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The Science Select Committees

Defence technology

Paul Stein: Applying science and technology to defence

Alison Wood: Industry and the wider defence partnership

Professor Ron Smith: Military and civil links

Statistical advice

Sir David Omand: Formulating effective policies

Professor Adrian Smith: The impact of statistical advice on policy

Sir Gus O'Donnell: Objective evidence, public perceptions and the issue of trust

Energy technologies

Dr David Clarke: A partnership to deliver the energy technologies of the future

Dr Mark Henstridge: Technological innovation and energy supply

Willy Rickett: The role of innovation in achieving energy security

Assessing risk

Sarah Veale: The struggle between instinct and reason

Judith Hackitt: Have we got the balance right?

Sir Alistair MacDuff: Achieving a balance between safety and convenience

Wellbeing

Professor Tom Kirkwood: Mental capital, skills and wellbeing

Lord Layard: Raising skills to counter inequality in the workplace

John Denham: Skills training in the recession and beyond

Obituary

Sir John Maddox



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Volume 20, Number 1, October 2009

contents



UPDATE

New Science Select Committee; Engaging the wider community; HE carbon reduction targets; Space facility at Harwell 2

THE SCIENCE SELECT COMMITTEES 3

DEFENCE TECHNOLOGY

Applying science and technology to defence
Paul Stein 4

Industry and the wider defence partnership
Alison Wood 6

Military and civil links
Professor Ron Smith 7

STATISTICAL ADVICE

Using statistical advice to formulate effective policies
Sir David Omand 8

The impact of statistical advice on policy
Professor Adrian Smith 9

Objective evidence, public perceptions and the issue of trust
Sir Gus O'Donnell 10

ENERGY TECHNOLOGIES

A partnership to deliver the energy technologies of the future
Dr David Clarke 12

Technological innovation and energy supply
Dr Mark Henstridge 13

The role of innovation in achieving energy security
Willy Rickett 14

ASSESSING RISK

The struggle between instinct and reason
Sarah Veale 16

Have we got the balance right?
Judith Hackitt 17

Achieving a balance between safety and convenience
Sir Alistair MacDuff 18

WELLBEING

Mental capital, skills and wellbeing
Professor Tom Kirkwood 20

Raising skills to counter inequality in the workforce
Lord Layard 21

Skills training in the recession and beyond
John Denham 22

OBITUARY

Sir John Maddox FRS 24

Engaging the wider community

Five new independent Expert Groups are to engage the science community, media, public, business and policy makers in changing cultural attitudes to science.

The Groups will bring key players together, with the aim of breaking down the traditional barriers to collaboration and driving forward action in the five areas that emerged from the consultation *A vision for Science and Society*.

- *Science for All*, headed by Sir Roland Jackson of the British Science Association, will look into how to better demonstrate the relevance of science to everyday life;
- *Science and the Media*, headed by Fiona Fox of the Science Media Centre, will consider how opportunities for partnerships between the media and scientists can be increased;
- *Science and Learning*, headed by Sir Mark Walport of the Wellcome Trust, will consider how the education system can help to ensure the delivery of a scientifically-literate society;
- *Science for Careers*, headed by Diana Garnham of the Science Council, will look at how to increase opportunities to study science in order to make the scientific workforce more diverse and representative of society;
- *Science and Trust*, headed by Aileen Allsop of AstraZeneca and Tony Whitehead of the Government Office for Science (GO-Science), will consider how science and engineering in the UK can continue to be underpinned by social responsibility and ethics.

A vision for Science and Society was a Government consultation published in 2008 by the Department for Innovation, Universities and Skills (DIUS). The consultation demonstrated the need to refresh relationships with science, unlock the talent of the people in this country and encourage closer engagement between the key players. □

<http://interactive.dius.gov.uk/science-and-society>

FST Journal Editor

Professor Sir John Enderby CBE FRS is the new Editor of *FST Journal*. He was Professor of Physics at Bristol University from 1976 to 1996. He was elected a Fellow of the Royal Society in 1985 for his pioneering studies into the structure and properties of liquids and amorphous materials. He served as Vice-President of the Royal Society from 1999-2004, responsible for publishing. Sir John was President of the Institute of Physics in 2004. He has edited a number of prestigious journals including *Proceedings of Royal Society A*. He is Chief Scientist at Institute of Physics Publishing.

New science select committee

The establishment of a new House of Commons Select Committee on Science and Technology has been strongly welcomed by the Chairman of the Innovation, Universities, Science and Skills Committee, Phil Willis MP. The new Committee came into being on 1 October and has the same Chairman as the outgoing IUSS Committee.

Phil Willis said: "On 5 June 2009 the Government abolished DIUS [the Department for Innovation, Universities and Skills] and relegated science to non-league status in a monster department. This move has reignited our efforts to

ensure that science and technology have a select committee of their own, to ensure that they receive the cross-departmental scrutiny that is required to ensure that policy decisions are based on good scientific and engineering advice.

"Now, the House of Commons has agreed to the creation of a new Science and Technology Committee. I cannot stress enough how vital the role of this Committee will be in ensuring that the Government's science policy is held to account and that adequate attention is given to such a crucial policy area." □

HE carbon reduction targets

A joint consultation between HEFCE, Universities UK and GuildHE on developing a carbon reduction target and strategy for higher education in England was published at the end of July. The consultation asks for views on proposed sector-level targets for the reduction of carbon emissions and a proposed strategy for achieving these targets.

It is proposed that the higher education sector:

- commits to reducing direct emissions and those from purchased electricity by 80 per cent by 2050 and by at least 34 per cent by 2020, against a 1990 baseline;
- aspires to reduce these emissions by 50 per cent by 2020 and by 100 per cent by 2050, against 1990 levels;
- commits to reducing other indirect emissions and to improving measurement of them with the intention of setting targets for these emissions in the future.

The strategy aims to focus efforts in areas that offer the greatest potential carbon reduction return, such as: energy use within the estate; transport; water consumption; waste; and procurement. It also aims to identify issues that need further consideration and support.

The consultation sets out areas where HEFCE, Universities UK and GuildHE will work with institutions and other stakeholders to achieve carbon reductions. It will be for individual institutions to decide, within the national set of targets, how to reduce, measure, review and report progress on their own emissions.

Institutions will be required to have carbon management plans and performance against these plans will be a factor in capital allocations from 2011, as requested by the Secretary of State for Innovation, Universities and Skills in HEFCE's 2009 grant letter.

The consultation closed on 16 October. □ www.hefce.ac.uk/pubs/hefce/2009/09_27

Space facility at Harwell

On 22 July, the European Space Agency (ESA) opened its first facility in the UK, following successful negotiations between the Agency, the Department for Business, Innovation and Skills and the British National Space Centre.

The ESA facility at Harwell in Oxfordshire is expected to be a key element of a much wider vision for the future of the UK's space economy which will see the creation of an International Space Innovation Centre (ISIC) at Harwell. At the ISIC, state-of-the-art publicly-funded scientific facilities will operate alongside industrial R&D. ISIC will bring together academia and industry dedicated to innovation in space science, research and technology.

The ESA facility will focus on three key areas:

- combining data and images from space satellites to create new applications for everyday life, such as automatic safety-of-life location services and ways of using space data to improve road and rail transportation;
- climate change modelling that uses space data to help us understand and predict the impact climate change is having on our planet;
- the development of new technologies such as novel power sources and innovative robotics which we can use to explore the Moon and Mars, and help answer many questions about the composition and structure of these celestial bodies. □

The two Parliamentary select committees charged with scrutinising Government policy on science and technology issues have published reports on a number of key issues during the 2008-9 Parliamentary session. We highlight a selection of them.

A scientific critique of Government policy

The House of Commons

The Government has reduced science to a political bargaining chip and must raise its game to produce an ambitious science and engineering strategy for the future, concludes a report from the Innovation, Universities, Science and Skills Committee in July. This report, *Putting Science and Engineering at the Heart of Government Policy*, says that while there are many positives to take from its inquiry into science and engineering policy in Government, such as the growth of the science and engineering community in the civil service, a broad vision is missing.

The failure to find a stable home for the Government Office for Science has reduced science and engineering advice to, at best, a peripheral policy concern and, at worst, a political bargaining chip, the report argues. The Committee has directly appealed to the Prime Minister to bring GO-Science into the Cabinet Office and it urges the creation of a Government Chief Engineer and a Government Chief Scientist.

To improve transparency and safeguard the independence of scientific advice, a press office should be established in GO-Science which would also serve all the Science Advisory Committees.

The independence of scientific advisers is crucial. The criticism by the Home Secretary of Professor David Nutt, Chairman of the Advisory Council for the Misuse of Drugs, after his comments about ecstasy could deter experts from serving on Scientific Advisory Committees. It is vital, says the Select Committee, that in such cases the Government Chief Scientific Adviser steps up and offers public support to safeguard the independence of the advisory system.

The Committee also undertook a detailed investigation into the “financial fiasco” of the Learning and Skills Council’s programme for further education colleges. The Committee’s report, *Spend, spend, spend? – the mismanagement of the Learning and Skills Council’s capital programme in further education colleges*, found that “catastrophic mis-

management by the Learning and Skills Council compounded by Government oversight failures could cost hundreds of millions of pounds”. It concludes that “a heinously complicated management structure at the LSC and approaching Government department changes bred a lack of responsibility and gave an air of distraction.” The Committee’s Chairman, Phil Willis, commented: “It really beggars belief that such an excellent programme which had showed real success in transforming the further education experience for students was mismanaged into virtual extinction.

“It is vital that the new Department for Business, Innovation and Skills (BIS) ensures such a situation is never allowed to happen again.”

A report on *Students and Universities* calls for urgent changes in the higher education sector, in a study examining students’ university experience. The report says the current system for safeguarding standards is out of date, inconsistent and should be replaced. The Quality Assurance Agency should be transformed into an independent Quality and Standards Agency with a specific standards remit.

Support for, and treatment of, part-time and mature students should be improved – the current system amounts to a form of discrimination. The Government’s forthcoming review of fees needs to examine all aspects of support for part-time and mature students, both direct financial support and changes to allow universities the flexibility to attract and retain part-time and mature students.

www.publications.parliament.uk/pa/cm/cmdius.htm

The House of Lords

The House of Lords Science and Technology Committee has published a report on *Genomic Medicine* which argues that recent developments in genomic science, stemming from the sequencing of the human genome, represent a unique opportunity for real advances in medical care. It says that the Government and the NHS must

take a range of steps to ensure that these advances are realised.

The Committee says that the Government should now produce a new White Paper on genomic medicine – pointing out that the last White Paper on this issue was published in 2003 and dealt mainly with the diagnosis and management of rare single-gene disorders. The potential impact of ‘genomic medicine’ has moved on significantly since then and now has implications for patient care across the NHS and for a range of common, genetically complex diseases such as diabetes, heart disease and cancer.

The report recommends that the new White Paper should include details on: how the Department of Health will facilitate the translation of advances in genomic science into clinical practice, including the operational changes needed to bring genetic testing into mainstream clinical practice; a roadmap for how such developments will be incorporated into the NHS; and proposals for a programme of sustained long-term funding to support these measures.

The Committee also published a follow-up report on *Pandemic Influenza*. The follow-up inquiry, which was begun in November 2008 before the emergence of swine flu, has evolved in the course of the inquiry as the new threat of the H1N1 has become apparent.

The Committee has ‘significant concerns’ about the delay in the operation of the National Pandemic Flu Service (NPFS) and has asked the Government to explain this delay. It also seeks assurances that the service will be able to meet anticipated demand and be fully operational by autumn to meet the challenges of the anticipated ‘second wave’ of swine flu.

The report calls on the Government to clarify how it will ensure NHS staff are supported in providing services that may be outside their areas of expertise and if they will be protected from legal action when they provide this treatment. The Committee also wants better guidance on ethical decisions on who could have access to limited flu treatments/vaccines.

www.publications.parliament.uk/pa/ld/ldsctech.htm

Applying science and technology to defence

Paul Stein

Defence research is essential for delivering battle-winning military capability to the UK Armed Forces now and in the future. MOD's research is focussed on areas that make a real difference to the Armed Forces: better equipment, better ways of fighting and better development of our people. It actively encourages more joint work and investment between industry, academia and small- and medium-sized enterprises (SMEs). Two thirds of the approximately £500 million investment in research has been opened up to supply chain competition over the past five years. The remainder is undertaken by Dstl, which remains the MOD's in-house technology centre of excellence for any research that must remain within Government.

The Minister for Defence Equipment and Support, Quentin Davies, launched the Defence Technology Plan (DTP) in February 2009. The DTP is a cost-balanced list of MOD's current Research and Development (R&D) priorities. It aims to encourage fresh and innovative thinking. It is the first time MOD has openly advertised its detailed technology needs as an easily-accessible, online publication in order to engage the whole of the UK science and technology supplier base. This is a significant change as it allows the full potential supplier base to see what MOD needs and thus allows them to plan and align their own work and investment. The DTP is available online at www.science.mod.uk. This dynamic format allows regular updates, ensuring clear – and most importantly current – direction to the research and development community, allowing industry and academia to better direct investment in defence science and technology.

