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Research and Development

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Traffic congestion

Managing urban congestion



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Congestion charge one year on

The London congestion charge was a year old on 17 February and, with some reservations, the optimism evident at the Foundation's discussion at the three-month stage (page 21 in this issue) seems to have been justified. The trends seen at three months were largely continued through the year. Traffic volumes inside the zone were down by 16 per cent over the year, compared to the predicted 10 per cent. But that brought complications. With fewer cars entering the zone than expected, the net income generated by the charge was just £68 million, well short of the £130 million predicted for in the first year.

As Malcolm Murray-Clark, director of congestion charging at Transport for London (TfL) says, the technology behind the scheme is vital to its success. The technology has worked well. But, according to the AA Motoring Trust, thousands of motorists have avoided the £5 charge by driving vehicles that are inaccurately registered with the DVLA.

Enforcement was also seen as a key factor. Net revenue from penalty charges in the first year of the scheme was about £50 million, a major source of income, especially with the lower than anticipated income from the charge itself.

Perhaps encouraged by the perception that some drivers are evading the charge and that fines are such an important source of cash flow for the scheme, motoring organisations report that drivers feel that enforcement is becoming increasingly fierce.

For the future, TfL is proposing an extension of the charging area to take in most of Kensington and Chelsea and more of Westminster. But the overall effect of congestion charging on the capital's economy is still not clear. Many but not all retailers are reporting a reduction in takings and blaming the charge. The Oxford Street store John Lewis reports a 9 per cent drop compared to stores in other sites.

As for other cities, Edinburgh is planning a scheme of its own, but Bristol seems less keen than before. Public transport alternatives to the car are important here. Although overcrowded and still lacking investment, London does have the comprehensive transport network that some other cities lack. □

Primate centre dropped

The future of top-level research in neurophysiology and other clinically important areas in this country is in the news following Cambridge University's recent decision to drop plans for a primate centre to conduct animal research into brain diseases.

The plan had been supported by prime minister Tony Blair as one "of national importance". But animal rights activists have waged a relentless campaign against the centre and, with no signs of any help, the university cited "escalating costs" due to years of delays and security concerns as the reason for the decision.

The Research Defence Society, an organisation representing medical researchers in the public debate about the use of animals in medical research and testing, has called the Cambridge decision a "serious blow to British medical science". The facility would have been a world-class centre of excellence for research into serious conditions, such as Alzheimer's disease and Parkinson's disease. Cambridge University plans to continue the primate research elsewhere.

Following the long-running security problems that dogged Huntingdon Life Sciences, the company that carries out toxicity tests on animals on behalf of drug companies, there is wide concern about the future for life sciences research in the United Kingdom. As is evident from the involvement of a South Korean laboratory in the recent advances towards the goal of human therapeutic cloning, there is a growing trend towards the "offshoring" of facilities and jobs to countries with suitable legislative frameworks and where opposition tends to be less stringent.

Opponents of animal research have greeted a paper published

in the *British Medical Journal* (Where is the evidence that animal research benefits humans? P. Pound, S. Ebrahim, P. Sandercock, M.B. Bracken & I. Roberts *British Medical Journal* 328, 514-517; 2004). This paper questions the need of some animal experiments, citing examples where research has been badly designed or where it has been carried out alongside human trials, rendering it unnecessary. The authors argue that animal testing needs to be reviewed and that the same standards that apply to human research be applied to animal research. They say they are neither in favour of nor opposed to animal experiments.

On the same day that the *British Medical Journal* paper was published, the Royal Society published a guide¹ highlighting the many ways in which humanity has benefited from scientific research involving animals. □

1. The use of non-human animals in research: a guide for scientists
www.royalsoc.ac.uk/files/statfiles/document-250

Consultation for ten-year science framework

On the 16 March the Chancellor announced that HM Treasury, DTI and Department for Education and Skills (DfES) would open a consultation on the future strategy for science in the United Kingdom. In the Economic and Fiscal Strategy Report¹ the next day there were frequent references to science, research and innovation as important ways in which productivity can be increased in the UK economy. The consultation will end on 30 April; the consultation document can be found at www.hm-treasury.gov.uk/consultations_and_legislation/science_innov/consult_sciinnov_index.cfm.

These documents are the first stage of the Government response to the Lambert Review (see *FST Journal*, Vol. 18 (2), pp.3-5) and the DTI Innovation Report (see 2 December 2003 Meeting Summary on the Foundation website). Richard Lambert was appointed by HM Treasury to examine how knowledge generated by universities was utilised by business. His report advocates strengthening the regional dimension by putting more emphasis on the role of the Regional Development Agencies and the devolved authorities in promoting science, and a dedicated budget for knowledge exploitation and university governance. The DTI Innovation Report focused on consolidating the many DTI business support schemes, innovative design, maximising the stimulation of innovation through the Government's procurement activities and progressing the skills agenda.

The Government intends to publish the Ten-Year Science Framework at the same time as the spending review outcome in July this year. The intent is to bring together in one document all the many strands of science support in the United Kingdom and to set out the priorities for the science spend. The Government is clearly seeking a closer partnership between business, charitable and Government funded science. Lord Sainsbury, the Science Minister, in a speech on 18 March said "the latest international comparison of data on business R&D show the UK well behind the US and roughly equal to the EU average. However, it is encouraging that, after a steady period of decline from 1.5 per cent of GDP in 1981 to 1.16 per cent of GDP in 1997, we have seen a move in the right direction to 1.24 per cent in 2002". The Government will also include in the Framework the actions required to implement the Roberts Review of skills (see *FST Journal*, Vol. 18 (1), pp. 3-5).

The preparation of the Ten-Year Science Framework will be managed by a steering committee chaired by Paul Boateng, the Chief Secretary of the Treasury, with Lord Sainsbury and Alan Johnson from the DfES. The consultation defines science to include all aspects of engineering, technology, mathematics, design, social sciences and the arts and humanities and also includes many references to the medical sciences. □

1. www.hm-treasury.gov.uk/media/DD446/bud04_ch3_281.pdf

GM wars end in stalemate

John Maddox

The long British flirtation with genetically modified (GM) crops came to a sudden halt at the end of March. On 9 March Margaret Beckett, Secretary of State at the Department of Environment, Food and Rural Affairs (Defra) had announced that only one of three crop varieties used in the field trials of GM plants would be licensed for use. On 30 March, the developers of the plants concerned, a variety of maize known as Chardon LL, said it would not carry the project further.

The announcement on 9 March was not a full-throated encouragement to farmers to try out GM crops, but was so hedged about with political and technical conditions that it must be regarded as a mere token that the British Government is not doctrinally opposed to GM crops.

The decision was that licences would be issued for a strain of maize developed by Bayer CropScience, but that the artificial varieties of sugar-beet and oilseed rape used in the same field trials would not be licensed. The maize (and the two other crops) had been engineered to be tolerant to herbicides, meaning that crops would not have to be mechanically weeded, but that fields can be sprayed with herbicide instead. That saves costs and avoids mechanical damage to a growing crop.

Re-licensing requirements

Within the terms of the Government's intended licensing scheme, those granted licences for growing Chardon LL in 2005 would have had to be re-licensed in 2006, when the herbicide atrazine, used in the field trials of the maize, is due to be phased out under EU regulations. The Government said that "consent-holders" would have to arrange for fields trials comparable to those completed last year (presumably at their own expense), using a new herbicide regimen, before licences would be renewed.

There are two further hurdles to be surmounted. First, Britain will insist that existing EU marketing consent for GM maize should be restricted so that it can be "grown and managed" only as in the trials or in such other way that does not produce adverse effects on the environment. The adverse effects include those that have led the Government to conclude that the strains of sugar-beet and oilseed rape grown in the trials could not be licensed for general use.

The Government also says that arrangements for the co-existence of GM and other crops should be in place before GM maize is licensed for commercial use. This is a contentious issue, given the interest of organic farmers that their status should not be compromised by neighbouring GM fields of maize. The physical separation of the two kinds of crops has not yet been agreed between the interested parties.

Field trials

Last year's field trials, the most extensive of their kind ever carried out, were designed for the specific purpose of assessing the influence of GM agriculture on the ecology of the fields in which GM crops are grown. It was never intended that the trials should allow an assessment of the toxicity (or otherwise) of GM crops to human beings and other mammals — in Britain, cattle are the chief consumers of GM maize, usually cropped as silage (that is, while still green, or unripe). Nor was it intended to test Bayer's claims that GM maize is more productive than conventional varieties.

The ecology of cropped fields, like the ecology of all other situations, is complex. Farmers most cherish their crop plants

because they may be able to sell them or use them as fodder. On the other hand, farmers are often hostile to the weeds that multiply between the neat rows of plants because they compete with crops for nutrients and sunlight. Yet weeds may be essential to the success of the crop plants, perhaps by indirectly providing sustenance for pollinating insects such as bees, which in turn are food for birds. Ecology is notoriously rife with trade-offs of this kind. How is a simple farmer to know what to do?

“Consent is a mere token that the British Government is not doctrinally opposed to GM crops.”

The simple answer is to follow government advice. Since the agricultural revolution of the late 18th century and the foundation of agricultural research establishments such as that at Rothamsted, farmers have been deluged with advice; now there is regulation to ensure that they follow it. For example, British farmers can plant only seeds of varieties included in the Defra's approved list, which is central to the legal basis of the Government's control of crop usage on British farms.

The crucial test by which the field trials have been evaluated is that of whether the weeds surviving among the growing crops provide an adequate habitat for the microfauna of the fields used in the trials. Less attention was paid to the protein yield of the three crops grown on a total of 96 fields (divided into halves to provide direct controls of GM and conventional varieties of the same crop).

What the measurements show is that GM maize provides micro-habitats superior to those associated with conventional maize, but that both beet and oilseed rape bring about a decline of the microfauna.

Bee increase

One of the most striking effects was a 50 per cent increase of the bee population in stands of GM maize compared with conventional varieties. Nothing is said (nor could be) of the effects on birds, which range more widely than single fields.

What happens next in the GM saga is anybody's guess. Bayer's retreat will seem like victory to the anti-GM lobby; other companies will no doubt note the British Government's flair for kicking awkward problems into the long grass.

