cancer services and other enterprises.

We will also launch a publication with ten articles from prominent scientists covering various subject areas and their futures. I hope that the think-tank will look down the line of what is happening in science, engineering and technology, what might happen and how the political process should handle it, both in the UK and globally.

With media support and research, we hope to make a difference and take science on into the political world where evidence should be central. The air of a bottom-up approach with full participation in debate, not listening to boring lectures, will, I believe, lead to a novel approach to the development of the science culture and hopefully break down the huge gulf between scientists and politicians.

Politicians in general understand the value of science and technology, but it is rare for them to recognise its pervasive influence on decisions in many less obvious spheres than radioactive waste research and consequent disposal. In fact, there can be an anti-science culture, which may prevent a simple political solution.

Participation and action

The role of the think-tanks in policy determination has grown since New Labour with various backers including political parties. I want Newton's Apple to be independent of party influence and to be attractive to our young scientists whose ideas can light the beacon for a new role for science and technology in policy determination. For far too long it's been determined by a few individuals whose influence far outweighs their knowledge of what science is about and how it is practised.

Newton's Apple can start a new dialogue between professionals, the public(s) and politicians. The book and the launch in October are a new beginning.

Scientists need to learn how politics works and take a less arrogant 'we know best' approach, come out of the comfort of their laboratories and engage a world beyond their area of understanding. The scientific crowd I talk to are yearning for participation and action. Let's go!

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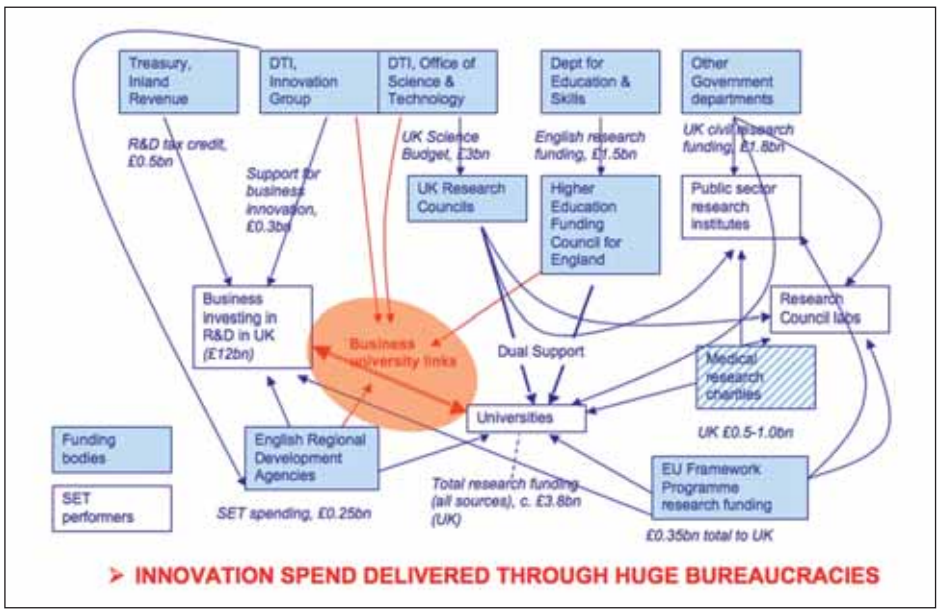

The innovation jungle

Science in Society events

at the BA Festival of Science 2006, Norwich

Working Lunches

Gathering Market Intelligence *Monday 4 September 12.00 – 14.30*

Science communication organisations have an invaluable and central role to play in social inclusion as well as promoting public participation in decisions concerning science and its impact on society.

A lack of market intelligence is often cited by science communicators as a reason why BME (black and minority ethnic) communities are hard to reach. The DISC (Delivering Inclusion in Science Communication) project has been working on a Market Intelligence Portfolio about BME communities to address this issue. The Working Lunch will share learning and skills gained from the project.

Representations of Science *Tuesday 5 September 12.00 – 14.30*

The way that science and science-related activities are portrayed in school materials or in science museums and centres often highlights the lack of racial diversity within science. There are few quality resources available to teachers and science communicators. How can we develop resources that move beyond a cursory glance at BME scientists and their achievements to make them a part of everyday experiences in science-related contexts and activities? The Working Lunch will explore methods for including BME contributions to science through new and existing resources.

Working Lunches are supported by Sciencewise.

community x-change East Anglia

The community x-change, East Anglia *Wednesday 6 September 12.00 – 14.30*

The BA's community x-change is a series of workshops where citizens meet to discuss issues involving science and share their thoughts, feelings and ideas for possible actions. In the months building up to the Festival we have been working with a panel of East Anglian residents to explore what environmental change means to them. Their thoughts and reports will be shared with stakeholders and policy makers in this session. Come and reflect on their experiences and view video diaries made during their participation in this process.

community x-change

For further details visit

www.the-ba.net/ScienceinSociety

the BA
british association for the advancement of science

the BA
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Whatever your age or background we want you to be involved.

The BA (British Association for the Advancement of Science) is working to help create a positive social climate in which science, and organisations dependent on it, can advance with public consent, involvement and active support.

To realise this objective we continue to run and develop long established cultural initiatives such as the Festival of Science and National Science week, as well as the innovative Science in Society programme, which provides opportunities for scientists and lay audiences to connect face to face.

In order to address as wide an audience as possible, all of the BA's publications are available free of charge to anyone who requests them. These include:

E-communications

- The Science News Digest - a weekly roundup of highlights from the science news as collated by the BA's Press Officer.
- The BA-lert - comes out every month and features just some of the BA's wide ranging and diverse activities connecting science with people.
- What's on elerts - provide monthly details of the BA's local and national events. You can choose to receive information about events the BA runs throughout the UK or about events happening in your area.

The BA's regular mailings

- Science & Public Affairs - the BA's quarterly magazine, bringing you the latest science and society news.
- Our regular newsletter - packed full of news of the BA's activities and events throughout the UK.

For more information about what the BA does and ways to get involved visit www.the-ba.net

To register to receive free communications from the BA visit www.the-ba.net/register phone 0870 241 0664 or email: supporters@the-ba.net