MOD's research programme within the DTP is described by discrete Research and Development Objectives (RDOs), which are high-level statements describing R&D investment associated with particular systems – ships and weapons, for example. These RDOs are broken down into discrete items of planned research activity, which are displayed as roadmaps to indicate how the RDOs should be achieved.



Paul Stein has been the Director General Science and Technology at MOD since 2006. As he nears the end of his appointment, he appraises the enormous changes he has overseen in Defence research in the last few years. The publication of the Defence Technology Plan has fundamentally changed the way MOD approaches research and development. Combined with initiatives such as the Grand Challenge, Capability Visions and the Centre for Defence Enterprise, MOD continues to work hard to harness the huge potential of the highly-innovative UK science and technology base.

The priority order of these objectives is generally indicated through the level of funding MOD plans to apply to this area. Emerging technologies are also included, such as Nanotechnology and Disruptive High Power Technologies.

Capability Visions

The DTP also contains a number of Capability Visions that are intended to promote a longer term perspective and to stimulate new activity in the wider R&D community. They also act as guides so that industry-funded research and suppliers can seek new applications for existing technologies. Across the field of defence science and technology there is a constant need to balance approaches to battle-winning technologies; those which are enhancements of today's capabilities and those which represent potential step-change enhancements for the future. History demonstrates that creating the smartest defence capability comes from a combination of both evolution and revolution.

It should be stressed that Capability Visions are not specifically-endorsed military capability requirements; however, they are means by which MOD wishes to achieve the following:

- To look at new concepts that can challenge existing thinking in capability

requirements and that ideally offer lower cost alternatives. A perfectly acceptable outcome for a Capability Vision may be to maintain a military capability at a much lower cost.

- By taking the technology to a demonstrable form, the transfer of technology can be expedited to the front line.
- By aligning MOD thinking with industry's future product planning, both for home and the export market, it is hoped to attract additional investment into the Capability Visions, although industry funding is not a prerequisite.
- MOD hopes to challenge thinking about the art of the possible and to examine some high-risk, high-payoff approaches.
- MOD wants to explore some challenges that may be faced when fighting the next conflict, not just in winning the current conflict.

One of the five Capability Visions explores a novel future-protected vehicle that offers the protection, mobility and firepower of a Main Battle Tank with the carrying capacity of an Armoured Fighting Vehicle yet within a 30 tonne payload. One key technology to ensure underbody survivability is the use of a hybrid electric drive system and hub motors to permit very large wheel articulation.

Another Capability Vision aims to reduce the load on the dismounted soldier from over 70kg to nearer 25kg by disaggregating the problem into new armour, new weapons, new electronics and power supplies, and possibly 'mule' technology to carry the equipment for the soldier.

A third Capability Vision seeks to find ways of reducing operational dependency on fossil fuels. Fossil fuels are costly, have a high logistical burden and make troops strategically as well as tactically reliant on supply lines. In addition, the burning of coal, gas and oil is seen as the cause of climate change. It is expected that 95 per cent of the technology in this Capability Vision will come from the commercial sector, with MOD looking solely at military-specific aspects.

A fourth Capability Vision looks at a



One of MOD's Capability Visions looks at a novel, unmanned air concept.

novel, unmanned air concept. This combines high agility and high payload for a range of missions not possible with existing unmanned aerial vehicles or manned aircraft. A fifth Capability Vision is designed to help understand the threats to electronic systems and develop special capabilities designed to defeat these threats – so called 'cyber war'.

Engaging with MOD

To publicise how MOD is utilising technology and the products of our suppliers, *Codex*, the online and printed journal for defence science and engineering, was launched in summer 2008. It explains to potential defence research suppliers the science and technology strategies, plans and priorities of MOD. It also encourages the submission of new ideas, supports networking and provides a forum for promoting defence science and technology. *Codex* is available free on subscription and online at www.science.mod.uk.

We have revolutionised the manner in which suppliers can engage with MOD through the Centre for Defence Enterprise (CDE), which was launched last year. It has been a great success as a gateway for new ideas that can benefit defence, providing responses to proposals within 15 days of submission – its strapline is the 'need for speed'. The CDE is a physical centre inside a commercial incubator unit on a science park in Harwell, Oxfordshire, offering a clear point of entry to potential defence suppliers. It increases access to the defence market and facilitates innovation within the defence supply chain by providing a quick, first response to ideas with a range of advice, assistance and research funding.

This is a further incentive for individuals, small businesses and academia to engage with MOD and the more established defence industry. The CDE is empowered to fund proof-of-concept and seedcorn investment, with a view to pulling successful ideas through to the demonstration and equipment programme. Monthly themed seminars are also run to help organisations which have never worked with defence to engage with users and experts.

The success of the CDE can be measured by the 35 contracts that have been placed so far amounting to £2.5 million – half of these with companies that had no previous defence connection. Examples include d3o Labs, who are exploring the potential of their shock-sensitive polymer as a helmet liner, and Teledyne, who have developed a landing aid for helicopters under dusty or 'brown-out' conditions.

Economic and social benefits

Innovation is not just important to MOD, but is part of a wider Governmental initiative to use the UK's research and technology base in order to drive economic and social benefit. The *Innovation Nation* White Paper published last year by the then Department of Innovation, Universities and Skills (DIUS) committed each Department to producing an Innovation Procurement Plan (IPP). This is championed by Lord Drayson, who is now Minister for Science and Innovation at the new Department for Business, Innovation and Skills (BIS) and Minister of State for Strategic Defence Acquisition Reform in MOD. MOD's response to the IPP has been to pull together ongoing initiatives which are

seen as leading the field: the Defence Industrial Strategy, published in 2005; the Defence Technology Strategy, published in 2006; the MOD Innovation Strategy, published in 2007; and the DTP. In bringing these initiatives together, MOD has formulated a comprehensive approach to encouraging innovation in defence throughout the UK.

Engaging with the wider public's imagination was a major part of last year's Grand Challenge. This competition aimed to provide an opening into the UK defence market for new innovators and suppliers. The challenge was to devise technological solutions to the problem of remotely assessing whether hostile people or equipment were present in an urban environment.

The Challenge provoked significant interest from across the UK science and technology base: large and small companies, research laboratories and academic science faculties. In total, the competition received 23 proposals from firms and research institutions, with six teams competing in the grand finale at Copehill Down Training Village on Salisbury Plain in August 2008. Team Stellar were the overall winners with their Sensing and Autonomous Tactical Urban Reconnaissance Network (SATURN), comprising a high level and a medium level unmanned air vehicle, an unmanned ground vehicle and a control station fusing visual, thermal and radar data. At the launch of the DTP, Min(DES) announced a £1 million contract to take SATURN to a higher level of capability. Several other teams have also been awarded follow-on contracts.

As MOD looks to the future and drives forward the research programme, the Innovation Strategy, particularly the commitment to move toward open systems, remains as important as ever. In addition, the need to be as transparent as reasonably possible, to be agile and to encourage lasting partnerships between MOD and suppliers, remain key.

It is more vital than ever that new and emerging technologies are exploited as the threats our troops face are constantly evolving. To do this, the wealth of talent and expertise found among small businesses, talented individuals and academia needs to be accessed. MOD is therefore making a significant move toward openness and a drive toward a more collaborative future. MOD's priorities are to keep the Defence Technology Plan fresh and relevant to reflect real priorities, to build on the success of the Centre for Defence Enterprise and to drive ahead with the Capability Visions. □

The use of science and technology was also discussed at a Foundation meeting on 21 May 2008

Industry and the wider defence partnership

Alison Wood

We are considering the two questions: "Can science and technology make a greater contribution to the defence of the United Kingdom?" and "What is the impact of defence spending on the wider economy in the United Kingdom?" We need to look at them together. The ability to bring these together has been one reason for the successful contribution science, technology and engineering have made both to defence and to the broader UK economy over the last two decades.

I speak as an industrialist. From my standpoint, the future environment is going to be much more demanding, far more dynamic and with a range of uncertainties that we have yet to fully understand. We have three challenges. First, the question of whether we are thinking sufficiently broadly about the definition of 'defence'? Second, how we can embrace the contribution of science, technology and engineering – and the capabilities these brings – in the products and services we deliver, and how we incorporate this innovation into our business models. Ultimately it is a combination of the product/service and the business model that leads to the goal: supporting the Ministry of Defence (MOD) to deliver the most effective military capability to our armed services. Third, how we support the MOD and its much broader set of partnerships in continuing to strengthen the delivery of science, technology and engineering capability in the UK.

The definition of 'defence'

This is a lot more than a debate about bringing COTS (commercial off-the-shelf) technology into defence. The parallels with civil markets are growing and we should be positively looking to manage and apply them, whether in cyber-security, knowledge management or information management. If you can enhance the competitiveness of the UK financial services industry with the competitiveness of the UK defence industry and the MOD, we should be able to get a world-beating set of capabilities.

Energy generation and power management will be defence and security issues as climate change progresses. This is not only about potential sources of friction

Alison Wood was Group Strategic Development Director, BAE Systems at the time of this talk. She was responsible for Group Strategy, Mergers & Acquisitions and strategic business development.

in the next two decades, but about how we secure and supply critical national infrastructure protection. Whilst that sounds very much a challenge, I think it offers the defence science and technology community opportunities for innovation and knowledge transfer.

In defence we have often struggled to share technology and innovation across national boundaries because of essential and appropriate national security restrictions. However, none of us – whether we are with UK companies, with US operations or US companies operating here in the United Kingdom and elsewhere in Europe – can now afford to hide behind national boundaries. We have to be able to share, exploit and develop technology within appropriate limits of operational sovereignty. That is going to impact how we train, manage and motivate our scientists, technologists and engineers to be competent and appropriately skilled in a global environment.

Innovation models

The agenda of embracing innovation – not just in the products and services we deliver, but in our business models – is critical. UK business has been at the leading edge of some of these developments, and I applaud the MOD for moving to models like contracting-for-availability. My own company, BAE Systems, has been involved, along with Rolls Royce and others, in the Tornado ATTAC programme, where we have changed our business model in the way we go about supporting the Tornado aircraft at RAF Marham.

We have a very successful partnership with the University of Cambridge, which has helped us work on models for logistical support, RF ID sensors, etc (there are a number of individual technology applications). It was the fusion of technology and process innovation that has changed the game sufficiently to require a new set of skills. We also have a partnership with the

Systems Engineering Innovation Centre at Loughborough University. Others have joined it as well, and again we are examining how best to deliver products and systems and process innovation.

Setting clearer priorities is essential, and I very much welcome the Defence Technology Strategy. Like a number of colleagues in industry, we have to ensure the widest possible engagement in order to search for relevant technologies and the abilities to bring them to market. We need to look across the university community, the regional development agencies and small and medium-sized enterprises. We also need to be very clear where we are drawing the technologies from: this is no longer as simple as it should be, because it does cross national boundaries. We need to embrace and positively control the way we partner, but learn that a lot of the technology and innovation will no longer sit within our own controlled environment.

The wider economy

As the defence science, technology and engineering community, we contribute to the wider economy not just in the pound notes that we invest, but also in the development and retention of key skills in science and engineering. In BAE Systems there is an established programme of making sure we embrace and develop university partnerships. We had the third largest R&D spend in 2006 of UK companies. For every £1 million in sales we spent £101,000 on R&D: about five times the national average. I suspect that all of our colleagues in the defence sector would achieve roughly the same gearing. And it is this gearing that creates an agenda for further investment and partnership.

The defence science, technology and engineering sector has made, and will continue to make, a very positive contribution to the wider economy. At the heart of that improvement is recognising, in this much more complex and global environment, that a wider partnership is absolutely essential to delivering science and technology: a wider partnership across the defence community, a wider partnership with the civilian community and, more importantly, a wider partnership on a global basis. □

Military and civil links

Ron Smith

Any society and its military are intertwined. They depend upon each other. As a minimum, society depends on the military for its security, and the military depends on society to finance it. At the moment, the bill is quite small, about 2.5 per cent of Gross Domestic Product (GDP), but during the World Wars the military took over half of national output.

One example of the link between the two is the use of the Global Positioning System, GPS. This is a military system that has very wide civilian applications. It is a technology that was crucial to the military in the first Gulf War. Armies have always had difficulty navigating in deserts and Desert Storm could not have been fought in the way it was without GPS. I heard the Commander of an armoured regiment say it was the first time in his life that a subaltern told him where he was and he could believe him! It is interesting to note that most military vehicles had not been fitted with GPS prior to the campaign, but they were fitted for the war because there was a large commercial industry producing GPS sets. So the links go both ways.

A central feature here is the size of the gap (the similarities and differences) between the science, technology and engineering used by the military and that used by the rest of society. The size of that gap varies. During the Second World War the gap was quite small: furniture factories could be converted to produce Mosquito aircraft, made of wood and fabric. After WWII the gap widened: military equipment became increasingly specialised and different. Then the gap narrowed again as civilian technology overtook military technology. Even really arcane technologies that had once been the sole preserve of the military and the spooks, like cryptography, became dominated by civilian research because of their commercial importance, particularly in finance.