Two little-noticed components of Mrs Beckett's original statement may nevertheless show which way the wind will blow. Noting that a conventional crop was the "worst" by the yardsticks of the evaluation of the farm-scale trials, she said that "we have nothing like the control" over conventional crops as over GM crops and that "we are giving very careful consideration to these issues". Farmers will not welcome that. She also promised to provide farmers with guidance on setting up GM-free zones in their localities, which Friends of the Earth has been urging on local councils in at least some parts of the country. □

On 10 June 2003, at a time when HM Treasury was focusing on how Whitehall departments were spending their resources, the Foundation held a meeting at the Royal Society to discuss how to measure the value added to the economy by research and development.

The culture of success in R&D

Gordon Edge



Professor Gordon Edge CBE is chairman of the Generics Group.

Professor Edge trained as an electronics engineer and was instrumental in establishing a succession of high technology companies in Cambridge. He has also served on the boards of a number of companies, including Biacore International in Sweden and Applied NanoSystems in the Netherlands. He is chairman of the advisory board of the Cambridge-MIT Institute.

I have spent most of the past 40 years in creating science-based companies, many in Cambridge but others in the United States, Australia and continental Europe. I will try here to distil some of the lessons we have learned about how to optimise the research and development based business creation process. In the Generics Group we are involved in just about every element of the process, from identification of emerging science and technology, its translation into a technology and then to its move through into manufacturing and products.

I will start by putting forward four propositions. The first is that output metrics alone — the assessment of performance by directly measuring objective results — are inappropriate in research and development. The second is that a cultural process model is essential to optimise research and development. Third, and perhaps most importantly, relative effectiveness drives relative added value and hence competitiveness. And finally, it is cultural values that dominate organisational processes in maximising effectiveness.

Most companies in businesses based upon R&D can be described using the “general technology” model. A company develops its products and/or systems and/or materials and is thus dependent on the technology base and on the science and technology emerging from that base and from the education system. All companies in this sector are thus dependent on emerging technologies and need to be able to identify those likely to lead to important innovations.

In terms of added value, the multiples are at their highest in materials technology. This is a very fruitful field for investment at the moment; something like 30 per cent of Generics’ portfolio is in the materials science area and we translate such materials into products, systems and into both horizontal and vertical markets.

The general technology model remained pretty constant for the past 30 or 40 years, but recently its interpretation has changed dramatically. Take the typical pharmaceutical business. Twenty years ago, pharmaceutical companies focused primarily on the development of therapeutics. The process was, in part, empirical and in part based upon evidence in the research process. But today, a pharmaceutical company has also become a systems integrator.

It is no longer enough to develop an efficient therapy and leave it at that. It is now vital to follow through to developing the use of that therapy in a tight regulatory context so that issues such as patient compliance can be monitored, for example by determining bio-availability. Ultimately the combination of diagnostic sensors with therapeutics will lead to a personal form of medicine.

This dependence on a family of technologies has led to the concept of platform technologies. Here is an example. Titanium dioxide is a platform technology; one in which, essentially, the same piece of science and technology has multiple applications. First, there is the classic use of titanium dioxide as a pigment in the ubiquitous white paint. The development of titanium dioxide pigments illustrates the inadequacy of simple measures of the value of R&D, because very small improvements in the optical qualities of the pigments were commercially significant. Try to measure output here in terms of patents and you would be very disappointed. On the other hand, the competitive advantage deriving from the ability to introduce very marginal changes into refractivity is very important. Therefore, scientists working in this type of industry have to be focused on incremental improvement rather than discontinuities.

In a second example, titanium dioxide is a metal precursor. Innovation here is best illustrated by the FFC process, which has also spawned the Cambridge University spin-off company Metalysis. This patented process, named after its co-inventors Derek Fray, George Chen and Tom Farthing, allows a metal oxide to be directly reduced electrochemically to its metal in a molten salt medium. The oxide remains in the solid phase, eliminating the need of costly pre-processing. Not surprisingly, the output in terms of intellectual property and patents was very high in such a situation. The output metrics here do not mislead.

There is a third area too, where a titanium dioxide variant can act as an electrical conductor. Here there is an important advance where Ebonex, a conductive but otherwise inert ceramic material based upon titanium dioxide, was produced by Atraverda Ltd. With this material, titanium dioxide is moving into very traditional areas such as lead acid batteries, where it

can have a strong segmental effect. That is, it can allow a lead acid battery to be used in industries where, traditionally, it is not used. In this example most of the “intellectual property” derives from the understanding of the way in which the titanium dioxide can be used as a lead replacement.

How can we identify the research likely to be a source of added value? A survey by SPRU and MITI looked at 28 different industrial segments and plotted the added value ratio in those industries against the “skill intensity”. The core message is that skill intensity and added value are strongly correlated. However, it is the relative skill intensity and relative effectiveness which underpin competitive advantage by creating relative added value which in turn gives pricing flexibility.

Maximum effectiveness and efficiency in the skill base are therefore crucial. The important effectiveness factors include creativity, innovation, optimal time to market and quality. But culture, perhaps, is the dominant factor in optimising effectiveness. What do we mean by culture? It is a shared set of beliefs and behaviours of a community within a firm. In other words, if I, as chief executive, believe that our organisation is innovative, it is much more likely to be innovative. If I believe that interdisciplinary working will encourage innovation, then that is the process that will happen.

But these are very soft factors and it demands quite strong leadership in one sense and very subtle leadership in another.

So why this emphasis on skill? One reason is that product lifecycles are becoming

Measuring effectiveness. It was asked how effectiveness was to be assessed if output metrics were not to be used. In response reference was made to past studies which had identified 17 variables affecting the effectiveness of scientists in industrial labs. The variables had to be optimised for the organisation in question. The development of titanium dioxide pigments illustrated the inadequacy of simple measures of the value of R&D, because very small improvements in the optical qualities of the pigments were commercially significant.

discussion

relatively short, but skill lifecycles are becoming longer. The time taken for an individual to acquire knowledge, the retraining to maintain that knowledge or skill, can span a very long period within an organisation. The consequences of this are so profound that inter-firm competition can be analysed in terms of skills rather than products and this comes back to the effectiveness argument.

In other words, going back to the titanium dioxide paint example, the product is basically very similar in the competing organisations but one might have a marginally different refractive index that is sufficient to justify a competitive advantage in the marketplace. It is from that difference that the added value differential also derives. That difference comes from one group of researchers being differentially more effective than in the competing group.

What are these cultural effects in science? Interdisciplinary working is one important factor — the ability of scientists and engineers to work together in groups, to be able to link and read across each

other's disciplines. Such an organisation needs to be able to look outwards as well as inwards. And innovation can also be seen as a cultural concept. There is no algorithm that tells you how to innovate; there is no algorithm that tells you how to organise to innovate. An organisation is intrinsically innovative if the cultural factors are correct. If you look within the most famous laboratories, the most successful, such as the Cavendish, have a cultural environment which shares much in common with an artistic renaissance.

So a value creating R&D process model should be based upon effectiveness, it should be culturally driven with emphasis on the quality of skill and it should be interdisciplinary with a great emphasis on effectiveness.

Finally then, just to repeat my propositions for you: in terms of R&D driven value creation, conventional output metrics are inappropriate, cultural processes are essential and relative effectiveness drives relative added value with culture dominating organisations in contributing to maximising effectiveness. □

Graduating from SME to multinational

Peter Williams



Sir Peter Williams CBE FRS FREng is chairman of the Engineering and Technology Board. He trained as a physicist and initially pursued an academic career. After a period with VG Instruments he joined Oxford Instruments in 1982, becoming its chairman in 1991. He was chairman of the Particle Physics and Astronomy Research Council from 1994 to 1999. He is also chairman of the National Physical Laboratory.

I want to tackle the question of how we can grow science-based small and medium enterprises (SMEs) into what the Singaporeans call MNCs — multinational companies. For me, the ultimate “measure of success”, the added value, is financial.

How do we get from the small “seedling” companies to the fully grown multinationals? Timescales for SMEs to graduate are often lengthy. It is more common for star performers, like Vodafone, to emerge from within a large established corporation or, like Amersham, from the public sector. The Ciscos and Oracles of the United Kingdom are few and their weight within the economy limited.

I will look at some of the key features in the SME “graduation process” and ask

why are we not better at it in this country? There are very few lessons to be learned from looking at the large successful technology companies when it comes to R&D. All the major technological companies spend extensively on development, come high up the R&D scoreboard, have recognisable and distinct technology which adds value to their R&D spend and are committed to the other ingredients in the innovation process.

R&D is simply the least common denominator, the minimum entry stakes, vital though it is as the lifeblood of many companies. What are the other dimensions in the innovation process?

Key factors distinguish the successful “graduate” company from the host of high-tech SMEs, focusing on the financial

environment in which they operate. In particular:

- Where does the R&D-hungry SME get its development capital from?
- What are the pitfalls, and advantages, of listing?
- What are the alternative routes to “graduation”?

First, development capital and the private equity markets. Raising new funds in the United Kingdom has been all but impossible recently, because the cash invested five or seven years ago is still tied up. The imprudent SME that spent lavishly in the boom of the late 1990s may well, by now, be close to starvation. The watchword today is “cash runway”.

However, recessions present great opportunities for the bold. The good news is that there is a positive wall of cash building up in the hands of both institutions and private investors. This is not just seed finance for the emerging SME, but serious money and it must eventually find its way to market.

But private equity nevertheless remains the best hope for many an emerging technology company. A classic example is the funding Oxford Instruments received from 3i which was at least as important as the subsequent public offering.

The public markets will remain the major source of growth finance for the graduating SME, much as they were for Oxford Instruments in 1983. At that time, the company was close to 60 per cent debt geared — a modest ratio by US standards, both then and now. The borrowings were to fund the growth of the subsidiary in magnetic resonance imaging magnets for body scanners; it was both R&D and working capital.

Clearly, a debut on the stock market would be the ideal way to wipe off these debts and provide development funds for the company’s next growth phase as well as liquidity for the founders and private equity investors.

The decade and a half following the initial public offering saw Oxford Instruments highly cash generative and follow-on placings of equity in the market were rare. Acquisitions like the £50 million deal for Link Systems, the X-ray company, in 1989, were financed out of cash reserves. A share buy-back was even undertaken to return some capital to shareholders.