Problems with linkages

One of the problems with these linkages is concerned with timescales. The lifecycle of commercial electronics is about 18 months. The average military procurement cycle is about seven years. This means that when the military system goes into service, not only is the electronics obsolete it may no longer even be in production. The US Department of Defense has a fabrication



Ron Smith is Professor of Applied Economics at Birkbeck, University of London, where he teaches econometrics and statistics. He has published extensively on defence economics. He is an Associate Fellow of the Royal United Services Institute, has acted as a consultant to the National Audit Office on defence projects and has lectured at the Royal College of Defence Studies and the Defence Academy.

plant for producing old chips which are no longer on the market but continue to be used in military systems.

Although it does some training of its own, the military draw on the unfortunately rather limited scientific, engineering and mathematical skills of the general British population. Society in general can rely on what is produced by the engineers trained in India and China, though. Unfortunately, the military are rather more constrained because of the need for security clearance.

There are a range of things that the military originally did for themselves but which have since become central to wider society: mapping (the term Ordnance Survey reflects its military origin), meteorology, air traffic control, internet and GPS. Often, when applications acquire more civilian than military importance, they are spun off from the military, just as mapping and meteorology have been.

The value of spin-offs

The extent to which technology has been spun-off from the military to the rest of society is controversial. It is certainly true that many crucial technologies have military origins, though it is less clear whether it was their military or their wartime origin that was important. When military spending took such a large part of national resources as during the World Wars, and subsequently took such a large part of national R&D, this is not surprising. It is quite possible that if those resources had been spent on civilian R&D without the secrecy restrictions and diversion of scarce scientific and technical skills to the military, there would have been more innovations.

The military origin of many technologies is not necessarily an argument for support of military R&D. The US defence technology organisation, DARPA, produced the internet. But CERN produced the World Wide Web, and that is rarely given as a reason to support particle physics. If you want to promote technology, there are better and less expensive ways to do it than relying on the military to spin it off.

In addition, it is very difficult for governments to target innovation effectively. Consider the growth of India as a major software producer. Partly this was the result of an education system that produced very good software engineers, although many say that it occurred partly because the Indian Government did not treat software as a serious industry. The industry actually benefited from not having the extensive government support that has doomed many other Indian industries, particularly in manufacturing.

Effects on the wider economy

Because the military are intertwined with society, they do have effects on the economy. The armed services create employment and those jobs can be crucial, particularly in a marginal parliamentary constituency: but if you want to influence employment there are many more effective ways of doing it than spending on the military. Arms exports do affect the balance of payments, but their net effect is controversial. A detailed study conducted jointly by the Ministry of Defence and academic economists came to a typical economist's conclusion: it depends.

The scientific and engineering links between the military and society are crucial and they work both ways, but they are complicated and not something that can be controlled. Buying weapons is difficult enough even if all you care about is getting the best value for money in providing military capability. The National Audit Office regularly documents the problems in doing so. To complicate it further, trying to fine-tune the technological spin-offs creates the danger of incapacitating the decision makers by the complexity of their objectives, resulting in even worse procurement decisions.

My argument would be to focus on science and technology for military purposes, recognising the wider spin-offs, but accepting that those spin-offs are very difficult to exploit for policy purposes. □

Statistical evidence is an important tool in the development of policy. The issue of how to make best use of this resource was discussed at a meeting of the Foundation on 29 October 2008

Using statistical models to formulate effective policies

David Omand

Since its inception in 2006, the Better Government Initiative (BGI) has involved experienced practitioners, including politicians from the three major parties and retired public servants, in a series of discussions and reports on how Government policy making might be improved. Its concern is not with the political choices to be made in deciding what policies to pursue – it is non-partisan – but with the arrangements for formulating policies and legislative proposals, and the mechanisms for subjecting them to scrutiny using sound methodology and the best possible evidence.

Although the role of evidence in the process of policy making is only part of the picture, it is a vital activity of Government. By the 'process of policy making' I mean the way in which Government translates its political vision into programmes and actions that will deliver outcomes in the real world.

Delivering these outcomes involves modelling aspects of human behaviour. Government has a number of options – such as taxation, benefits and grants, regulation, legal compulsions, contracts and public communication – that all have to be connected through a model of relevant behaviours to the desired outcomes in society. A good model, based on sound hypotheses, can help Government select the best combination of levers to effect desired changes – and to spot important connections to other policy areas. The modelling can be explicit, for example, running different assumptions through the Treasury econometric model, or it can be implicit as when policy makers in a smoke-filled room try to gauge the likely reaction of the media to legislation to ban dangerous dogs, to choose a notorious past example.

In modelling a policy, a number of things can go awry and lead the policy maker astray. First, the relevant information may not be available for use in the modelling process, or the effect may be too small to distinguish from everything



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else – a 'signal-to-noise ratio' problem that often occurs, for example, when intelligence assessments fail to spot a coming crisis. Second, time-lags in the data may not be sufficiently understood or the data may not be sufficiently current. This is a common problem when trying to judge policies that have differential outcomes in local authorities, given that the census data may not reflect recent immigration patterns. Another instance is trying to judge where we are in the economic cycle in order to take counter-cyclical action.

Unspoken assumptions

Another area of difficulty in model building is more pernicious and occurs when the model relies on false causalities or implicit, unspoken assumptions that may not reflect real behaviours. The problem is particularly acute when ministers and officials involved do not realise they are making assumptions. It is more likely to arise when policies are rushed through or debate truncated. It was an implicit, and never properly challenged, assumption in 2002 that Saddam Hussein would never allow work to stop on his weapons of mass destruction (WMD). An untested assumption about what the British people would regard as a 'fairer' system led to the poll tax; this could have been avoided if the interaction of tax, housing benefits and other social support had been effectively modelled as this would have revealed that some of the worst-off households would

be hardest hit. 'Care in the community' policy may have made sense in its own terms but it relied upon an assumption that local social services would be in a position to take the strain without extra resources.

More and better data may illuminate some of these issues in time for policy makers to consider them. Yet the problem of superficial policy making is more fundamental than merely the availability of information. The Oxford physicist David Deutsch quotes a story told by Bertrand Russell in his philosophy lectures to make the point. Imagine a chicken farm where the chickens spy on the farmer and discover that he is stockpiling chicken food. Does the 'Joint Intelligence Committee' of chickens conclude that the farmer is at last going to look after them properly, or that he is fattening them up for the kill? The same reliable data produce two opposite interpretations, depending upon an implicit assumption about the farmer's behaviour. The implicit assumption often follows the inductive fallacy that tomorrow's behaviours will be like those of yesterday and the days before, because that is all we have observed statistically. Without an adequate explanatory model, Government may, to quote Paul Dirac's description of Nils Bohr's hydrogen atom spectra, have reached the right answer for the wrong reason.

However, there are exceptions. One good example of putting detailed workings into the public domain is the analysis of economic tests for joining European monetary union prepared by HM Treasury (although whether ministers ever got down to discussing the evidence collectively is another matter). Yet most day-to-day Government policy making is far removed from such sophisticated analysis. To improve matters, Government will have to allow more time for proper consideration of policy, view it as a team effort between those with the vision and those with the experience, and make available for scrutiny the basis on which policies have been constructed. This includes

not only the data, but the models, the methodology and the key assumptions.

Unfortunately, Government publications – whether White Papers, Green Papers or consultation documents – have in recent years become glossy, illustrated vehicles of public persuasion. Persuasion is a perfectly legitimate activity for Government but it is not the same as the provision of clear, reasoned and intelligible accounts of the intended policy and the evidence base behind it. As we saw in the notorious Iraq WMD dossier, it is very hard to preserve the fine line between producing the strongest evidence on the one hand and making a case on the other. Problems with policies are frequently a consequence of rushed public commitments (often prompted by moral panics in the popular media), insufficient analysis and preparation, or over-hasty Parliamentary scrutiny. The result, though, is flawed legislation.

Do's and don'ts

There are some clear do's and don'ts that the BGI has tried to highlight. First, avoid committing to legislation merely to signal resolve. Parliamentary time should not be wasted putting right incomplete Bills. Legislative and other major proposals should be accompanied by the precise statements of policy we expect in a proper White Paper, with detailed analysis and documentation of the case available for scrutiny.

There should be information about the means by which the proposed policy will be brought into effect and the ways in which its effectiveness can be judged.

Second, Government departments should ensure that policy modelling has been conducted (and options costed and tested) with frontline professionals and other Departments affected. This is not just to get the analysis right but also to build partnerships with the deliverers. Those who have to implement the

policy should be given the opportunity to negotiate delivery, cost and quality: in return, they should fully accept responsibility for ensuring successful outcomes. Government should at all times avoid treating policy making and delivery as if they were separate activities.

Third, Government should avoid the error of seeing policy formulation as an activity only for the politically committed. Final decisions are of course for the ministers of the elected Government, and views should also be sought widely from outside as well as inside. However, the system works best when policy formulation and modelling are seen as central functions of a politically-neutral permanent Civil Service.

Finally, if policy fails to achieve its aims, if costs are significantly greater or the benefits markedly less than expected, the public should have sufficient information to judge whether the failures are a result of inadequacies in the policy or of factors outside the Government's control. □

The impact of statistical advice on policy

Adrian Smith

In the context of policy making, statistics has three broad roles – to inform the development of policies, to monitor their effectiveness, and to serve the interests of Government, Parliament and the public. Health service waiting list times and school performance league tables are two examples of policies that were driven by, and monitored with, statistics.

Another example of the use of statistics is crime, including knife crime. A few years ago it was virtually impossible to have a sensible debate about policy in relation to knife crime because there was little acceptance or agreement, either within Parliament or among the public, about the statistical evidence regarding knife crime.

What is actually meant by 'violent crime'? The answer may appear obvious but investigation reveals that the term can mean different things to different people. When we produced a report on crime statistics we found through retrospective analysis that 50 per cent of the crimes categorised as 'violent' involved no physical injury. National figures that bore no relation to people's own experience were having a powerful impact on the public's perception of statistics and the trust they placed in them. In the case of crime statistics, public trust was at a low level.

To raise the level of public trust in sta-



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istics, we needed to ensure that statistics were accurate, appropriate, timely, independent, relevant to people's experience, robust and transparent.

A clear distinction

We must make a very clear distinction between the statistics that are produced to inform, monitor and communicate, on the one hand, and those that are directly designed to support evidence-based policy making on the other. This requires a strengthening of the independence of statisticians working within Government

structures. To ensure equal access to information for all purposes, rules are needed: for example, who has access to statistics, when they are given that access and what information they are given.

How can we address this effectively? We had a Statistics Commission with, in recent years, the ability to monitor and comment on the workings of Government statistics but it had no real authority to change anything. Now we have the UK Statistics Authority, which has three main functions. It oversees the Office for National Statistics (ONS), it monitors and reports on all UK official statistics wherever they are produced, and it furnishes independent assessments of official statistics. Its monitoring and assessment role is very important as it is not apparent to the general public – or to many sophisticated observers – that there is a plethora of different departments and agencies producing official statistics in addition to those from the ONS.

So the UK Statistics Authority will have a fundamental role in protecting and maintaining the integrity of the statistics profession within Government, setting standards for the production and reporting of official statistics, as well as ensuring that best practice is promulgated across Government.

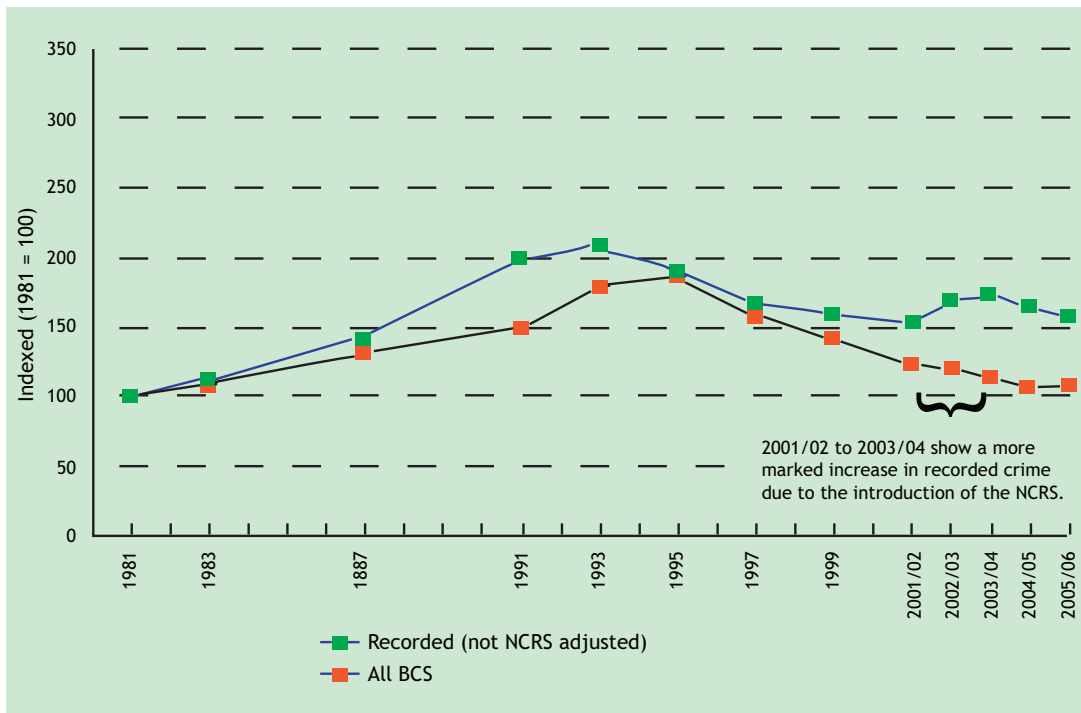


Figure 1. Police recorded crime and National Crime Survey figures (NCS). Note the rise in recorded crime between 2001-2 and 2003-4 due to the introduction of the National Crime Recording Standard (NCRS).

Planning for the future

In policy making, and in other contexts, people often mourn the fact that the right data are not available. 'If only we had started 10 or 15 years ago' collecting this or that, they say, we would know all sorts of things that we really want to know. It takes time and money to produce statistics, and we need to pay more attention to the requirements of the evidence base of the future. The National Statistician may disagree, but a 10-year run-in would have helped to get a real grip on migration. If we are going to continue with censuses (and the logic of that is not clear to me at least) it may take 10 to 20 years to create something that robustly counts and measures who is here, where they are and what they need.

There are two projects underway which seek to build statistics for future use. In the first, the Economic and Social Research Council (ESRC) is investing £28.5 million in a major birth cohort study – involving tens of thousands of people – to record a very wide range of

medical and social data on a long-term, longitudinal basis. In 10 or 15 years this will be an extremely useful and valuable national resource.

The second project is to gather the best and the brightest of those who have been involved in Foresight exercises and ask them to look ahead 10 or 20 years to determine the evidence base that will be needed for policy making in Government. This has never been done before.

Tension may sometimes exist between, on the one hand, the production and interpretation of statistics close to, and valued by, policy makers in Government Departments and, on the other, the demand by some external communities for visible independence from these same users in order to give them reassurance about integrity. There is no simple solution to this tension. Perhaps we need to think a bit more about the structures that would provide such reassurance, although structures do not solve all such tensions. One approach would be to separate day-to-day policy involvement from the activ-

ity that leads to the production and publication of independent, official statistics. The difficulty with this is that very often it is the same people, the same brains, the same software in the same office that is working on one type of statistics in the morning and the other in the afternoon. One solution might be for all statisticians to work under the National Statistician, who will second them to Government departments to do policy work whenever that is required. When they are working on the production and reporting of official statistics, their line manager would revert to being the National Statistician.

Although it is still early days, we now have a UK Statistics Authority. It has the potential to change both the culture of Government statistics and people's perceptions of published statistics. Statistical data are fundamental to the creation and monitoring of policy. We need to ensure that everyone understands the strengths and limitations of statistics and we need structures that will ensure trust and independence. □

Objective evidence, public perceptions and the issue of trust

Gus O'Donnell

Evidence-based policy making has become much easier since I joined the Civil Service in 1979. At that time, it was limited by

constraints such as lack of data as well as a lack of time and resources to analyse the data. A macroeconomic simulation that used to involve thousands of equations

and take days to complete is now a 15-second operation.

As Cabinet Secretary I have tried to influence the way in which evidence is

used in policy making, taking departments through capability reviews and publishing the results. One of the 10 measures we publish is their use of evidence in policy making. We have reviewed 17 departments, of which 11 have done reasonably well and six have development needs. In future we will be able to track whether departments are increasing their use of evidence. I have also tried to professionalise the civil service and ensure that those professionals are influential. There is little point in having a brilliant finance director or statistician if they have no influence on policy making.

However, things do go wrong. There may be no data; the effects we are looking for may be too small; there may be time lags in policy making. For example, one of our targets is to get more ex-offenders into homes and jobs. When I looked at this I asked: "What determines whether an ex-offender gets a job or a home?" I found there were no data readily available to answer this question. Moreover, we were faced with a 'simultaneous equation': a person with a home is more likely to get a job; a person with a job is more likely to get a home. It became evident that one of the most important variables is the overall economy. The number of ex-offenders finding homes and jobs is going to fall because of what is happening in the wider economy: this has nothing to do with Government policy. Separating the effects of a policy from the effects of other variables is very difficult.

Evidence and persuasion

I want to raise the question of the balance between objective evidence and the need to persuade. An example of this is health. Interventions that alter lifestyles, such as diet and exercise, are much more effective in improving people's health than spending more money on a particular drug. Yet of the money we spend on medical research, only a very small proportion is allocated to interventions that change behaviour. In any cost-benefit analysis this would seem to be wildly out of kilter.

However, this takes us into dangerous territory because we are starting to think about behaviour change. Now, governments influence people's behaviour from the cradle to the grave. We send them to school, teaching them a certain body of knowledge, rules about behaviour and values. So we are already in this business. The question is: in what areas is it legitimate for the Government to try to change people's behaviour? There are some very strong views on this question.

The media

Let us consider the influence of the media. Government ministers become very frustrated when they have achieved successes, for example reducing waiting times in the health service, and no one appears to believe them. We need to look at how messages are being delivered to people. In the past, most people would listen to the same news programmes. Today, the media are very diverse and people pick up information from many different sources. So we need to think about what the incentives are for the media to report information accurately and what are we doing to educate people about how to interpret evidence. One improvement we have seen is the ability for people to access information directly. For example, if a person is ill they can phone NHS Direct or use the internet to consult a variety of sources of health information. If we want direct citizen engagement in politics, we need to lead the way in giving people direct access to public sector information.

We also need to devise ways of gaining information and feedback from people, just as the private sector does with its reward cards. For example, people are very interested in school league tables and we could find a way for schools to interact directly with parents.

The issue of trust

This takes me to the issue of trust. The public need to be able to trust the information they receive. It will be very difficult to achieve public trust in politicians. A



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survey asked people what they believed the Government worked for: the country, its citizens, the political party or for itself. The conclusion was that most people believed the Government was mainly interested in promoting its own interests and those of its political party. This survey was undertaken in 1944 so lack of trust in politicians is nothing new. However, if we move too much out of the political domain then we may have problems with accountability. We have a democracy with elected, accountable politicians. If we remove areas from their control, will the lines of accountability be clear?

Public trust

I will conclude with an example of one area where public trust is high and behaviour change has been very successful. This area is road deaths, where Government statistics are among the most highly trusted. A substantial amount of policy work has been done to address safety issues such as drink driving and the wearing of seat belts by back seat passengers. In the case of seat belts, it was found that telling back seat passengers to wear them for their own safety had little effect. However, a series of very graphic television advertisements showing people in the back seats of cars pitching forward and killing their mothers, fathers or daughters had a massive impact on the public. Partly because of policy work such as this, in 2008 road deaths decreased to below 3,000 for the first time in 70 years. This example shows that Government policy can be used very successfully to achieve behaviour change in a controversial area.

Finally, to quote John Maynard Keynes: "Economists set themselves too easy, too useless a task if, in tempestuous seasons, all they can tell us is that the storm is over and the ocean is flat again." □

Personal data sets

Some concern was expressed about the emphasis placed on the Government's ability to use much more disaggregated and personal information. Clearly there are advantages in a detailed understanding of what the public wants and thinks, knowledge of their circumstances and how they could be helped. But references to 'personal data sets' raise great concern about privacy and Government use of information. Such risks could be minimised by better security within Government on the use of information, coupled with greater effort in persuading the public of the value of the Government having such data.

How can technological innovation help us meet our carbon reduction targets and how is it changing the energy supply balance? These were the questions considered at a meeting of the Foundation for Science and Technology on 5 November 2008.

A partnership to develop the energy technologies of the future

David Clarke

The Energy Technologies Institute (ETI) is a unique operation. It is a partnership between a number of major global industry groups and the UK Government and its remit is to address the challenges of accelerating deployment of low carbon energy systems.

Our intention is to enable large-scale demonstrations of system level capabilities – what in engineering parlance we would call ‘the whole solution’, the complete turbine, the complete carbon separation system, etc, but at a scale where we can demonstrate the critical high-risk technology elements. Clearly the funding we have (which at the moment is up to £1 billion over the next 10 years), does not go very far if you start talking about full scale carbon capture and storage (CCS) projects for instance. So a typical ETI project will focus on the critical high-risk elements.

A key aim is to identify the big scientific problems we need to fix for the next generation. Most of our activities will either have academic involvement in the projects themselves or else outputs which will be fed back into the academic base. For this we have to carry out modelling to show us which are the areas most likely to yield a good return on our investment.

Four major sectors span all the programmes: heat, power, transport and infrastructure. Heat, power and transport are responsible for the majority of the CO₂ emissions from the UK. Infrastructure underpins them and all are interlinked – that is a key issue.

Looking at major power generation sources, the ETI emphasis is on the period 2020 to 2050. From the point of view of developing new technological capability, it is unlikely we can get into mass production and mass deployment before 2020 so, for many of the projects we undertake, the main impacts will become apparent as we approach 2050.

The ETI is concerned with identifying



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and adopting what I would term ‘sound engineering and commercial practice’; we are developing a model that we would class as ‘fit for purpose’ in this regard, one which we can use to make reasonably pragmatic decisions about what to support and to develop. In-house we are developing a capability which is not just about engineering technology, but also about modelling capability.

We have been looking at various technologies that could make a big difference. Take for instance solar PV, which today is very expensive compared to most other generation sources. There is a large opportunity for cost reduction, in the order of 70 per cent. It also has great CO₂ abatement potential.

But then we begin to model what is likely to happen over the coming years. Then we see that solar PV – for the UK, at least – is likely to account for only a very small amount of overall supply, whereas nuclear, offshore and onshore wind all look a great deal more promising. We are using a probabilistic model with cost-curves built into it, simulating what is actually likely to happen from the point of view of costs and competition between technologies.

I want to look at two specific examples. The first is offshore wind, the second is the electrification of vehicles.

Offshore wind power

The latest sites under consideration in the North Sea are in excess of 60 miles offshore where the water is more than 40 metres deep. In those conditions, installation and maintenance become critical but it is not just a matter of whether such projects can be achieved, it is also a matter of affordability.

Offshore wind has to operate in a very difficult environment and there are a range of issues that have to be addressed in order to make it an affordable proposition. The cost is of the order of 9-11p per kWh, against typically about 5p from centralised generation. Offshore wind must therefore achieve major cost reductions. Take a typical 2.5MW offshore turbine: the cost of the turbine itself is around two-thirds of the total and the foundations are around a fifth. With installation costs of around £2.5 million per megawatt, it would be very advantageous to reduce the cost of the turbine and the foundations before setting off into very deep water.

The turbine is challenging, but there are things that can be done. From the point of view of both reliability and weight, the ideal would be to remove the gearbox. The turbine nacelle structure weighs 200-250 tonnes. Reducing the weight makes installation so much easier: there are more vessels that can then transport it to site and there is a ‘ripple effect’ in terms of cost-benefit and deployment benefit. From an ETI point of view, we are very interested in projects concerned with redesigning the turbine.

Then there is the question of foundations and the feasibility of floating systems. One small machine has already been deployed and Statoil Hydro is trialling a 2.5MW machine.

So we can do something to make offshore wind more affordable. Whether we can do it by 2020 is another question. To meet current UK targets the ideal solution would be to put something like 3,000 machines offshore by 2020, which means

one every working day for the next 10 years – except that in the North Sea you cannot go out every working day because of the weather.

Where are we today? The ETI is developing over £30 million of projects for systems demonstration and work on next-generation offshore systems. The Carbon Trust has announced a further £10 million, and industry is investing in nearer-term cost reduction opportunities including foundations, electrical systems, access and logistics. So we have made significant strides, but the challenge of delivering it by 2020 remains.

Transport

While for offshore wind the big issues concern the supply chain, the engineering of the actual machines and deployment, once we step into the transport sector we find the big questions are about how to

develop and use cars in the future.

Bearing in mind that light vehicles account for about 50 per cent of transport CO₂ emissions in the UK, a major focus for us is the electrification of these cars and small vans, particularly through the development of hybrid electric vehicles. The ETI aims to utilise the skills, capabilities and synergies of our industrial partners in order to combine fossil fuel and electrical technologies, and so create the infrastructure necessary to provide a wide network of electric charging points: this whole programme clearly plays to the strengths of our partners.

I have talked a little about power and I have mentioned transport, but I have not mentioned heat. Now this is a massive topic and we have to address this issue too, particularly through energy efficiency.

I did not mention infrastructure either, but without the right infrastructure there is

a great risk that all our endeavours will fail. The total costs of achieving the renewable energy targets for 2020 are of the order of £100 billion – much of it to do with infrastructure costs. To get to the 2050 targets will probably cost at least the same again. In many cases this is not primarily constrained by planning issues as is often highlighted, but by the availability of suitable engineering and skills. We have to develop and deploy not just a new electricity grid, but heat grids, CO₂ grids (for carbon capture and storage) and potentially infrastructure for a future hydrogen economy.

Fundamentally, the ETI is concerned with accelerating the pace of energy R&D; we are doing this through industry and Government, getting technology and engineering solutions deployed faster. There is an element of risk in all this, but we need to take risks and have an appetite for higher risk across the energy sector. □

Technological innovation and energy supply

Mark Henstridge

The BP Statistical Review of World Energy compiles global data on energy production, consumption and reserves. The data are freely available online, as is the analysis of them by BP's Economics Team.