R&D spend at Oxford Instruments ran, year in year out, at 8 per cent of sales. But was this organic approach the correct strategy for a quoted company?

I ask this question because a glance at the techstars of the FTSE 350 today shows few companies with “genetically pure material”. ARM, Logica, Misys and

Investment levels. Attention was drawn to the relatively low level of investment in R&D by industry compared, for example, with other European countries. It was suggested that the picture was more complex than it might seem, because large companies active in science and technology in the United Kingdom were liable to generate R&D in other countries as well. There was a problem, though, in converting ideas into commercial reality. Venture capitalists and retail banks were not interested in investing in manufacturing in the United Kingdom because the added value was low compared with investment in R&D. In America pension funds were much more willing to invest in high-technology industry.

Scale might also make it unrealistic to expect the UK to punch above its weight commercially as well as scientifically, because a company needed to be big if it was to carry the risk of a major investment in a new process. Emerging companies had to get overseas partners. This should not be seen as a matter for regret.

Renishaw could be said to be essentially the same character of company as when they listed, as is Oxford Instruments, but a great many more have used the financial markets to change and adapt.

Amersham, which was launched at the same time as Oxford, grew organically, then reshaped itself and moved into a major European merger. It became a member of the FTSE 100 before its recent acquisition by General Electric of the USA and is a very different organisation from the government spin-out of the early 1980s. They have truly added value to their R&D.

Hindsight is always 20/20, but if I had my time over again as chief executive officer of Oxford Instruments, would I pursue quite so singlemindedly a core technology, R&D-based strategy? Maybe I would press for a more heavily acquisition-based approach, positioning the original core within a larger and more diverse group, still well and truly R&D based, but with the greater scale demanded by the need to be internationally competitive.

Amersham marginalised its core radio-pharmaceuticals business before moving on. PowderJect even disposed of its needle-free injection — its original core business — and became a successful vaccines company. Such moves may well be typical of a better strategy for a public company.

But what about alternatives to private and public equity financed growth? What about “corporate venturing”, or life within the big company? It is no accident that two of the Techmark/FTSE 100 stars grew to significant size within their original parent organisation, missing out completely on adolescence as a

small company. Vodafone de-merged at just the right stage from Racal. Zeneca, now Astra Zeneca, came to market in an equally far-sighted de-merger from ICI. Both had become major businesses in their own right before they assumed an independent existence.

A good model, therefore, for my third key point, might be for the emerging mid-size company to shelter under the coat tails of an existing giant, funding R&D in partnership with a major like-minded corporation. Look at Psion and its Symbian joint venture with all the major mobile phone manufacturers and Oxford Instruments’ joint venture in magnetic resonance imaging with Siemens.

Sometimes, such a strategy can result in the loss of independence, something we always felt very strongly about at Oxford Instruments. Recently, PowderJect agreed to a bid from a US suitor. In the process, it has produced an outstanding return for the shareholders.

I have talked about private equity, the public markets and corporate venturing. At the Engineering and Technology Board, in partnership with the Royal Society, the Royal Academy of Engineering, the Office of Science and Technology and the Engineering and Physical Sciences Research Council, we are looking at these and other issues and intend to produce a report to Government in time for next year’s Comprehensive Spending Review, SR04, under the general label of “wealth creation from science, engineering and technology”.

With a team on which John O’Reilly sits alongside people like Robin Saxby from ARM, Peter Fehlner from Celltech

discussion

and Hermann Hauser from Amadeus, we hope to be able to shed some more light on the question of why insufficient UK-based SMEs graduate to world scale. Is it the taxation environment, government's role, education or something else?

There will be no easy answers, but one common success factor I am confident will emerge, in addition to a res-

olute commitment to R&D, is good leadership.

The role models of the people I have just mentioned, plus James Dyson, David Potter, Paul Drayson and many others, are vital in encouraging the up-and-coming entrepreneur in the typical SME. They are the successful risk takers; they add value to R&D.

But we have a propensity in the United Kingdom to wait for the banana skin to bring down these heroes. Perhaps it is this cultural failing which distinguishes us from our cousins across the Atlantic. If we are to rival them, we need to separate our inhibitions relating to the creation of wealth from our prodigiously successful science base. □

Fostering cooperation for wealth creation

John O'Reilly



Professor John O'Reilly is chief executive of the Engineering and Physical Sciences Research Council. His technical interests lie in communication networks and applications and he chairs the UK's Network Interoperability Consultative Committee (NICC) for Ofcom and the industry and has served as a specialist adviser to UK Government (DTI and the Foreign Office) and to the European Commission.

The Engineering and Physical Sciences Research Council (EPSRC) is the UK Government's leading funding agency for research and training in engineering and the physical sciences. Our programmes put more than £400 million a year into world-class research that forms the basis for future economic development in the United Kingdom. Out of that investment comes knowledge and skills and, from that base, innovation. If that innovation is timely and properly handled it can make money — that's the added value. To a significant extent the flow of funds back into research and research training is dependent on the success of the innovations to provide those funds.

The council works alongside the six other research councils (see Fig. 1, p. 8) and, on issues of common concern via a strategic body, Research Councils UK. Almost all our activities are carried out in conjunction with the universities, with which we have strong links. We also have strong links to industry.

The outcomes from our investment are in three areas: new knowledge, a pool of trained or skilled people and knowledge transfer. To manage that, we think in terms of a strategic framework. First, who are we working for? We support work that is relevant to industry from the heavy end — bulk products

and chemicals — through to materials, computers and telecommunications and the energy sector. Defence, transport and other sectors can also benefit from the research that we support.

Second, what is the purpose of this work? Essentially, the research councils' job is to serve the needs of society. For us that means contributing towards advances in energy, sustainability, transport, health and wealth.

We put all this together into a business planning process. We evaluate and include input from scientists and engineers to help balance our programmes and funding allocation.

Much of the research we sponsor is published in the scientific literature. Publications are a tangible measure of the success of our research and we monitor the output carefully. From this we can ascertain that, in many areas, we punch above our weight. The citation data also suggest that, overall, UK publications are influential.

But there are also some warning signs when we look at the change in the United Kingdom's share of publications around the world by field. In engineering, mathematics, materials science and chemistry, core disciplines for the EPSRC and for industrial applications, our share is going down. The quality remains high, but the falling share tells

Knowledge transfer. One speaker expressed concern that the Government, having encouraged higher education institutions to interact with business in the past, seemed now to believe that knowledge transfer should be left to those institutions which were less active in research. In response it was suggested that such a polarisation was not intended. To engage in knowledge transfer it was necessary to have something to transfer. There were many universities with different assets, and the question was how to make the most of them.

discussion

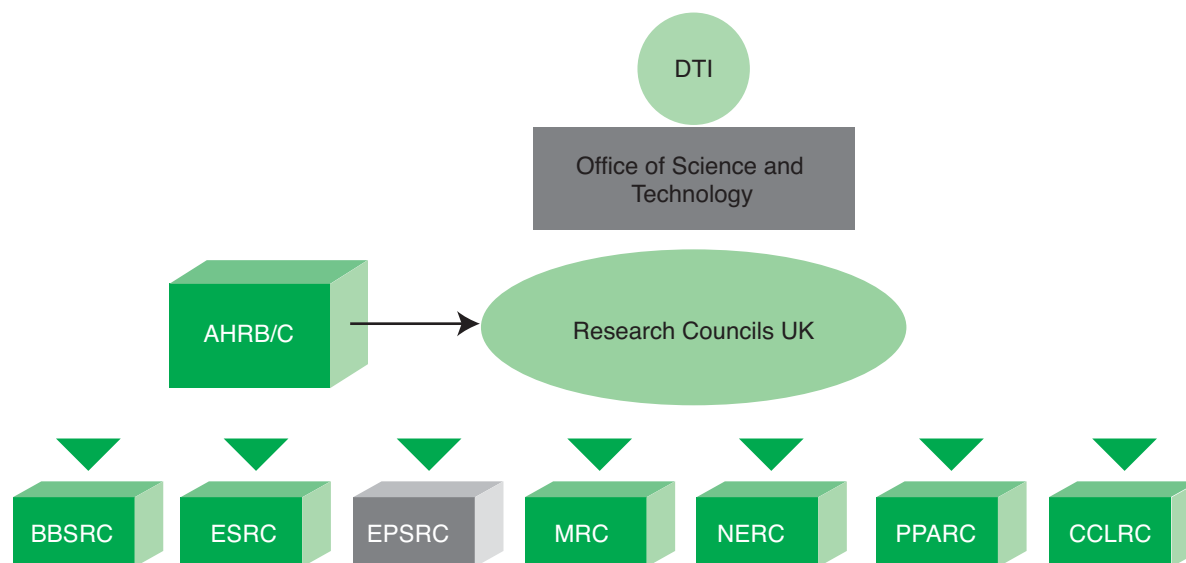


Figure 1. The relationship between the research councils in the United Kingdom.

us something about the volume of work we are doing in these areas.

The figures on staff numbers tell a similar story. In key fields, academic staff numbers are declining in relative, and in some cases absolute, terms. That is true of civil and chemical engineering, physics and chemistry. Not surprisingly, the same disciplines are faring badly in terms of research income. This prompts the question: “do we have the right fit for the sort of economy that we need to be?”

The disciplines that we support in the universities are headed by physics and chemistry and include all branches of engineering, materials, computer science and mathematics.

In almost all of these subject areas additional research spending from industry, European Union and other sources roughly matches that from the EPSRC. There is no doubt that the research-council funding, that supports relatively unfettered and free thinking, is vitally important. But, at the same time there is a strong coupling with industry in almost all subject areas and this, I believe, is very healthy.

In the 10 years since the EPSRC came into existence, industrial participation with us in grants has trebled; approximately £120 million from industry is now forthcoming, alongside EPSRC investment.

Recently, we have developed some strategic partnerships. With BAE SYSTEMS, for example, we have agreed a five-year £30-million research investment programme — £10 million from EPSRC and £20 million from BAE SYSTEMS. The research we fund will be

fully and openly peer reviewed in the normal way but our agenda is fundamental long-term research. Similarly, a £14-million programme with the Carbon Trust will promote new technologies for a low carbon future — energy-efficient buildings, renewable energy technology and green process technology.