The global fuel mix has been changing slowly but steadily. The single most important fuel remains oil – accounting for more than a third – but its share of primary energy has been declining steadily. Gas has been increasing and coal fluctuates. Coal is completely dominated by Chinese demand when you look at the global total. Hydroelectric and nuclear energy are pretty steady in terms of their share of global energy consumption.

We have just been through a commodity boom, driven by rapid growth in the world economy. The difference between this and a similar situation in the early 1970s is that this time the rate of growth of primary energy consumption (oil, gas, coal, hydro and nuclear all added up) slowed even through the last year of economic growth.

Demand

Two things have been happening in the last few decades. First, economic growth is increasingly driven by countries out-



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ments, developing Group planning assumptions, contributing to the BP evaluation of country risk, and other work where the BP Group encounters macroeconomic issues, particularly in developing countries.

side the OECD – the main and most obvious example being China. Economic growth in these areas is considerably more energy intensive but, despite that, the rate of growth of energy consumption has slowed overall: we are becoming relatively more efficient.

The other factor shaping energy demand is price. The best example is the USA, a land of liberalised markets where prices, particularly at the gasoline pump, are flexible. These have gone up and gasoline consumption in the US has gone down. US consumption of oil was more than one million barrels of oil a day less in 2008 compared to 2007. President Bush said that one of his targets for energy inde-

pendence was to reduce the consumption of oil in the US by two million barrels a day. Well, high prices at the pump, although not politically popular, have achieved half that objective within one year.

Supply

On the supply side, there are three elements. OPEC (the Organisation of Petroleum Exporting Countries) chose to reduce production in 2007 in order to push the price up. There were also declines in production in 2007 in mature provinces outside OPEC like Norway and Mexico. The former Soviet Union saw the biggest increase in that year, but in 2008 Russian production fell because the state taxes oil production at 95 per cent on all revenues over \$30 a barrel: as a result, as costs go up the tax wipes out any revenue benefit for producers.

So we had declines in mature provinces within the OECD, policy in OPEC countries reducing production, tax policy in Russia doing the same – all constraining the response of oil production to high prices.

The world is not running out of oil, however: reserves keep growing. All the reserves shown in BP's 1980 edition of the Statistical Review have since been consumed, but they have been replaced (and

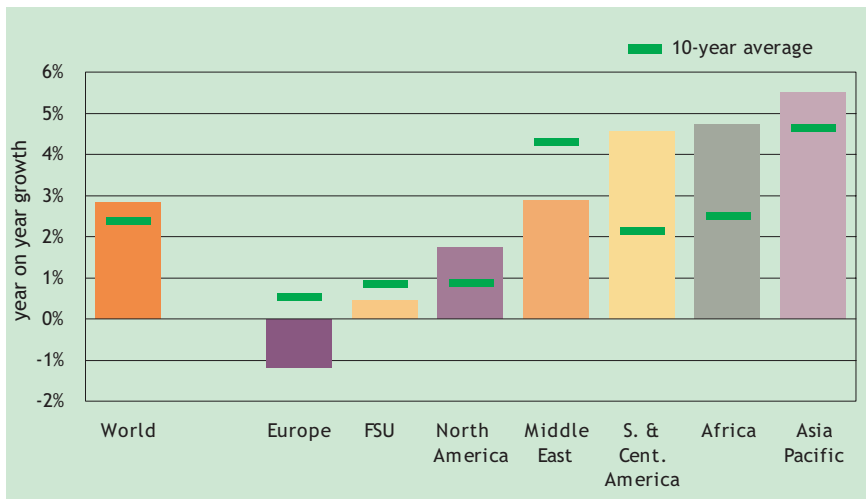


Figure 1. 2007 Carbon emissions growth.

more) by new reserves. The supply side challenge is whether we can access these reserves in order to exploit them.

The role of technology

So how does technology fit into this? First, it allows us to make more of what is there. We can increase the recovery factor from an oil field in a variety of ways. Increasing recovery factors from a low level, say 35 per cent, to a much higher yield of perhaps 50 per cent would unlock an additional 30 billion barrels of reserves for BP and that

is significant. Worldwide a five percentage point improvement in recovery factors could unlock between 300 and 600 billion barrels of oil. So technology matters in delivering additional supplies of liquid hydrocarbons from known resources.

The second area of technological focus for BP is 'convergence' – transforming one form of hydrocarbon into another. Oil is currently the monopoly fuel for transport, but if gas or coal can be transformed into liquid, that changes the economics of the oil market substantially. The monopoly

is broken, the power of a cartel is undermined and the sources of liquid hydrocarbons become much more varied and less geographically concentrated. Reserves of coal in the Western hemisphere are as large as the reserves of oil in the Eastern.

Low carbon energy

At BP we like to think we have taken a lead in investing in low carbon technology – we are investing in a number of technologies that make for more efficient use of energy, whether for mobility, heat or light. That creates demand side reduction, but we have already seen a similar effect through people's own responses to high prices as in the US fuel markets.

So to conclude: there has been a change taking place over a number of years, shifting from an OECD-dominated pattern of global economic growth to one where the non-OECD zone increasingly matters. This has an impact on carbon emissions because non-OECD growth is not only more energy-intensive, but also more carbon-intensive.

There are constraints on the operation of prices in the oil market, but where they are allowed to work they do have an impact. □

BP Statistical Review 2009: www.bp.com/statisticalreview

The role of innovation in achieving energy security

Willy Rickett

The creation of the Department of Energy and Climate Change (DECC) was an acknowledgement that we are in a new era of energy policy. We have moved from being an exporter to an importer, from low prices to high prices, from easy carbon savings by de-coking and de-industrialising our economy to a quest for harder and more urgent carbon savings. The department is a recognition of this change and of the challenge it represents.

Figure 1 comes from the IEA's *Energy Technology Perspectives*. The top line shows the growth in emissions being driven by the growth in energy demand, which is really our security of supply challenge. The bottom line shows the path that we would have to take to halve our carbon emissions by 2050 – and that is the climate challenge. The coloured wedges show the potential contribution of technology to achieving that goal. So



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deals with a wide range of energy-related matters, from its production or generation to its eventual supply to the customer. He has held a wide range of appointments in Whitehall, serving as a Private Secretary to Margaret Thatcher and being a key player in the privatisation of the electricity industry.

that is the agenda.

Innovation

What does energy innovation mean in detail? Well, first, it means using technology to maximise fossil fuel recovery from

reserves as this becomes more demanding and more urgent. It also means developing new conversion technologies to widen the energy options. Both of those are key to energy security.

It means doubling the rate of energy efficiency improvement, our first and a most important goal. This involves the widespread conversion of existing buildings, not just setting high standards for new ones.

It means, on the IEA's calculations, one billion electric vehicles on the road by 2050. It means half of our power coming from renewables, a quarter from nuclear and a very big role for carbon capture and storage (CCS).

We have already achieved a great deal in terms of energy efficiency. We will progressively move into more challenging ways of improving still further: vehicles and appliances are two obvious areas where improvement may be quite easy

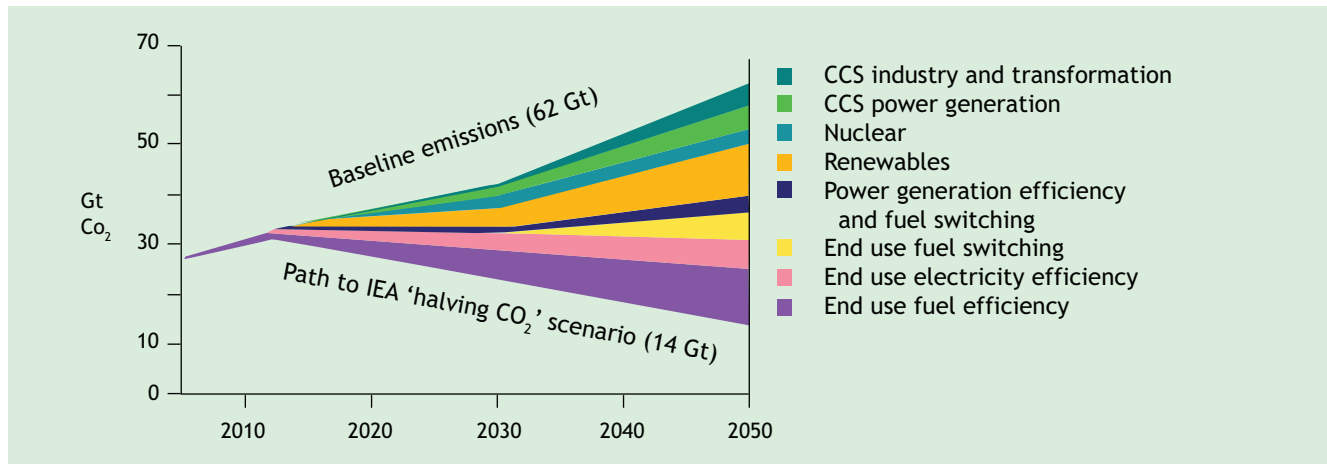


Figure 1. The challenge to reduce emissions.

from a technological point of view. With old buildings, unless we are prepared to pull them down and rebuild them, the options become more and more expensive; solid wall insulation, for example, is intrusive as well as expensive. I do not think we have yet found the policy instruments that will drive a step change in the energy efficiency of our buildings.

Our vision for the future puts a tremendous emphasis on electricity and in particular on low carbon electricity. So first of all, we are pursuing the demonstration of post-combustion Carbon Capture and Storage (CCS) for coal-fired generation. We are pressing, in Europe, for the development of funding mechanisms for further demonstrations. We are looking to the EU Emissions Trading Scheme to drive deployment of this technology. We are looking at what our planned technology should be and how far we go beyond the requirement for carbon-capture readiness.

Nuclear power

On nuclear, we have developed a policy that will permit more than one nuclear operator in the UK. We are helping the Nuclear Installations Inspectorate (NII) to recruit the inspectors it needs for generic design assessment and we are putting in place a planning policy based on a strategic siting assessment that will, we hope, deliver planning permission faster than in the past. We are working on a funding framework for decommissioning and waste. We have also set up an Office of Nuclear Development and a Nuclear Development Forum.

Renewables is the third leg of the low carbon electricity future and we have set out our renewable energy strategy to hit the European target. We have announced

that we will be introducing feed-in tariffs for microgeneration and a renewable heat incentive. We are setting up an office for renewable energy deployment to start tackling the supply chain issues, some of which are very challenging. We are also undertaking a study on tidal barrage options for the Severn.

Of course, the infrastructure – the electricity grid and a national CO₂ grid – underpins all this and we are working with National Grid and Ofgem on the access and investment regime.

Innovation and new technology

If we are to move into a world of low carbon electricity with large amounts of renewables on the system, then we need to look at the technologies of the 'smart grid' as some people call it, of electricity storage, of dynamic demand and of future generation options (including solar PV). If sustainable bioenergy is to be a key component of the future then we must examine the options here as well.

What are the drivers of innovation? Well, you need both market 'push' and 'pull'. The push is funding for basic research, and the removal of risk associated with demonstration and deployment. The pull involves incentives to deploy technologies once they are near enough to market. However, while politicians strive for ever-faster and deeper policy instruments, there is a need to maintain a reasonably consistent framework and a stable policy regime in order to give the market confidence and certainty.

There is a wide range of organisations and mechanisms involved, from the Research Councils at the initial stages, through to the demonstration phase supported by the Environmental Transformation Fund and the market mechanisms we use like the

Renewables Obligation. In DECC, we tend to be focussed more on the 'delivery' end of the process and take an arms-length view on basic research.

There have been suggestions that this landscape is too crowded. Are there too many organisations involved? Is it too confusing for those who are trying to innovate and bring technologies to market?

The Government's role

This whole process is a partnership between the public and private sectors – it is not totally the responsibility of the public sector, nor indeed of the private sector because there are questions of public good involved. It is important that the Government sets a consistent policy framework which creates a market pull: simply pushing more and more money into research and demonstration will not work unless there is a demand in the market. Public funding is important but how much and is it sufficiently focussed?

How do we choose our priorities? Do we support those technologies that have the most potential in the UK (so wind, wave, nuclear, carbon capture and storage) or should we direct most support to the development of smart grids and advanced bioenergy options? Another option is to concentrate more funding on our international policy objectives through such technologies as the retrofitting of carbon capture and storage.

But the Government's role is not only concerned with the funding framework. It also has a primary role in tackling the regulatory barriers remaining in the planning system. It must also address grid capacity and all the other things that underpin the deployment of new technologies. □

How should we strike a balance between freedom to take risk and a paternalistic government wishing to restrict freedom of action? This was the question debated at a meeting of the Foundation for Science and Technology on 26 November 2008.

The struggle between instinct and reason

Sarah Veale

Enormous progress has been made over recent years on the regulatory agenda. Regulations have been simplified, removed, amended. Information requirements have been quietly shelved. Committees and data gatherers have been consigned to history. Yet the drip, drip, drip of new regulations continues to attract our attention.

The Better Regulation Task Force and its successor, the Better Regulation Commission, both sought to embed necessity, proportionality and effectiveness as fundamental precursors to any intervention by Government.

The more we looked at the situation on the ground, the more we found evidence of the inappropriate handling of risk. At a very deep level, there was a tension between 'instinct' and 'reason' or the heart and the head. The bad news is that 'instinct' seems to be winning. There is a pressing need to give 'reason' a shot of adrenalin.

Instinct is winning because we fool ourselves that we understand risk and that we are masters of our own destiny. Yet the evidence suggests otherwise. In fact, our instincts seem to be conditioned by a number of distorting forces which lead us, on the one hand, to demand more protection in our extraordinarily safe lives (by historical standards) and, on the other, to bemoan the rise of the nanny state.

So what are the forces shaping our views of risk? If we try to inject some logic into our thinking about risk, then we will almost certainly be swept along by a tide of incomplete information from the media: sensationalism sells and there is always someone who has a statistical slant on some new hazard in our lives.

And then we are surrounded by an establishment that is institutionally risk averse. Local authorities, responsible for spending public money on the services they provide, live in fear of the slow but inexorable rise of the blame and compensation culture, preferring to nip risk in the bud. Even in our Parliament, the very place where reasoned debate take place, our MPs spend too much of their time in a political battle looking for someone to



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blame in the event of failure.

It is no wonder that instinct is winning and is looking to drive risk out of our lives still further. Only later do we realise that instinct has sold us down the river. We look around and are surrounded by unwelcome curtailments of civil liberties, ineffective risk interventions and unnecessary regulatory burdens.

The victory of instinct

So how did instinct win? Well, generally with the unwitting collusion of the Government of the day – and I mean politicians and officialdom. Politicians make their name by introducing or lobbying for new legislation. Civil servants make their careers out of delivering it.

I say unwitting because, in my experience, no minister embarks on a deliberate journey of inappropriate policy making. He or she will recognise that any intervention in matters of risk generally involves complex social systems wherein there are no easy solutions. However, a single issue lobby group may see an opening, a tragedy hits or an MP sees a career-making opportunity. Suddenly all that systematic, evidence-based thinking gets tossed out of the window and complex issues are conflated into simplistic constructs. 'Something must be done' – and soon it is. The intervention is all too often inappropriate and doomed to fail.

Meanwhile, an army of risk entrepreneurs waits in the wings: the insurance

company selling protection; the local inspector seeing risk where little exists; the university researcher talking up hazard in search of attention and funding; or the local councillor imposing bans to avoid an improbable event.

Instinct, if it is allowed to win every time, threatens to bog us down with inappropriate and disproportionate responses and regulation. So, at the Better Regulation Commission we felt it was time to re-inject reason on a systematic basis. The Prime Minister agreed, which is why he backed the formation of the independent Risk and Regulatory Advisory Council (RRAC), replacing the Commission.

The seven members of the Council would not claim to be experts in risk. We do not need to be because the world is full of people that know an enormous amount about risk, its effects, perceptions and communication. Rather we are convenors and catalysts – making sure reason gets a hearing.

We convened Risk Forums – meetings of up to 50 people who, in a very short space of time, built a shared understanding of the risk landscape, identified the most effective points for intervention (should any intervention be deemed necessary) and started the journey towards a systemic, evidence-based policy, one that acknowledged uncertainty while offering the greatest chance of success.

One Forum brought together all ranks of the police, their representative bodies, victims of crime, the public, regulators, academics and government officials and aimed to tackle the issue of risk aversion in the police. At the heart of this debate is the freedom of officers to exercise judgement.

The potential gain is greater effectiveness, less bureaucracy, more time out and about, reassuring and engaging with the public at local community level. But there is the associated possibility of more mistakes, mistakes that in the past have been met with intolerance and inevitable consequent risk aversion.

Unpick these issues, see the whole picture, engage the public in the full debate and a different conversation emerges almost immediately. Instinct gives way to

reason and new solutions become possible. Sir Ronnie Flanagan recognised this in his report which is why he asked the RRAC to help.

Helping SMEs

Another Forum discussed how the HSE could best couch its regulatory code to encourage Small and Medium Sized Enterprises (SMEs) to deliver better, safer workplaces with minimum process burden. The current principles-based code seems to scare rather than inform small firms – they want rules, boxes they can tick to say they have got the job done. There is also the role of what we call the ‘risk actors’, the insurance companies, brokers and lawyers.

SMEs must conduct a risk assessment in order to get the compulsory insurance that they need. When they are not fretting about insurance they are looking over their shoulders at the law firms advertis-

ing their no-win/no-fee wares to the public – where, for example, someone falls off a ladder at work and breaks his leg, sues the company and gets several thousand pounds. There must surely be a more effective way of avoiding the accident rather than focussing on compensation.

We do publicly praise politicians or civil servants that have got things right – we wrote to Ed Balls supporting his calm approach to the Baby P tragedy, for instance. But our goal is not really to take on specific issues but rather to encourage a change in the culture of risk-policy both in Government and in the wider risk community, providing examples and practical processes. To change culture you have to influence all the relevant conversations – including those that take place in the pages of our national newspapers and on radio, TV and the internet.

We also sometimes take on the risk

entrepreneurs. Recently, we spoke up when BSI put a standard out for consultation that would have imposed a considerable burden on landowners and would probably have led to people cutting down trees unnecessarily.

I would just like to take the opportunity to congratulate the HSE for their ‘mythbusters’ exercise, by which they debunk some of the most inaccurate “it’s the ‘elf and safety’ again” stories.

Increasingly, policy reform initiatives around Whitehall have started to look beyond process to tackle the myriad of conversations that shape thoughts and actions. Meanwhile, behavioural scientists have entered the fray. Change is happening – risk has moved centre stage. Its understanding and influence is so important to matters of policy making, regulation and our lives in general. That is why the supremacy of reason over instinct is so important. □

Have we got the balance right?

Judith Hackitt

The mission of the Health & Safety Executive (HSE) is to prevent death, injury and ill health among those at work and those affected by work activities. Working practices are changing (e.g. flexible hours, home working), different patterns are emerging in industry (e.g. more smaller businesses, declining manufacturing and growing service industries), there are more women in the workplace, new processes and technologies are being introduced – and there are different attitudes to risk.

Our role also takes us into areas of public safety where risk to the public is created by work activities. Here, regulators like HSE face a challenge in trying to strike the right balance in regulation and risk management. The culture of ‘where there’s blame, there’s a claim’ can make people attempt to eliminate risk in order to avoid exposure to civil litigation.

Yet, individuals complain about regulations or restrictions on their lives; the media myths which incorrectly blame HSE for banning conkers and requiring trapeze artists to wear hard hats reflect this aversion to ‘nannying’. In fact, these stories do damage in a number of ways: they devalue real health and safety; they increase employers’ uncertainty about what action they are required to take; they undermine the important principles



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She returned to this post after working with the European Chemical Industry Council as Director of the ‘Chemistry for Europe’ project based in Brussels. This was a project to restructure the network of Chemical Industries Trade Associations across Europe. She was previously Group Risk Manager at Elementis PLC with worldwide responsibility for health and safety insurance and litigation.

of common sense and reasonableness; and they provide a perfect excuse for not doing things.

Risk is part of life. Well-managed risk is an important part of learning, and we all accept certain levels of risk every day. Innovation and change are founded on taking risks, and the world would be a dull place without it. So, health and safety regulation is not intended to eliminate risk or to stop things happening. Health and safety should be seen as an enabler. When it is done well, it ensures that risks are managed in a sensible and practical way, which will then allow important innovative activities to proceed. It should not stifle such creativity. Good regulation

is essential to creating an environment of public confidence where innovation and controlled risk taking can take place.

The HSWA Act

Prior to the 1974 *Health and Safety at Work Act*, around 1000 people a year lost their lives at work, compared to 229 in 2007-08. Regulation was disjointed, with multiple sets of regulations calling for different practices and setting different standards in different industry sectors. Numerous sectors and work activities were not covered by regulation at all. There was no requirement for employee involvement in managing health and safety.

The health and safety system which has developed in Great Britain under the Act has been successful in delivering a 70 per cent improvement in performance and has created a model which other countries seek to emulate.

One of the key concepts in the Act is that the HSE as regulator promotes a generic goal setting (or outcome-based) approach based on the principle that “those who create the risk are best placed to manage it”.

There are a number of advantages associated with such an approach. First, it is non-prescriptive, setting down instead non-specific, generic principles that can be applied across all industry sectors.

Second, it ensures that duty holders think for themselves rather than adopting a 'tick-box' approach to compliance. Third, it puts responsibility for risk-management onto employers and their employees, and encourages ownership of risk-management activities.

The time for action

Who decides when an employer has done enough? The simple answer is of course the courts. But, as only a few health and safety cases ever go to the higher courts, the judgement on a day-to-day level rests with the creator of the risk – the employer, not the enforcer. And it would seem that the vast majority do a very good job in getting the balance right.

HSE helps employers by outlining the standards that duty holders are expected to achieve. Our key message is that employers are expected to reduce risks 'so far as is reasonably practicable' (SFAIRP), a very important principle of proportionality which we have rigorously and successfully defended. We also use the term ALARP – 'as low as is reasonably practicable'. The two terms mean essentially the same thing and at their core is the concept of weighing a risk against the trouble, time and money needed to control it. HSE has always felt that SFAIRP is a reasonable and appropriate way in which to qualify what would otherwise be absolute duties within European Directives, and is glad that the courts have supported our view.

Consistency of enforcement

HSE seeks to be consistent in its enforcement through publishing the enforce-

ment policy statement (EPS) that sets out its general principles of enforcement – proportionality, targeting, transparency, consistency and public accountability – and by being open and transparent about our priorities. Individual inspectors can exercise discretion (as the principles of law allow) taking into account individual factors and also whether a particular case is in the public interest.

There are some who believe there is a case for relaxing health and safety law in some areas. HSE's view is that a great deal of flexibility already exists within health and safety legislation, which allows duty holders to be practical and proportionate when addressing risk. It is therefore much more a case of building confidence among duty holders to do what is good enough and appropriate rather than a question of exemption from, or relaxation of, the law.

We recognise that some – particularly small employers – struggle to understand what is and is not required. HSE has produced a number of example risk assessments to help them. These aim to give a steer to small businesses as to what 'good enough' means. The example risk assessment web page is one of the most visited pages of our website with over 100,000 hits every month.

For the last two years, we have also been running a Sensible Risk Campaign aimed at regaining the focus on what real health and safety is really about, rebuilding the health and safety 'brand' and embedding a sensible approach to managing health and safety.

Sensible risk management is concerned with ensuring that workers and

the public are properly protected, reducing real risks, and being clear about roles and responsibilities. It is not about creating a totally risk free society, stopping work or leisure activities taking place – or wrapping children in cotton wool.

The future

The HSE's recently launched strategy for health and safety emphasises common sense and proportionality (sensible risk management), the importance of leadership, as well as worker involvement and consultation.

We will continue to work with the SME community to help them to understand how to comply with health and safety law in a way that is proportionate to the risks of their business.

HSE and its partners in local authorities will focus on key activities to ensure that duty holders manage health and safety in their workplace, through providing advice and guidance on what the law requires, taking appropriate enforcement action in cases of breaches of the law, and by alerting duty holders to new and emerging risks as they are identified.

Through this strategy, HSE aims to achieve widespread recognition of, and commitment to, real health and safety. And by so doing it hopes to reduce still further the number of accidents and cases of ill health in the workplace.

I believe that we will get the right balance in regulation and risk management by having good regulation that supports businesses and innovation, and sensible risk management which ensures that employers focus on real, not trivial, risks. □

Achieving a balance between safety and convenience

Alistair MacDuff

I am going to consider the issue of actions for damages in the case of negligence or breach of statutory duty, and what has been called 'the culture of compensation'. There are three criteria for establishing negligence in the courts. It has to be shown, first, that the defendant owed a duty of care in law to the claimant. Second, it has to be shown that he has broken that duty of care and, third, that the breach caused the injury.

The first point about Duty of Care is that there has to be a relationship. The

obvious example is that of employer to employee. The occupier of a premises also owes a duty of care to the visitor – to keep the visitor safe (even in the case of a trespasser, though this is less). A motorist owes a duty of care to other road-users; so does the Highways Authority to keep the roads safe. There are other examples: teachers to pupils, doctors to patients, and so on.

What is the extent of the duty? Well, it is really to take reasonable care in all the circumstances. Yet this is obviously open

to wide judicial discretion. 'Reasonable care' depends on one's own understanding and on the circumstances, including the remoteness of the risk and the severity of the consequences.

The second criterion is 'has there been a breach of this duty of care?' It is for the judge to decide whether the defendant has / has not taken 'reasonable care'.

The third element concerns whether the breach caused the injury. This is a matter for lawyers but if, for example, it can be shown that a claimant would not

have used safety goggles had they been provided, then the failure to provide them would not have caused the accident. On the other hand, there may be two competing causes for the injury which the judge has to consider.

The whole law of negligence can be summarised in one word 'fault': is the defendant at fault and if so, is the claimant also at fault?

The law in practice

The case of Tomlinson and Congleton Borough Council went all the way to the House of Lords. I propose to give an overview of this case to demonstrate the way the law works. It is a working example. The defendant had a public park in which there was a lake used for recreation, windsurfing, canoeing, sub-aqua diving and other regulated activities, as well as sitting and picnicking on the 'beach' and paddling on the edge of the water. On a nice sunny afternoon people would visit from all over the locality. The lake was in fact an old gravel pit which had been flooded and the edge of the lake was shelved, so that it was a bit like a beach.