Are we, as a research council, succeeding in our mission? Are we contributing to wealth creation and improving the quality of life through innovation, driven by knowledge and skills? We don't know exactly where innovation will flourish in the future; ultimately perhaps we can influence that only at the margins. Crucially important is the need to ensure that, through the research that we promote, we foster a broad base of knowledge and skills that can feed the innovation process rather than attempting to second-guess it.

As the saying goes, the heroine has to

kiss a lot of frogs to find a prince. I take the view that EPSRC can, at least in part, help in the business of kissing enough technological frogs to ensure that the nation has the knowledge and skills needed to produce future “princes” of wealth creation.

If “spin-out” companies are a measure of our success, we can point to something like 500 spin-outs in the past 10 years. A recent survey by the Royal Society of Chemistry identified that 85 per cent of spin-outs came either wholly or partially from EPSRC-funded departments; a survey by the Institute of Materials gives similar statistics. There is no doubt that the work done in universities, which is secured by relatively unfettered funds, is crucially important to this.

It is a positive picture in some parts. But some worrying underlying trends, such as the decline in popularity of certain vitally important disciplines, deserve our attention. □

Research councils. A number of speakers saw it as the prime job of the councils to fund unfettered research and pursue scientific excellence, as measured by international standards. The classic way to do this was by responsive mode funding, working with industrial partners where appropriate but not trying to pin researchers' feet down or impose research policies. It was said that a quarter of the gross domestic product of the US was based on European research, for instance in quantum physics, which would never have been funded under a system dominated by research policy factors.

discussion

In early 2003 the Government announced three related reviews into genetically modified (GM) crops: a science review, an economic review and a public debate. On 28 October 2003 the Foundation held a discussion meeting at the Natural History Museum; the speakers' presentations are summarised here. Government has now decided to allow GM crops to be grown in the United Kingdom.

The science of GM agriculture

Howard Dalton



Professor Howard Dalton FRS is chief scientific advisor at the Department for Environment, Food and Rural Affairs (Defra). Professor Dalton trained as microbiologist and undertook research at Sussex and Purdue, Indiana, universities. He now holds a Chair at Warwick. He was deputy chairman of the GM Science Review Panel.

The GM Science Review was commissioned as part of the wider GM public dialogue announced by Margaret Beckett, the Secretary of State for Environment, Food and Rural Affairs (Defra) on 31 May 2002. The dialogue has three main strands: a public debate, this review of the science around GM and an economic study.

This science review was informed by the foundation discussion workshops carried out by Corr-Willbourn for the Public Debate Steering Board. Deliberate attention was given to any differences of opinion among scientists and uncertainties, unknowns and gaps in current knowledge. The review does not aim to be exhaustive in surveying all that is known scientifically about the various GM crops; rather, it aims to cover those areas where there is clear public concern.

The review is specifically concerned with the potential use of GM crops in the United Kingdom. However, the use of GM crops in other countries, particularly in developing countries, was raised in the public debate and so was discussed by the review panel. We hope our approach and the scientific material we have brought together may be of use in other countries in clarifying GM issues and informing debate.

The Science Review Panel is chaired by Professor Sir David King, the Government Chief Scientific Adviser, with myself as deputy and with the Food Standards Agency (FSA) in an advisory role. The panel has two main functions: first, to monitor the progress, quality and

credibility of the Science Review and second, to review and summarise the state of scientific knowledge and consensus, and to identify significant/relevant areas of uncertainty.

With 26 members, the panel is large and has an exceptional breadth of expertise, including leading scientists and social scientists from a number of fields, and with a wide spectrum of opinions on GM.

The Science Review Panel met on seven occasions over a six-month period. Members of the public were encouraged to observe these meetings which they did, but in relatively small numbers. The public was specifically engaged through a series of workshops, meetings and through a website. This allowed the review panel to consider the concerns and interests of everyone, irrespective of their involvement.

The Science Review website has been the major instrument in the exchange of information between the scientific community, the general public and the Science Review Panel. It provides details of all meetings in relation to the review, gave guidance on how interested parties could make contributions and provided the principal medium by which the panel communicated on the science and looked at the evidence.

So far almost 100 contributions have been received. The names and status of the scientists submitting contributions was requested so that readers could judge for themselves the accountability and experience of each contributor.

An "interests and concerns" page was

Press and public. It was asked how far the engagement of the press had improved the public debate or undermined its quality. The answer offered was that it varied from newspaper to newspaper, some being partisan, and also depended on which correspondent covered the topic

There was agreement that some meetings in the early stages of the public debate had been hijacked by a baying mob of activists. Others agreed but considered that there had been some excellent discussions. One person complained that the facts were not forthcoming and few young scientists cared to take part.

discussion

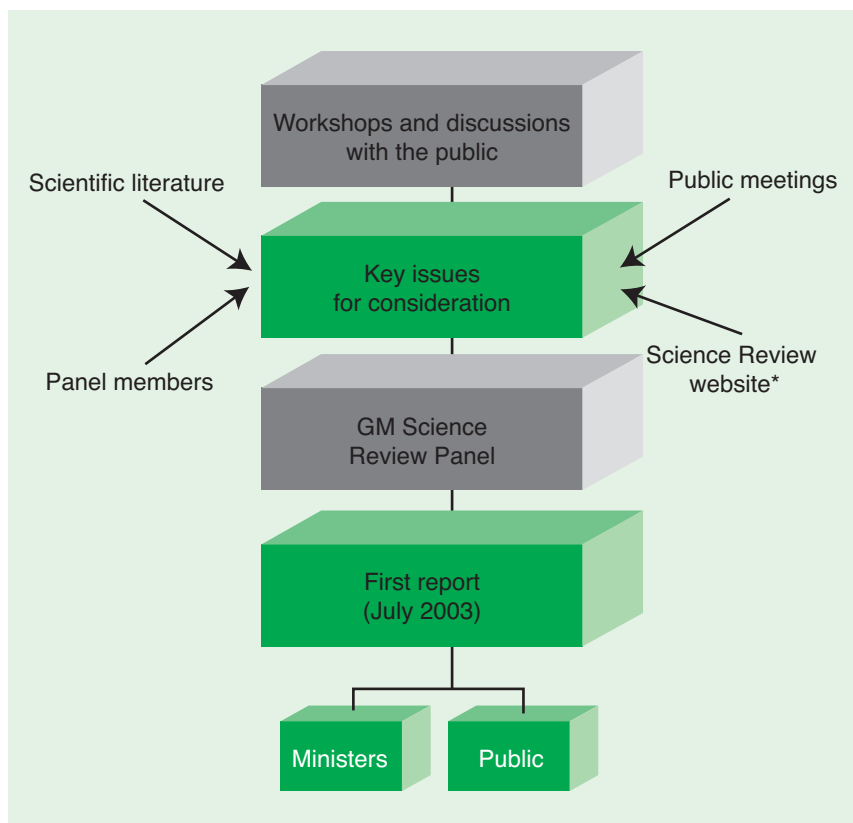


Figure 1. Where did the evidence come from? First phase. *www.gmsciencedebate.org.uk

developed to make the review especially accessible to the public. This hosted a review of public concerns (from the Corr-Willbourn Report) and summaries of the Science Review open meetings held around the United Kingdom. These public meetings were organised by the British Association for the Advancement of Science (BA) between January and March 2003. Their purpose was to offer a wide spectrum of scientists the opportunity to put their views to the Science Review Panel and for the public to have an opportunity to enter into dialogue with experts. The meetings were well attended, with audiences of 70 to 100 people. In addition, the Royal Society hosted a meeting in February on “GM Crops, Modern Agriculture and the Environment” in which many issues pertinent to the review were discussed.

There was initial criticism that we were not sufficiently “joined up” in our approach. Professor Philip Dale therefore served on both the Public Debate Steering Board and the Science Review Panel, while two members of the panel also had roles in the Strategy Unit (SU) expert groups. Others have contributed to seminars held by the SU as part of their work and there has been a comprehensive two-way flow of information with the SU.

The review looked at three main areas of concern:

- GM food and feed safety issues;
- Environmental impact of GM crops, such as biodiversity;
- Gene flow, detection and impact.

Within each of these areas the panel considered:

- The range of views and quality of evidence;
- Is there general scientific agreement?
- Is the issue unique to GM?
- Are there gaps in our knowledge or scientific uncertainties and are these important?
- What are the likely future developments?
- Where there is recognised scientific uncertainty, what is the potential way forward?

The first report was published in July 2003.

Briefly, the outline of the main conclusions of the report were:

1. There were no verifiable ill effects reported from the extensive consumption of products from GM crops by humans and animals over seven years.

There is no compelling evidence that horizontal gene transfer from GM foods to gut bacteria occurs in natural conditions. For this to happen, a series of natural barriers would need to be overcome.

With respect to GM-derived animal feeds, several research studies have been unable to find transgenic DNA (or its gene products) in milk, meat or eggs produced from animals fed on GM crops.

2. Risks to human health from GM crops on the market are very low.

However, depending on the crops developed, it is possible that GM may present greater challenges in risk management in the future (for example, edible vaccines/functional antigens or other pharmaceutical proteins). Traits must be assessed on a case-by-case basis. Each new GM product should be subject to testing through the Advisory Committee on Novel Foods & Processes or the Advisory Committee on Animal Feedingstuffs.

Regulatory evaluation also has to keep pace with the challenges posed by developments in this technology. It is important that research to ensure effective risk assessment is supported.

3. Experiments show that GM crops are very unlikely to invade the countryside or be toxic to wildlife.

Detailed field experiments on several GM crops in a range of environments have demonstrated that they are unlikely to invade our countryside or become problematic plants (although herbicide-tolerant oilseed rape and beet could become weedier in agricultural settings). Nor are they likely to be toxic to wildlife or to perturb soil structure in such a way that the functioning of soil communities could be substantially affected.

However, the possibility of horizontal gene transfer to microbes other than soil bacteria (for example, fungi) has not been well studied.

4. There is insufficient information to predict what long-term impact herbicide-tolerant crops will have on weed populations and wildlife that depend on weeds for food.

From the results of the farm-scale evaluations it appears that there were differences in the abundance of wildlife between GM herbicide-tolerant crop fields and conventional crop fields. In the case of spring oilseed rape and fodder beet, there were fewer weeds to encourage insects and bird life (although birds were not studied in the trial). On the other hand, GM herbicide-tolerant maize had more weeds than conventional maize. These differences were due to the fact that the GM crops offered farmers new options for weed control. The researchers did emphasise that issues other than GM would affect wildlife, mostly due to crop management by farmers.

The results are also being considered by the Advisory Committee on Releases to

the Environment (ACRE).

At present, there is no scientific case for ruling out all GM crops and their products. It would be short-sighted to decide the future of a powerful diverse new technology on the basis of its application — and in some cases violent opposition to that application — in only one area, and to ignore the analysis of risks and benefits in other areas.

There are a whole host of potentially beneficial prospects for GM already in our sights. On the other hand, there are risks in any new technology, and the lessons of history tell us that sometimes we have rushed forward to exploit new technologies, only subsequently to appreciate the medical, social and environmental impacts that these may bring (thalidomide, nuclear energy, pesticides, mobile phones and so on).

We have to be able to cope responsibly with incomplete knowledge and

uncertainty. Therefore, a case-by-case approach to making assessments of environmental impacts continues to be the best way forward.

In making proportionate judgments about GM crops, it is important to bear in mind that non-GM plant breeding is becoming progressively more sophisticated and able to provide novel modifications to crops that raise similar issues to those considered in the review. Indeed, GM techniques rather than GM technology have allowed us to answer fundamental questions about the plant genome, and have shown how we may use traditional genetics more effectively in breeding programmes of the future.

The panel is now considering:

- Comments received on the first GM Science Review report published in July. To date, over 20,000 people have downloaded the full report and 200 paper copies have been requested.

There have already been over 50 detailed responses to the report on the website, plus a number of letters;

- Report on the GM public debate “GM Nation”;
- Results of new and significant GM science published over the summer (nine papers) and the results from four Defra-funded GM research projects;
- The results of the farm-scale evaluations (FSEs).

A second and supplementary final report is due to be published in early 2004, taking into account the factors outlined above. Once the second report is published and ACRE’s advice on the FSE results and the Agriculture and Environment Biotechnology Commission (AEBEC) report on co-existence is available, then the Government will be able to publish its report on the Public Debate and announce its policy on GM. □
www.gmsciencedebate.org.uk

Potential costs and benefits

Ian Coates



Ian Coates is seconded to the Strategy Unit in the Cabinet Office, where he led the Unit’s analysis of the costs and benefits of GM crops.

After training as an economist, Mr Coates worked at the Department of Transport on railway privatisation, regional economics and assessing the impact from transport policy. Before moving to the Strategy Unit, he spent two years at Defra providing economic advice to the UK Climate Change Programme, the Kyoto Protocol negotiations and the UK’s greenhouse gas emission trading scheme.

The Strategy Unit was formed in July 2002, bringing together a group of other organisations, including the Performance and Innovation Unit, the prime minister’s Forward Strategy Unit and part of the policy studies directorate of the Centre for Management and Policy Studies. The remit of the Strategy Unit (SU) is to provide a clear focus for strategic thinking and policy analysis at the heart of government. It does this through a programme of long-term strategic reviews and policy analysis.

The SU GM Crops study aimed to provide a comprehensive and balanced analysis of the costs and benefits of commercial cultivation of GM crops in the United Kingdom over the next 10–15 years. This was a difficult task. The unit was clear from the outset that there is limited data available about how GM crops will fit into existing product chains. As this is an issue in which uncertainty abounds more generally, the unit also decided to look at a range of different future scenarios for GM crops in the UK. Nor can GM crops be considered in isolation; GM is just one possible tool that can be used to achieve a variety of objectives and has to be compared with other tools. The SU report sought to provide clarity.

All three strands of the GM dialogue have been interacting with the various agencies and exchanging information. In particular, the SU has been interacting with the Food Standards Agency’s analysis

of consumer opinion on GM food, the Agriculture and Environment Biotechnology Commission’s (AEBEC) work on co-existence, the EU Commission’s work on co-existence and many others.

The SU did not attempt to come up with a single answer in terms of the net costs or benefits of GM crops to the United Kingdom. However, monetised and quantified data have been used wherever it was robust and appropriate. Also, GM crops were considered as a collective whole rather than on individual crops and traits. This meta-analysis has set a useful framework that needs to be used alongside the case-by-case assessment of GM crops which, in turn, needs to be reinforced.

I would like to highlight some of the important points in the final report and to assess their implications.

First is the way in which we established the policy context. The costs and benefits of GM crops are determined by their relative contribution to goals and objectives in a number of policy areas. Rather than treating GM crops in isolation, the SU study has assessed GM crops in terms of their impact on key goals and objectives alongside or compared with other alternatives. Although the report does not deal explicitly with ethical and moral issues, they are central to it because society’s preferences will determine what the goals and objectives should be to which GM crops are going to contribute.

Second, the use of scenarios was essential in helping to reach a comprehensive set of conclusions.

Third, our analysis of shocks and surprises forms a central part of the final report. In a similar approach to the way in which we generated the scenarios, we invited around 30 important stakeholders, covering the full range of interests and views, to a seminar at which we identified possible types of shocks and looked in detail at the implications of some illustrative shocks.

In our report, shocks are defined as events which are perceived to have a low or uncertain or perhaps disputed probability of happening but which, if they do occur, have the potential to disrupt all future scenarios. Shocks are impossible to predict but, by considering a range of illustrative shocks, we were able to develop a richness of analysis.

We have drawn some important and much-quoted conclusions. First, we focused on the short term and on the market for GM crops grown in the United Kingdom. We concluded that, on the basis of the available evidence, existing GM crops could offer some cost and convenience advantages to UK farmers. This conclusion needs to be very carefully caveated. The evidence available to us:

- is mixed and sometimes contradictory;
- is largely based on experience from other countries which may or may not translate to the UK;
- is otherwise based on trials which may or may not be a good guide to commercial farming;
- generalises a huge range of diversity in terms of the types of farming operation in the UK.

Even if there are some cost and convenience benefits from GM crops, the GM varieties available are insignificant in terms of UK agriculture as a whole. The types of crop include sugar beet and fodder beet, forage maize and oilseed rape — no wheat or potato varieties and, of course, we can't grow soya beans or cotton in our climate.

It is important to look at the demand side of the market, as well as the supply side. Even if it is cheaper for some farmers to grow GM crops, will they be able to sell them? If we are looking at animal feed, the answer is probably "yes", but if we are looking at food for human consumption, consumer attitudes and retailer policies say "no".

Through the use of scenarios, we tackled the various possibilities that might emerge over the next 10–15 years. What we found was that there is no clear "best" scenario. Instead, each scenario sees costs in some areas and benefits in others that will need to be weighted by policy makers

Evaluation. Not everyone agreed that case-by-case evaluation was the way forward.

One speaker wondered whether it was appropriate in a complex ecosystem. Another thought there could indeed be an overall approach. Another participant wondered who would bear the costs of case-by-case assessment. Food was not the kind of high value-added commodity that could support expensive regulation. In response it was suggested that the public interest in proper regulation could justify an element of public funding, but that the industry should also contribute.

The question was raised whether there was any advantage in pursuing the technology, given that so few GM crops would ever be grown in the UK. One response to this came from a plant pathologist who observed that food was subject to attack by 11 different types of competing organisms. Their importance should not be underrated, given that potato blight had reduced the population of Ireland by a quarter in the 19th century. Various techniques involving genetic modification would help to keep plant pathogens at bay. It was also noted that the current debate was all about herbicide resistance, whereas resistance to frost and salt were much more important worldwide.

discussion

in the light of the evidence that has emerged from GM Nation.

Future developments in GM crops may have the potential to deliver much more wide-ranging benefits than are currently available. But the overall balance of future costs and benefits will depend on three key factors:

- Will the public become more accepting of GM foods?
- Will the regulatory system convince the public that it is effective, rigorous and able to deal properly with uncertainty?
- Will GM technology deliver crops and traits that contribute to desirable goals, and that cannot be delivered so effectively through other means?

We also considered the incentives faced by farmers in factoring the environment into their farm management practices. Our conclusion was that farm management of GM crops could have positive or negative impacts, depending on the approach adopted. For example, does the farmer do best by blitzing his fields with herbicide early and often? Or does he do best by spraying late and infrequently? The role of agri-environment schemes is key.

Second, we looked at GM crops R&D in the United Kingdom. A major risk of saying "no" to GM crops now, would be the danger that we could lose our capability to act as intelligent supplier or customer of GM crops in the future, when our views may have changed.

Finally, we noted that this debate is not going on in isolation. Close attention is being paid by wider science-based industries and by developing countries, both of which will be influenced by what the United Kingdom does with GM crops.

The SU study includes a wide range of diverse interest groups debating across a wide range of issues (economic, scientific, social, ethical, moral) in a context in which the Government is not trusted to be an "honest broker".

In this context, it is not surprising that we made some mistakes, particularly in the early days. We failed to reflect a full range of issues and perspectives in our Scoping Note, alienating some of our potential constituents. We failed to recognise the way in which consultation has developed over the last few years. We needed to involve stakeholders, as representatives of a wider community, directly in our work.

However, based on the feedback we have received since our report, we have done a lot of things right.

First, we brought an objective and balanced approach, with a willingness to listen to all sides of the debate. We had no preconceived ideas about what the report should say. We remained flexible and the project saw an ever-increasing role for our stakeholders in our meetings, our expert groups and in seminars and workshops.

Finally, we published copious material along the way, including notes of key meetings, background papers and a methodology paper, ensuring that the wider world was able to see how our work developed over time.

In the light of this experience, I would like to offer a few suggestions for how this sort of exercise might run in the future, for other controversial issues, such as nanotechnology.

Despite every effort, the interactions between the three strands of the debate did not work as well as they could have

done. In hindsight, the main reason for this is clear: the process was not project-managed as a collective whole. As soon as the three strands moved forward as separate entities, it was never likely that they would dovetail neatly together. The three-stranded approach was innovative and a good model for future programmes, but better forward planning and project management would be needed for any similar exercise in the future.

Second, it is important to be aware of one's own position and influence on a controversial issue such as GM crops. The ripple effect of actions in one part of the universe can easily have a major impact elsewhere. This needs to be taken into

account at every stage.