Swimming was prohibited. There had been previous mishaps and signs had been erected which said 'dangerous water, swimming prohibited'. These signs were in abundance and visible. At busy times in the summer rangers were employed to prevent unauthorised use and they were often verbally abused according to the law report.

Mr Tomlinson visited the lake, he ran into the water and he dived into the shallow edge, striking his head against the bed with sufficient force to drive his fifth cervical vertebrae into the spinal canal, causing paralysis from the neck down. He would never work again and would require nursing for the rest of his life.

He had seen the signs and knew he was prohibited from swimming. He alleged that the shores of the lake should have been made inaccessible. Following the accident this was done with the planting of shrubbery and other vegetation, in places protected by secure fencing. This prevented people from getting access and of course stopping anyone from sitting on the so-called beach or allowing their children to paddle.

So was the council negligently responsible? Was it the council's fault? Was Mr Tomlinson himself to blame – after all, he had seen the signs. Should liability be shared – contributory negligence?

The judge, Mr Justice Jack, found that: Mr Tomlinson was aware he should not



The Hon Mr Justice MacDuff KB is a High Court Judge in the Queen's Bench Division. Sir Alistair read law at the London School of Economics and went on to do a Master's degree at Sheffield University. He was called to the Bar in 1969 where he made his career specialising in health and safety cases, and claims for damages for personal injuries. He took silk as a QC in 1993. He became a Circuit Judge 1997 and a High Court Judge of the Queen's Bench Division in 2008.

swim; he had seen the notices; the risk was obvious; there was no duty on the council to protect him against himself as it was his choice; and, crucially, there were no hidden dangers of which he was not aware. It was not as if there were some spikes submerged invisibly below the water on which he might bang his head and which might have mandated the council to make it even clearer that he should not go in. The accident was his own fault and he received no damages according to the judge.

Then the case went to the Court of Appeal. By a majority of two to one, it was found that there was a grave risk of injury. Internal documents disclosed previous injuries to swimmers though not, it has to be said, by striking their heads on the bottom of the lake. The defendants knew there was unauthorised use, they could reasonably foresee that people would ignore the notices. The attractiveness of the location was an 'allurement'. The court of appeal held that sooner or later there would have been a serious incident and this accident was 'reasonably foreseeable': thus a duty of care existed. It was necessary that the council should have provided the landscaping and planting and prevented physical access in order to discharge their duty of care.

The claimant got his damages though reduced because of contributory negligence.

One of the Lord Justices assessed it at 50 per cent, but the others at two-thirds. So he received one third of his very substantial damages claim from the Court of Appeal.

Different judgements in law

This all goes to show that lawyers can take different views about what the law actually says, how one interprets it and what is reasonable.

The case then went to the House of Lords (it is always the ambition of a first-instance judge to be reversed by the Court of Appeal and then be told he was right by the House of Lords!). The Law Lords held that just because there may have been a foreseeable risk, there was no duty upon the defendant to do everything possible to prevent it – only what was reasonable. It was important to recognise that people could judge the risk for themselves. There was no hidden danger; that was the crucial point. Had there been a hidden danger in the water then the council might have been under an obligation to do more. The balance of reasonableness included the ability of people to enjoy the beach and other amenities which would otherwise be closed to them.

Lord Hobhouse said: "Does the law require old trees to be cut down because youths may climb them and cause themselves to fall? Does the law require the coastline and other beauty spots to be lined with notices? Does the law require the attractive waterside picnic spots to be destroyed because a few foolhardy individuals refuse to acknowledge warning notices and indulge in activities dangerous only to themselves?"

A final thought: we have to look at the balance between safety and convenience. The Government could reduce road accidents at a stroke by setting up a 4mph speed limit and requiring a man with a red flag to walk in front of the car. But that would be an extreme reaction, not a balanced one. There has to be a proportionate approach to what is – or is not – reasonable. □

DISCUSSION

The blame culture

A major concern was the prevalence of the 'blame culture', the search for compensation for any injury, and the enormous costs incurred in defending claims, or insuring against them. But it is not solely driven by a desire to get compensation, it also stems from the cries of the media and politicians for someone to be 'held responsible' and be punished. There is a great deal of public frustration about the many cases where corporate complexity or confusion between authorities means that no person could be found to whom blame can be attached.

What investments should we make as a country to maximise the mental capital of all our citizens? This was the subject of a dinner/discussion held at the Royal Society on 1 April 2009.

Mental capital, skills and wellbeing

Tom Kirkwood

The term 'mental capital' was coined in the Foresight Report *Mental Capital and Wellbeing* to represent the totality of our cognitive and emotional resources. The brain defines us as individuals. It enables us to acquire and apply skills throughout life, but it is also a vulnerable organ, vulnerable to stress, deprivation, alcohol and drugs, illness, inactivity and isolation.

The earliest period of life — the pre-school and primary school years — have a vital role in contributing to our mental capital. A safe and secure environment is needed if the capacity to develop mental capital is to flourish. Early stimulus, nutrition and exercise are important in the development of mental health, mental capital and the development of social skills.

Socio-economic disadvantage presents a substantial threat to the acquisition and proper development of mental capital. A significant number of children suffer specific, intrinsic learning difficulties. Dyslexia, dyscalculia and other learning difficulties, if detected early, can be overcome to a large extent.

Adolescence

There is significant biological development of the brain during adolescence. One of the skills to be developed is the capacity to become self-motivated, to apply oneself to work for what may be a delayed reward. To develop this requires a significant degree of maturity.

There are important social and peer pressures that apply during this phase of life. Nutrition and exercise are important in all stages, and have particular relevance during this stage. Adolescents are particularly vulnerable to social exclusion, failing to make the right social and peer group connections, failing to develop the right motivational structure or the capacity to work for delayed reward. And, for many adolescents, there are significant threats that come from drug and alcohol misuse.

In the adult phase, 'cognitive resilience' or 'cognitive reserve' becomes important — the capacity to cope with what life throws at you — and also build-



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ing the reserves needed for sustaining mental capital through the later years of life. The threats in this phase are stress and anxiety.

Later years

The later years of the life-course trajectory have been seriously neglected by society to date. We must take account of what is happening because of the continuing increase in life expectancy. Importantly, it is in large part a decline in late life mortality that has raised the average life expectancy in recent decades, and this is having a huge impact on the structure of populations around the world. The ques-

tion is: what are these 'extra' years late in life going to be like when we come to use them and can we make them better?

In the Newcastle 85+ study (funded by the Medical Research Council and the Biotechnology and Biological Sciences Research Council) we are discovering what people are like at the age of 85, and studying their life trajectory over the next five years. We approached everyone in Newcastle and North Tyneside registered with the National Health Service born in 1921 and asked them to take part; three-quarters said yes.

Strikingly, we have found that 85-year-olds, as a group, are in much better health than we tend to appreciate. And for those who do not have anything wrong with their brains, their cognitive skills are comparable with those of younger ages.

As a society, we seem to be unsure about whether what is happening is a good or a bad thing. Some economists stress the 'burden' of an ageing population on the productive sectors of society. Yet the University of Chicago calculated contributions to the US economy from the gain in life expectancy between 1970 and 2000 and came up with a \$73 trillion benefit to the US economy. It is not all fiscal bad news.

We worry whether we can afford increasing life spans. There are many

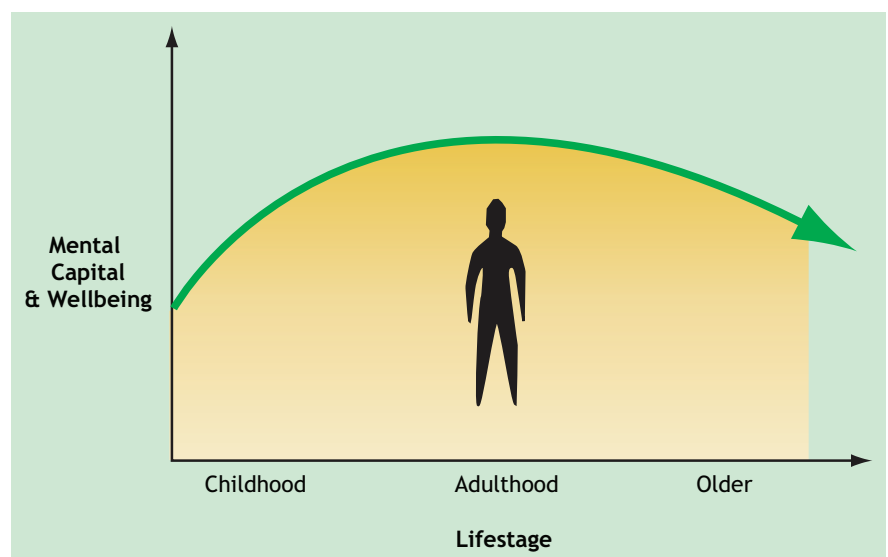


Figure 1. The life course trajectory of mental capital and wellbeing.

misconceptions here. Increasing medical costs are not so much driven by the fact that we are living longer as by the fact that medicine is becoming intrinsically more expensive because for most people most of the medical expenditure is incurred during terminal illness. The fact that the 'good' years — the healthy years — are stretching out is not a significant burden on the health service.

High-cost social dependency very often arises from failure to address problems or to invest in the interventions that could easily protect against them: old people can be much more productive than they are normally given credit for.

Huge amounts of mental capital are simply discarded by society and, sadly, discarded by older people themselves because

some of the most ageist people in our society are old. If you are ageist when you are young there is no reason to suppose you are going to change your attitude simply because you have become old yourself.

Old and young

Will a greater focus on the interests of older people harm the interests of the young? Some 85 per cent of today's children will reach the age of 65 or more. There are a number of barriers to changing the status quo. We tend to be too fatalistic. We indulge in negative stereotyping. There are good reasons to invest in the growth and the potential of young people, but there are very good reasons also to pay attention to the whole course of life.

We traditionally regard mental capital as what we teach people when they are young. There is a view that it is inevitable that mental capital loses its value in older people, that older people are simply 'past it': they need to be pensioned-off, looked after for a while, but that is the end of the story.

We need a new view. We gain mental capital throughout life, high-value exists in the mental capital of older people, but we under-use it. There are many dimensions to mental capital and wellbeing and the essence of happiness and mental wellbeing is a well-skilled brain. □

Foresight Report on Mental Capital and Wellbeing: www.foresight.gov.uk/OurWork/ActiveProjects/Mental%20Capital/ProjectOutputs.asp

Raising skills to counter inequality in the workforce

Richard Layard

The revival of apprenticeships and the Apprenticeship Bill now going through Parliament are welcome developments. If this legislation can succeed in delivering apprenticeships to almost every young person who would like one, it will be considered as one of the main achievements of this Parliament.

Low skills levels are among the biggest challenges facing any advanced country. Technical progress and globalisation are shifting the demand for labour towards high-skill occupations, and over the past 25 years the result has been an increase in inequality within the workforce between high and low-skilled labour. The solution is to reduce the amount of low-skilled labour faster than the demand for it is reduced.

Inequality has an insidious effect on the quality of life for everybody, rich or poor. The problem is particularly severe in Britain, largely because of our peculiarly unequal educational system. Contrary to popular perception, the greater part of the educational inequality arises not because people have unequal provision of education, but because after the age of 16 or 17 about half of the population gets almost no publicly-provided education, whereas another 40 per cent are getting a further two years in the sixth form and three years at university.

We have to find ways of inducing our



The Lord Layard FBA, was founder-director of the London School of Economics' Centre for Economic Performance.

He has written widely on unemployment, education and inequality and is the author of *Happiness: Lessons from a New Science*. He is campaigning for NHS provision of evidence-based psychological therapy for those people with clinical depression and chronic anxiety disorder.

young people — particularly in the 16 to 19 age range — to continue developing their educational competencies, vocationally or otherwise. Many will only be willing to do it (whatever the law says) if they can earn while learning: that is the fundamental argument for apprenticeship. We passed a law that says that everybody has to continue learning to the age of 18, but unless we have something like apprenticeships to offer them, it will not be possible to implement this law successfully.

The economic case

There is also a strong economic case for apprenticeship. The social rate of return for apprenticeship, a measure of the net

benefits to society of educating its citizens, is 35 per cent — extremely high compared to most full-time education in sixth form or university undergraduate courses, which is more like 10 or 12 per cent. In addition, the learner is both producing something while he learns and learning something directly relevant to his work. Apprenticeship should be more vigorously promoted.

Apprenticeship has a bigger impact on wages than National Vocational Qualifications (NVQs) on their own. This is because of the off-the-job learning which is essential to complement the on-the-job learning. This is a matter of some controversy but it is vital in a world of rapid economic change and substantial job turnover that we do not just instruct the half of the population that does not go to university how to do their present job and assume that is enough. Skills training should not focus solely on the immediate skill that the person needs in their current employment. That is a feature of many aspects of NVQs and a weakness.

There has to be, within the apprenticeship, at least a day a week, or equivalent, away from the individual's workstation. Yet many employers resist this.