Third, it is important to be aware that most people don't divide issues neatly into categories such as "economic", "scientific" and "ethical". Instead, people's views tend to be an amalgamation of ideas in all these categories. Finally, somewhat tongue-in-cheek, "trust no-one"! There is no such thing as an objective opinion in GM crops.

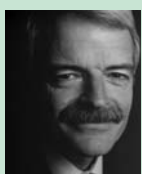
The evidence from our study is that, irrespective of what government decides, the take-up of GM crops in the United Kingdom over the next few years will be very low. Would it be acceptable to let the market determine whether GM foods are going to become the next microwave meal or the next irradiated food? Is the

market stacked too much in favour of corporate multinationals, such that the consumer would never get a look-in?

Our study suggests that a key question will be what GM technology can deliver, compared with alternative approaches. Fundamentally, what is it that we want from plant science? Do ever more efficient and high-yielding plants fit with the future direction of agriculture and the countryside? Our analysis suggests that this sort of joined-up thinking isn't happening enough, with the result that many ideas and initiatives are pulling in many different directions. Who would be a humble farmer or scientist in the midst of this maelstrom? □

The public's view

Malcolm Grant



Professor Malcolm Grant CBE is Provost, University College London and chair of the GM public consultation process. Professor Grant trained as a lawyer in New Zealand. From 1986 to 1991 he was Professor of Law at UCL and until this summer was Professor of Land Economy and pro-vice-chancellor at Cambridge University. He has served on a wide range of public committees.

What about the public? When governments are faced with a dilemma that submerges ministers in controversy, the British constitutional tradition has been to set up a royal commission. Royal commissions, as Harold Wilson once memorably said, "have the function of holding meetings, keeping minutes and taking years". The GM debate provided such a challenge and, as a result of a review of biotechnology policy across government in 1998, a commission called the Agricultural and Environment Biotechnology Commission (AEBEC) was set up in the year 2000.

The AEBEC was established with the remit of being a voice of the public in Whitehall and to give the Government advice on some of the complex issues around biotechnology, the environment and agriculture. To that commission 20 people, all articulate, intelligent, fluent and able and with at least 20 differing views, were appointed. There could hardly have been a more challenging brief for a commission, to which I found myself appointed chairman.

The AEBEC evolved a mode of working that may prove to be a model worthy of development in other contexts. The commission comprised people as divergent as the chairman of Greenpeace UK, the director of the National Consumer Council, the former director of research at Astra Zeneca and the chair of the Soil Association. It included plant genetic scientists, bio-ethicists, lawyers, farmers both organic and non-organic, and a wide range of consumer and other public interests.

The suspicion in which its members regarded each other initially made the commission almost unworkable at first. During our first year we held large public

meetings but we also conducted our own meetings in private. We have developed to the situation now where we conduct all our meetings openly and in public; our meetings are advertised on the web, our papers are displayed on the web and even our draft reports, as they come through, are on the web. Public faith in the development of technology will only be regained and reinforced by the openness and transparency of the processes of those who are responsible for taking decisions.

One of the outcomes of the commission's deliberations was a report to government in 2001 concerning the farm-scale evaluations (FSEs) of certain crops that had been modified to make them resistant to a broad-spectrum herbicide. Our conclusion that these trials should proceed, despite the public controversy, was hard-fought. We took the view that, as an experiment, the trials had to be allowed to proceed to produce results.

But we urged the Government that to go ahead with the commercialisation of GM crops on the basis of nothing more than those trials would be mistaken. There needed to be a broader discussion; there needed to be a public debate.

I want to reflect this evening on the process of the public debate on GM and to be as open and transparent with you as I would be in our own meetings about some of the flaws of that process. The principles around which we wished to organise the debate could be summarised as follows:

- the questions for the debate should be framed by the public, rather than by us or the Government;
- the debate had to be conducted openly and transparently, and be independent from government;

- it was to be an innovative exercise in public engagement.

Our first step was to commission Corr-Willbourn, to whom reference has already been made, to set up a series of workshops with members of the public to try to understand the issues that were in their minds around GM.

Those workshops were a revelation. GM was not on the public's list of immediate concern; the Iraq war and the possibility of Manchester United losing at home took precedence. But, when our expert investigators drilled down into the second and third layers of opinion, out came the GM concerns. These weren't concerns about science or technology, they were concerns about trust and ownership: about "who takes decisions?" and "who controls the technology?" and "is it possible to have GM crops growing in the UK, whilst retaining consumer choice for organic or other food that does not contain GM organisms?"

We used the questions derived from these sessions as the framework for the public debate but we also transmitted them into the other two strands of the debate. This helped resolve another tension; when the Government announced the three-stranded debate that would include the Science Review and the Economic Review, I feared that the public debate might get squeezed out by the other two strands.

A meeting was convened early on between those who had responsibility for the three strands. We had some difficulty in understanding and reconciling each other's perspectives and processes but the consequence of our resolving to work together was that the three strands became connected in a way that has produced a remarkable outcome.

The Science Review was an open process in which the public could attend the meetings. It comprised a panel in which non-scientists contributed to the work of the scientists and it pursued the questions that we had come up with from the public's framing of the issues: what are the uncertainties, the limits to knowledge, the further research that needs to be done? The Science Review is much richer and more valuable politically for having adopted this open approach.

So too with the study by the prime minister's Strategy Unit. Their sophisticated process of engagement and understanding of public opinion has produced a rich and varied report.

Indeed, an important test of the validity of the whole exercise is that the various stakeholders, who had the capacity to disrupt or disown their progress at any stage, have remained engaged and have,

Government response. One participant thought it remarkable that the process had focused politely on the procedure for making sure that the Government was aware of public opinion on GM crops without anyone asking how the Government would respond. The elaborate process had led a large number of people to believe that nothing had been decided and that their views would make a difference.

It was suggested that the debate had come far too late. The UK had to get ahead of the game, and leadership was needed. The results of the farm-scale evaluation trials had shown that variability between different crops and crop management methods in their effects on biodiversity mattered more than whether they were genetically modified or not. It was hoped that the GM debate would feed into more important issues about land management and its impact on wildlife.

discussion

in general, respected the process and the outcome.

The importance of trying to lead a process on the basis of consensus, engagement and participation should never be underestimated. I appointed six members of the AEBC to the independent steering board for the public debate on the grounds that they had found a way to work together. I also appointed to the steering board the director of the Five Year Freeze and the chairman of the Agricultural Biotechnology Council, to make sure that our engagement with the stake-holding community was as complete as we could make it. It is not surprising with this varied composition that our discussions were often extremely difficult.

But how were we to conduct the debate? We received a range of methodological advice. We wanted to invest in a new way of doing things. Opinion poll methodology has been used extensively in the arena already, but we wanted to get something more than a knee-jerk response. We also wanted to engage a large number of members of the public. And so we set about, with a budget that was inadequate and a timetable that was tightly prescribed, trying to engage the public.

First, we arranged a series of six regional conferences, each attended by around 200 people, who, instead of sitting in an auditorium, sat around tables. A facilitator would lead a discussion and encourage participants to talk, argue and think about GM issues. We had prepared what was called a "toolkit". It contained information that was called "stimulus material" but, in the tense process of holding stakeholder contributors together and in translating it into straightforward communication, was stripped of its passion and was dull as ditchwater. There were methodological issues around its design that proved unresolvable in the time available. The science community

wanted statements of fact while the non-science community were including statements of opinion which could not be weighed against the statements of fact. By the time that crisis had come to a head we had limited opportunity to improve it. We were operating under a spotlight in political "real time" in highly contested territory.

The public face of the debate — "GM Nation" — was launched on 3 June 2003 with a six-week time span. An important objective of the six big public meetings was to increase public awareness and to train people to run meetings of their own. The second-tier meetings that followed were largely organised by local authorities. Some were remarkable events, with articulate and passionate arguments.

Then we had third-tier events where we acted as a catalyst for people to run their own meetings. We estimated there were more than 600 meetings of 30 people or more around the country; one of them, admittedly, was on *The Archers!* The momentum was far greater than we had anticipated. Meetings were held by people as disparate in ideology as Greenpeace, Five Year Freeze, the Women's Institute, the National Farmers' Union, Cubs and Scouts and local village organisations around England. We also ran an extensive website and supplied feedback forms both on the web and in hard copy. We had 37,000 returns.

The success of this whole exercise must be qualified: individuals who engage voluntarily in such exercises, by definition, are not the general public; most of the population will not go out for an evening's discussion even on an issue that is of such interest. Yet, in terms of the extent of public engagement, it was a remarkable success more than bearing comparison with the Government's "roadshow" on the euro.

Continued on page 23

In 2003, the Royal Society of Edinburgh held an inquiry into the crisis in the Scottish fishing industry. On 23 October 2003, the Foundation hosted a workshop, followed by a discussion meeting at the Royal Society of Edinburgh, investigating how science and political choice can be better integrated with the Common Fisheries Policy and the special position the Scottish fishing industry has.

Responsibility should be regional

John Selborne



The Earl of Selborne KBE FRS was chairman of sub-committee D (agriculture and environment) of the Select Committee on the European Union of the House of Lords. He has had a distinguished career in science policy and as a farmer. He first entered the House of Lords in 1971 and has served on a wide range of non-departmental government bodies. He is also a vice president of the FST.

I have nothing to do with the fishing industry, although I have been involved, over 12 years, in four successive parliamentary reports on the subject. My background is that of a farmer. I have to say that trying to tell what would be a successful European fisheries policy is complicated and difficult.

The task is much easier elsewhere — the South Atlantic for example. There, you do not have home fisheries, a multiplicity of species, historic rights and so on. In the European Union (EU), we are faced with historic fisheries, with elaborate existing rights as well as conflicting policies. There are also 15 member states, due soon to be increased by a further 10.

These are not easy issues to address. The Common Fisheries Policy (CFP) has been trying for over 20 years, but has not been conspicuously successful. Yet not all EU fisheries have failed. After a difficult time some 20 years ago, the herring and mackerel fisheries off Scotland have

attained stability. To be sure, there is an enormously expensive “right to entry”, but that is a legitimate way to ensure that capacity and effort match the resource. When we turn to the failures of the Common Fisheries Policy with other species of fish, we should remember that not every aspect has failed.