Now, if the Government is providing money it is because there is a social interest; general as well as specific training for the apprentice is less in the interest of the

Young and old

There was concern that the Government is focussing on vocational training for the young, at the expense of older people who, while already skilled, need further training if they to find work in the economic downturn. There is scope for bringing together intergenerational and cross-industry groups who could share experiences, further training and opportunities. Other sectors of the population, such as postgraduates, also needed help even after years of university training. 'Executive skills' such as the ability to control emotions, solve problems, work in groups and understand the constraints of a daily job, do not come automatically. These abilities need to be inculcated at an early age, ideally with good parenting.

employer than of the employee. We must have proper apprenticeship standards of the kind that you see in many countries on the continent.

Current Government policy is on the right lines. It involves compulsion (by 2015) on all youngsters under 18 to be in part- or full-time education. It also guarantees (by 2015) access to apprenticeship for all those with five GCSE passes at any grade. This will be the main route

through which the additional participation in education will be achieved.

Finding the places

Finding enough apprenticeship places (for at least 20 per cent of youngsters under 18) will be a major challenge. There is a huge scope for the expansion of apprenticeships, but employers need inducements if they are to contribute fully. Educational Maintenance

Allowances are paid to sixth formers, and it is right that they are not paid to apprentices, since these earn an average wage of about £120 at the moment. But there is no reason why the state should not be paying that amount of money to employers, on behalf of people who are entitled to Educational Maintenance Allowances, in order to encourage them to offer apprenticeships.

It matters how people feel. The subjective wellbeing of the population should be the main measure of how we are doing as a society. That is the way we should think about the progress of nations. In the Enlightenment it was the general view of most educated people in this country that you would decide whether a country was making progress, and whether it did well compared with another country, by looking at the happiness of the people. If we are to pursue this 'progressive agenda' it should be a major purpose of social science to unravel the causal processes involved in the determination of subjective wellbeing. □

Skills training in the recession and beyond

John Denham

The credit crisis and associated recession, which began with sub-prime lending in America, has swept the world. No country is immune. The challenge we face in the UK is not just to support businesses, families and individuals through the immediate crisis, but to take action to ensure that we come out of the recession as swiftly and strongly as possible.

As we develop a clearer idea of the sectors of the economy in which we have particular strengths, potential competitive advantage and the ability to generate wealth and jobs, we must ensure that Government policy makes the most of this potential.

Industrial activism

'Industrial activism' is a new policy direction – not a return to picking winners, but consciously organising ourselves for success in the areas of greatest strength. This means being coherent across public policy. A key part will be played by a new 'skills activism'. In



The Rt Hon John Denham MP, since June 2009 Secretary of State for Communities and Local Government, was Secretary of State in the Department for Innovation, Universities and Skills at the time of this talk. His first government appointment was as Parliamentary Under Secretary of State at the Department of Social Security in May 1997 and he was later Minister of Health. His early career was spent working for aid charities including War on Want, Christian Aid and Oxfam.

December 2006 the Leitch report, *UK Skills: Prosperity for all in the global economy*, set the target of positioning the United Kingdom in the premier league of world skills by 2020. This ambition has been underpinned by rising investment in further and higher education,

and by the revival and renaissance of apprenticeships. But we need to go further, to ensure that in these key sectors at least, we can be sure that we have the right people in the right place at the right time.

Over the past few years, the skills system has become increasingly demand-led, responding to choices made by employers and learners. While this has produced a more responsive and effective skills system, we need to know more about how employers use skills and what drives their investment in training.

Most skills investment comes from employers, not through Government. The same factors drive skills investment as other investment – the certainty and predictability of market demand, effective and proper regulation.

Both markets and regulation are important in ensuring that we get a properly equipped workforce. In certain areas, such as the nuclear industry, employers have the confidence in the future to invest in skills needs. In other sectors of potential

A lifelong project

The development and maintenance of mental capital is a lifelong occupation, and crucial to both economic success and subjective wellbeing. Important investment decisions flow from this view: intervention is needed at the earliest moment when mental capital is being threatened, by bad parenting, isolation, social stress, drug and alcohol problems, for example. Money spent at the start of a problem repays itself many times over in money saved on social or health problems later. Getting young people — indeed everyone — to understand that learning does not stop at 16 is vital. Thus there is great value from: investing in post-16 education; in removing barriers to further education; and in increasing opportunities for advancement from lower- to higher-skilled jobs.

growth, for example in the construction industry, the future opportunities are less clear.

It will be an important part of the role of the new Skills Funding Agency to ensure that the skills system becomes sufficiently flexible to meet such demands. The newly licensed sector skills councils must also play a role.

The word 'skills' is often assumed to be synonymous with vocational skills, but when it comes to the relationship between skills and future economic prosperity, we have to look much more widely.

Some globally mobile IT companies come to the UK because of our skills base and not, primarily, our technician or even our graduate skills base: they want to recruit people who have conducted fundamental research in a world-leading computer science research team.

HE sector

Given the increasing necessity for higher-level skills in the jobs of the future, the responsiveness of the higher education sector to employer and industry needs is essential. Universities must engage in two broad areas. First, they must deliver high-level skills for employment. Last year, our high level skills strategy, *Higher Education at Work — High Skills: High Value*, stressed the need to step up employer engagement with the design, development and delivery of courses, as well as to expand vocational and work-based study.

Some universities are already rising to that challenge. Last year, interactions with businesses and communities earned universities £2.64 billion — 17 per cent up on the previous year. Given the amount of training across all levels that

higher education providers could compete for from business — perhaps £5.5 billion — the scope for such collaborative activity remains huge.

In future, universities will need to offer greater diversity in methods of study, as well as qualifications, in order to satisfy a growing need for graduate-level workers. That means, especially, more opportunities for part-time study and study in the workplace.

The second area where universities can do more relates to learner and employer demand for skills above Level 4. Demand is growing, but we lack clear public policy in taught and research postgraduate studies. Our universities must not only be able to attract the world's best postgraduate researchers but also ensure that research careers are attractive and attainable for home students. We need a coherent strategy for postgraduates and a clear division of responsibility between funding and research councils.

Delivering more, and more employable, graduates is not just to drive economic growth. Graduates are more likely to have higher levels of wellbeing, as well as enjoying better health and better pay.

In looking at future challenges to the skills system, I do not want to understate our recent achievements. The creation of the Train to Gain programme showed our commitment to putting the buying-power of public funding for training under employers' control. By next year, over £1 billion will be available to support the training that employers need to drive their businesses. The Government has built up apprenticeships so that they can become a mainstream training option for young people. The number of apprentices today is about four times higher

than in 1997. In addition, most employers want people who can read and write. In the past five years we have taught 5.7 million people basic skills.

Personal and economic needs

The Foresight report provides a sound academic base for challenging the false choice between personal needs and the economy. It also stresses the debilitating effects that unemployment can have on mental health. That is one reason why we are offering extra assistance in the short term to help employers and individuals weather the recession.

We are funding 35,000 more apprenticeships next year, at a cost of £140 million, and spending an extra £158 million to help people facing redundancy. In addition, £83 million is being made available to fund 75,000 further education places for those out of work for six months.

In the *New Opportunities* White Paper, the Government set out its commitment to provide more opportunities for the most vulnerable people in society. We are piloting new rights for low-income families in work who are on tax credits.

The benefits of learning are not found only in skills or employment outcomes. Learning for its own sake makes an enormous contribution to creating the kind of society we can be proud of. We recognise that informal adult learning can transform individual lives and boost our nation's wellbeing.

The *Learning Revolution* White Paper aims to encourage people to engage in more forms of informal and community learning. We are working with the Department for Health to use informal adult learning as a way of keeping older people physically and mentally well and the Government is committed across all departments to develop and deliver solutions to Britain's mental capital challenges. □

Leitch Review of Skills: www.dcsf.gov.uk/furthereducation/uploads/documents/2006-12%20LeitchReview1.pdf

Higher Education at Work – High Skills: High Value: www.dius.gov.uk/consultations/high_skills

New Opportunities White Paper: www.hmg.gov.uk/newopportunities.aspx

Learning Revolution White Paper: www.dius.gov.uk/skills/engaging_learners/informal_adult_learning/white_paper

Summaries and presentations accompanying all FST dinner/discussions can be found on the website: www.foundation.org.uk

Sir John Maddox was Editor of *FST Journal* from 2001 till his death earlier this year. Here, Charles Wenz recalls the man who had a major impact on the reporting and discussion of science.

Sir John Maddox FRS

27 November 1925 - 12 April 2009

In his 60-year career in science and journalism — he was a lecturer in theoretical physics at the University of Manchester in 1949 and was still an active editor of *Nature* and working on other projects at his death at the age of 83 in April this year — John Royden Maddox was a major influence on the scientific enterprise (a term he liked to use when writing a leader on how it should be conducted) and its role in society.

He was science correspondent at the *Manchester Guardian* in the 1950s and after a spell as head of the Nuffield Foundation he began the first of two stints as Editor of *Nature*. During his editorship (in 1966-73 and 1980-1995) it is fair to say that the journal's influence increased immensely. I was working at *Nature* when John returned in 1980. In the years immediately before that, we had developed a team of subject-specialist editors and a rigorous peer-review system that helped to ensure the quality of the research papers in the journal's 'back half'. With that authority as a firm platform, John used the news and opinion pages to inform and influence scientists and politicians.

By the 1980s, science had become the province of the specialist. But John was not one of them; perhaps emboldened by his dictum "everything is physics", he maintained his interest across the science spectrum. As well as writing copiously on the events of the day in leaders, John introduced the concept of the *News and Views* leader, intended to air challenging ideas in a different field each week, and ideally to provoke a lively discussion. This was not intended to be solely 'his' page. But it very often was. Not many specialists held heterodox views that they were keen to air in 1,100 words in order to stir up debate. Journalists commissioned to do it would ask for much more time than would be available to get up to speed in a new field, check facts and test their ideas on experts. But John was happy to immerse himself in the most arcane of topics, identify what stimulus he felt that it needed, and apply himself to arguing a case. Noses were put out of joint and apple-carts upset, but that was the point of the exercise: job done, and on

to next week's topic with relish.

John's voice, and his ability to pose probing questions, worked well on radio. *Scientifically Speaking*, which ran on Radio 3 in the 1970s, was 'Reithian' broadcasting at its most Reithian. The programme set out to educate, inform and entertain. The emphasis was on the first two, though it was certainly entertaining to hear Richard Feynman answer "no", when asked if he could put a particular aspect of quantum theory into layman's terms.

Ahead of his time

John was in many things ahead of his time. His approach to science publishing was one example. He split *Nature* into three weekly parts at a time — for the years 1971 to 1973 — when the market was not really ready for it, and when the clunky subscription fulfilment systems that publishers used at the time could not cope with the challenge. That experiment was aborted but four decades on, the *Nature* name appears on 30 different titles; John was just early with the move.

John influenced many people over the years, particularly those in science journalism. Many of those who worked with him will still ask themselves, when a story breaks or a scientific advance is announced: "What would John do? What would John say?" They might go on to do or say just the opposite but John would have informed their decision and stimulated discussion as he always did.

He believed in the scientific process, but not necessarily in the scientific consensus or orthodoxy of the day. To a reporter about to tackle a story on ocean cadmium pollution — a popular theme in the 1980s — he asked them first to spend time establishing whether it was a bad thing.

There have been many obituaries for Sir John Maddox published in the past months. They have recorded the spats and memorable clashes — his unconventional publish-and-be-damned approach to Jacques Benveniste's paper claiming that water had 'memory' and his enthusiastic criticism of Rupert Sheldrake's theory of morphic resonance are perhaps the most memorable. But through all of them,

John's enthusiasm for science has been a recurring theme. And as Steve Connor wrote in the *Independent*, everyone who came across him has their "John story". Connor's recalls "The night I fixed drinks for Sir John" (<http://tinyurl.com/c5xdkb>).

John's influence spread wider still. On being introduced to a sixteen-year-old starting that day in the office, John asked what science classes he had done at school and if he had enjoyed them. He had, and they were classes developed at the Nuffield Foundation when he ran its science teaching project (he had later become the Foundation's director).

A newsman

So that is John Maddox. A man of science and a newsman. He was in his element one 'news night' at the typesetter's in 1986 when sketchy details of an accident at a nuclear power station in Chernobyl began to emerge. He had views on nuclear power (and had covered the 1956 opening of the first commercial plant at Calder Hall), plenty of views on the Soviet Union and his inner physicist was fascinated by the details of what isotopes were heading our way.

That — a few days after 'Chernobyl' — was too early for the long-term effects of radioactive pollution in the Welsh hills to have emerged. But this was his territory too. He was Welsh and proud of it. He had a cottage in Wales and was a councillor there. Many a time he would be rushing to finish his copy so that he could get back home in time for a council meeting.

And back in Wales, we were once at Cardiff Arms Park to watch Australia — with David Campese — play the Barbarians. As 'Cwm Rhondda' sounded out and the crowd sang, John said in a breaking voice, "This is as near as I get to religion, Charles".

Charles Wenz is on the *Nature* staff and is an occasional contributor to and sub-editor for *FST Journal*.

A series of tributes by his colleagues, and a selection of John Maddox's journalism covering four decades at *Nature*: <http://tinyurl.com/dm6p7s>

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