A successful CFP must, above all, match capacity to resource. (Assessments of the resource may increase or decrease, so there must be scope for adjustments of capacity.) As things are, there is too much capacity in relation to several species, so that we have at present a whole range of measures: total allowable catches (TACs), effort control, technical measures such as control of mesh dimensions and the like. All of these are attempts to deny the laws of economics.

A fishing industry has to make an economic return on its investment. The more the ability to use the investment is artificially limited, the more punitive will be

**Professor Gavin McCrone CB FRSE,
vice president of the Royal Society of
Edinburgh,** introduced the discussion meeting; his words are summarised below.

introduction

The Scottish fishing industry and the Common Fisheries Policy are of great concern to us in Scotland. The industry, particularly the white fish sector, is in crisis. Although the industry is sometimes said to be small, that depends on what you mean by small. There are some 90,800 jobs in the sector as a whole — fish catching, fish farming and fish processing — but the Scottish Executive estimates that there are also about 48,000 jobs dependent upon the fishing industry in Scotland. To put that in perspective, about half as many jobs are dependent on fishing as were dependent on North Sea oil at its peak. So Scottish fishing is by no means a small affair. The future of this industry is of great importance to us.

That is not the whole story. The industry is concentrated in what tend to be the more remote parts of Scotland where alternative employment is very hard to come by. The same estimates of the Scottish Executive suggest that about 50 per cent of jobs depend on fishing in Fraserburgh, 28 per cent in Peterhead and 22 per cent in Shetland. So the future of this industry matters a great deal.

That is why the Royal Society of Edinburgh decided, earlier in 2003, to mount an independent inquiry on the subject. The Royal Society of Edinburgh report has now been published; see www.ma.hw.ac.uk/RSE/enquiries/fishing/scottish_fishing_industry.pdf

Research. The need for improved and better funded scientific research was endorsed. Multidisciplinary research was needed and closer links with marine science researchers were desirable. It was noted that the available resources within the EU for relevant research were very limited. Because research was expensive, better coordination of current efforts was needed.

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the measures needed to stop people using their vessels — and the more illegal fishing there will be.

How do you balance catching capacity and resource? Observation of the successful fisheries policies around the world suggests to me that they all embody some form of a licence to fish. Fishery rights take many forms: territorial rights, individual transferable quotas, community fishing rights. When they are built into a fisheries policy, they seek to align the interests of conservation with the interests of long-term sustainable fishing and economic returns.

Without defined rights, everyone tries to catch the fish first. Then it becomes very difficult to align fishing interests with conservation. Of course it is easier to establish rights in other less complicated fisheries, where there are fewer historic claims; we heard earlier today that Individual Transferable Quotas (ITQs) are being operated in New Zealand, Australia, Iceland, the Faeroes and even the Netherlands. These are all small and conservation-minded countries and, moreover, are mostly single jurisdictions. I concede that it would be very difficult to determine who should have the ITQs in fisheries as complicated as ours. But that is not to say that we should not try.

One of the tragedies of the Common Fisheries Policy is that, at the time of the mid-term review in 1992, it was already clear that the multi-annual guidance programmes (MAGPs) were not yielding capacity reduction, but the opposite. Over-reliance on TACs, effort control, technical measures and the like led us nowhere. This was recognised, but there was no serious attempt at more radical reform of the CFP. The result has been the ratcheting up of controls and enforcement to the detriment of the economics of fishing.

Near the end of the 20-year CFP, there was a three-year period of consultation, which led to the green paper of 2001. By then we had had four MAGPs, but technological improvements meant that smaller vessels with modern gear could catch more fish than the larger vessels they replaced. Capacity had increased, not decreased. It is no wonder that quotas

became ever more stringent.

Throughout these 20 years, we have failed to reconcile the conflicting agendas of the member states. Now we have the so-called "Friends of Fishing". The six member states involved (Spain, France, Ireland, Greece, Portugal and Italy) are in total denial of the measures required for a sustainable fishing policy. It is inevitable that proposals emerging from the commission are watered down, even emasculated, by the Council of Ministers. That is because there is no agreement on what the problems are, let alone what policies are needed.

The fishing industry also complains that scientific advice is not consistent. This is only partly true. It is in the nature of science that you cannot always be precise. Take haddock, of which there was unexpected recruitment in 1999; we are still benefiting from that. There is always uncertainty.

But if you give the Council of Ministers the latitude of scientific uncertainty, ministers will arrive at the December council determined to win some prize for their own fishing industry. The result is that, while they may claim that they are beneath the top limits of the scientific advice, the TACs set over successive years have clearly been well beyond what is supportable.

Fishermen also criticise the lack of common enforcement in European fisheries. That is a legitimate complaint. How can you expect respect for a policy if it is quite unevenly regulated across the member states?

The CFP is therefore over-complicated, over-bureaucratic and too slow to react to events. If Iceland, Greenland or Norway want to close down a fishery, they can do so more or less overnight. In Europe, we set ourselves the target of doing that within 30 days, but that will rarely happen: two or three months would be a more realistic target. So we have a policy that cannot deliver sustainable fisheries.

The commission's green paper was followed by the Road Map of May 2002 by which many people (but not the Friends of Fishing) were impressed. Its most controversial proposal was that regulation

should be based on the concept of long-term stock management. That must be right. You cannot let the highly political annual negotiations of the December council meetings decide how stocks are managed for the next 12 months. We need a policy that runs from season to season, from year to year. There must also be a more effective policy of fleet management.

Rational plans for environmental protection and an ecosystem approach were among the major proposals of the Road Map, but when it came to the council meeting in December 2002, a compromise was fudged.

One of the most important of the Road Map proposals, widely accepted, was to set up regional advisory councils to give all stakeholders (not just the fishing industry) a voice in the management of regional fisheries. In the first 20 years, the CFP was "top down" and totally remote from reality. I, for one, welcome the concept, but we still await detailed arrangements. I only regret that they had not been mooted earlier.

In December 2002, the blocking minority of the Friends of Fishing sought compromises on fleet policy, on the use of subsidies and delayed the introduction of long-term management plans. Even at this late hour, the plans are not agreed. The proposed reform of the CFP involved four years of analysis and consultation, but it has been emasculated by the backsliding compromises made by the Council of Ministers.

The most iniquitous decision is that subsidies for modernising and renewing fleets may continue until December 2004. Think what that means! We have a policy that has been undermined by the ill-conceived idea of allowing money from the FIFG (Financial Instruments for Fisheries Guidance) to be used, in effect, to increase capacity; that will continue to the end of 2004.

The FIFG funds will end in 2006, but they could easily be spent up before then, leaving nothing in the kitty for more enlightened policies. The irony is that, because the new scheme applies only to countries that met their targets on the most recent MAGP and because Britain has never availed itself of EU subsidies for modernisation, the new arrangements do not apply to the United Kingdom.

My perception is that the political will to address these problems simply does not exist. The failure of the Council of Ministers to recognise its responsibilities has damaged the marine environment and has needlessly impeded the rational management of the fisheries.

Now, a few weeks before the 2003 Council of Ministers, there are still not in place the long-term programmes of management and recovery first mooted in

December 2001. Yet the green paper and later reports argued that such programmes, together with a sense of ownership (which is where the regional advisory councils would have a role), are urgently needed.

The European Commission, of course, has not been ignoring the requirement for management plans. There are indeed proposals for the long-term management of fish stocks, but they are so complicated that I doubt that any of you, experts though you are, would understand the

mathematics of the concepts incorporated into the management plans. Something simpler and more user-friendly is essential.

So there will be another fisheries council in December [2003] with further quota cuts, technical measures and restrictions — all inadequate stopgaps in the absence of effective long-term policies. The blame for this impasse and for the failure to reform the CFP in a user-friendly way ultimately lies with the Council of Ministers. It is not capable of

managing fisheries, either locally or regionally. Its proper role, as a consortium of sovereign nations, is to decide long-term policy.

Until we delegate back to the regions the responsibility for managing the fisheries and, ideally, get long-term ownership of the fish stocks aligned to fishery interests, we shall continue to move from expedient to expedient. The fishing industry here in Scotland and, indeed, in the rest of Britain, deserves better. □

The need for multi-sided dialogue

David Smith



Sir David Smith FRS FRSE is chairman of the Royal Society of Edinburgh Inquiry into the Crisis in the Scottish Fishing Industry. He built an international reputation for his research on the physiology of symbiosis. In 1987, he was appointed principal and vice-chancellor of Edinburgh University. Sir David has also served on various research councils, national committees and learned societies.

I am the chair of the Royal Society of Edinburgh's inquiry into the crisis in the Scottish fishing industry. We are an independent committee nearing the end of its inquiry. We have concentrated on three themes: science, management and the socio-economic impact. What follows is nevertheless my own view in which I shall concentrate on the white fish sector and on how the CFP has led to the current crisis.

I begin with the science and with our knowledge of the fish populations. The various national fish laboratories in Europe supplement their own survey data with catch or landing data supplied by fishermen. These are used to compile assessments of the size and age composition of the stocks of target fish, the spawning stock biomass and whether it is sufficiently large to maintain recruitment.

Many people have told us that this is an arcane subject. It is certainly poorly integrated into marine science. Both marine biology and marine science are popular at British universities, but in very few is there any significant teaching of either fishery science in general or stock assessment in particular.

My impression (as an outsider) is that it is also a conservative field. This is in

part driven by the need for consistent records over 10 to 15 years, which gives the impression of reluctance to adopt new techniques. I am also worried by the difficulty of arranging for clear and rigorous peer review for publications in the field. That may account for the variable quality of the surveys carried out by different nations' fisheries laboratories.

The catch and landing data that go into the assessment process are also unreliable; the true extent of discards is unknown, as is that of illegal landings. (Scottish fishing communities make alarming guesstimates of the size of illegal landings.) The result is to increase the uncertainty of forecasts of stock sizes and recruitment.

In my experience, research projects important to the future of fisheries do not have high priority with the research councils. I have in mind projects to study the dynamics and interaction of the ecosystems in which fish live, the mechanisms (and rates) of stock recovery in areas closed to fishing and the likely impact of climate change. Marine ecosystems are much less well understood than those on land.

Recently the CFP has rightly emphasised the need for ecosystem-based fisheries management. It is a good idea, but it

Regional Advisory Councils. The "advisory" role of RACs was questioned.

The proposed councils were a welcome first step but they needed to develop a management role. It was hoped that, if the RACs showed they could act responsibly, the EU Council of Ministers would, over time, be prepared to decentralise management responsibility, while retaining responsibility for long-term strategy. It would certainly be desirable to move to a situation where RAC advice would normally be accepted by the commission and by the Council of Ministers, save in exceptional circumstances. The aim should be to move towards the de-politicisation of fisheries policy.

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is far from clear what it means. How does an individual fisherman operate ecosystem-based management?

On the scientific input to the CFP, the commission evidently has concerns. In February [2003], it expressed concerns about the accuracy of catch data and the lack of openness of the scientific advice. But the national scientific advisory services are not designed to provide a rapid response to urgent questions, especially those concerning particular fisheries. The underlying problem is that, when the sources of advice have different lines of accountability, there is no mechanism for managing research strategy.

At the outset, I believed that stock assessments were probably as reliable as possible, given the unreliability of the data. But there may be deeper difficulties. For example, the recovery of stocks in areas closed to fishing is often unexpectedly slow. Is it possible that, when stock sizes are drastically reduced, the fertility of female fish is also reduced? Some land animals have that characteristic. That would make the prospects of stock recovery even bleaker than we now suppose.

On the management of the EU fisheries, I do not want to go over ground that Lord Selborne has covered. He is right, of course, that the European Commission is slow and bureaucratic, but so are almost all other EU organisations. My own particular regret is that it is a poor source of socio-economic information, the Science Technology and Economics Committee notwithstanding. But we should not forget that the commission does not have executive authority; that belongs to the Council of Ministers. In all the circumstances, I believe the commission does an excellent job.

That cannot be said of the Council of Ministers, where national interests overwhelm the paramount need to develop sustainable fisheries. The council seems not to understand or to take into account the limitations and uncertainties of scientific stock assessment. It seems to have no deep concern for conservation. Grandiloquent statements are plentiful, but they are not matched by what actually happens. Then the council's reputation is harmed by the horse-trading seemingly required before quotas can be fixed. Unfortunately, for a country such as Britain, the result is to bolster Euroscepticism.

In reality, the UK fishing industry presents a somewhat amorphous image to the outside world. Fishermen have no sense of ownership of their fisheries, nor do they participate in decision making. The imperfectly enforced regulatory mechanisms increase discards and illegal landings. Fishermen demand that industrial fishing should be banned, but there is no

Cod Recovery Programme. Reference

was made to the cod recovery programme recently proposed by the International Council for the Exploration of the Sea (ICES) and its implications for local communities. It was argued that, if it were approved at the Council of Ministers in December and if it led to a recovery of stocks, the industry would be in a stronger position. On the other hand, the scientific evidence regarding recovery was lacking and it seemed that the recovery of stocks on the Canadian Grand Banks was proving to be a slow process. In the meantime, serious socio-economic problems would arise for local communities and the EU resources available to deal with them were insufficient.

Fishermen saw the ICES report as very negative and the cod crisis had further damaged relations between fishermen and scientists. For example, recently in Scotland skippers had become reluctant to accept scientists as observers on their boats. It was recognised, however, that better dialogue between scientists and fishermen was essential to progress.

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hard evidence of its effects on the ecosystem. Profits are declining and morale is low. The commercial sector, essentially a group of small businessmen in competition, presents a fragmented image.

It is obvious to us all that harvesting capacity must be reduced, but by how much? We need an accurate and reliable calculation because the economic impact will be considerable. And what is the optimum method of regulating catch? There has been long and widespread dissatisfaction with the use of total allowable catches under the CFP. But what is the best way? Effort control (days at sea) may well be the best for the demersal sector.

I turn to the regional advisory councils (RACs); they represent a much-needed first step in the decentralisation of management of the CFP. There are some problems. The commission has suggested, for example, that the North Atlantic region might be one area. Rightly, it also recommends that the RACs should have a fairly small membership. The fishing communities in Scotland worry that the North Atlantic would be too large an area for them to exert any real influence; if the regional advisory councils were small, the whole Scottish fishing industry might have just two representatives. (Areas like the Shetland Islands would like a RAC of their own, and would run it competently.) So the question for the commission is whether RACs should be enabled to set up sub-RACs.

The key problem is how to give RACs executive responsibility, given that the Council of Ministers will not give up ultimate authority. We need to cultivate a culture in which the advice of a RAC is not rejected except in extreme conditions, when the Council of Ministers would be accountable to the ministers of that region.

The question of how scientists should be involved with RACs is another open question. The commission proposes that they should not be members, but sources of advice; others would prefer a closer integration of science into the decision-making process.

That is a potentially contentious issue. When we talk to fishermen, we get one explanation of why science is distrusted: fishermen in many areas continue to find more fish than they are allowed to catch, so they scorn the scientific surveys. They complain that the surveys always use the same sampling points, even though the distribution of fish in the ocean changes. Although RACs could help to bring scientists and fishermen together, they will not suffice on their own.

To bridge the gulf between science and fishermen, two avenues should be explored. One is to give fishermen a greater sense of ownership of the research. The industry could employ its own scientists, existing fisheries laboratories could be freed from explicit government control, or both. Second, because scientists are notoriously bad at explaining themselves to the public, much more effort should be spent on explaining what even many scientists describe as an arcane subject.

Meanwhile, we have the recently published Cod Recovery Plan, which gives no estimate of the time it will take for cod to return. There are very few studies on which such estimates can be based, but if the experience of the Grand Banks is anything to go by, it might actually take as long as 10 or even 20 years. If that were to be the case, the socio-economic consequences for some fishing communities would be literally disastrous.

So, given the multi-species nature of

most fishing grounds, we need to ask whether the Cod Recovery Plan should be abandoned in favour of sustainable fishing of a species such as haddock. Cod still exists elsewhere, after all, so that biodiversity would not be harmed. Then, the socio-economic consequences for the fishing

communities would not be so disastrous.

Finally, what help should be given to fishing communities? We have recently lived through the rapid decline of British coal and steel. We can guess that for fishing communities within commuting distance of cities such as Aberdeen, the conse-

quences of a decline in fishing will be less serious than in areas such as the Shetlands, where fishing and fish processing provide 20 per cent of jobs and where the only other major industry, oil, is in decline. The impact of fishery closures on these isolated communities is difficult to imagine. □

Planning an engine for growth

Maja Kirchner



Maja Kirchner is a member of the Cabinet team of EU Fisheries Commissioner Franz Fischler with responsibilities for the Common Fisheries Policy, Justice and Home Affairs, Social and Employment Policy and legal matters in general. Her previous position was head of Unit for Agriculture at the Permanent Representation of Austria to the EU. During the Austrian presidency in the EU she presided a council working party on fisheries policy.

begin with some critical remarks on science in Europe. The United States and Japan are expert at translating research into dollars and yen, while we in Europe are expert at translating euros into research. In Europe, moreover, scientists are often assessed on the amount they publish and are often tied down for long periods to work on particular questions by inflexible contracts and budgets. The result is they cannot react quickly to management needs. There needs to be more money for scientific work, but more of it must be focused on practical problems, such as fisheries.

We need a deeper understanding of fisheries. Why are stocks decreasing? Why are discard rates so high? And what other fish stocks could be exploited commercially? In that spirit, the Fisheries Research Centre in Aberdeen has pointed to an increased abundance of sardines and anchovies in Scottish waters due to higher water temperatures. We need more of that type of information.

There is much that we could learn from the United States. Research should become a more economic activity, paying for itself. In Europe, scientists have great difficulty in selling their inventions or their findings to industry. In an ideal world, there would also be more interaction between scientists and fishermen. But let there be no mistake: it is up to the fishermen to deliver real catch data if they want to have realistic assessments of fish

stocks. Delivering fictitious data and then complaining that scientists have not delivered good stock assessments is counter-productive.

My second topic is the crisis in the white fish sector, cod in particular. The latest advice from the International Council for the Exploration of the Sea (ICES), received on Monday, is that we should close a number of fisheries: Beaufort, the North Sea, west of Scotland, the Eastern Channel and the Skaggerak and Kattegat.

This is a dilemma, which raises in my mind this important question: does the need to allow the cod stocks to recover take precedence over all other considerations in fisheries policy? That way, we lose the cod and other fisheries, while thousands of fishermen may lose their livelihoods. Is there a way out? Can we refine our recovery plans so that, even if recovery takes longer, fewer fishermen will lose their jobs?

Before the Council of Ministers can decide about the Cod Recovery Plan in December [2003], it must answer this question. I believe that this concept of cod recovery offers a good chance that, one day, the management of this stock will be a more normal task. The Scottish fishing industry has the most to gain from the recovery of the cod stocks. But because progress in the Council of Ministers is slow, it could also be the biggest loser.

We in the commission are often portrayed as a bunch of pencil pushers who

Ownership rights. It was argued that the key to the effective management of endangered fish stocks was through ownership rights. In Iceland there is a broadly effective system of Individual Tradeable Quotas (ITQs) which has evolved over 30 years. Its successful operation also required good science and good inspection systems. Such a system, however, was more easily operated within a single country than within the CFP. The RAS proposals might, however, provide a way forward for the EU if the RACs developed a clear management role. Property rights would be an essential element of the EU's approach but these need not necessarily be based on ITQs.

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are imperiling the Scottish fishing industry by basing our cod recovery plan on a so-called "mixed fishery reality". Some say, "Sod the cod! Let us fish haddock and whiting." Those are short-term solutions that also carry a risk. We know that cod is often caught together with haddock and other white fish, so, realistically, we can achieve less pressure on the cod stocks only if we reduce the pressure on the associated species as well.

Our priority is clear. We want to put in place a long-term recovery plan that can function as an engine for growth. We are now in a box of our own construction: for far too long, we have managed stocks by quotas and technical measures, with only occasional closures. Now we are faced with historically low stocks of several commercially important species.

The charge that the commission is simply using the cod crisis to push through ideas that have long been on its agenda is ludicrous. Take acreage management, which has indeed been on our agenda for a while. It is not there because we want to undermine the Scottish fishing industry, but because we are convinced that acreage is a better management tool than catch quotas.

I hope the Cod Recovery Plan will indeed be adopted by the council in December. Why? Because it would bring an advantage to the Scottish fishing industry. At present, the industry is saddled with the days-per-month system. Our plan proposes a kilowatt day system. The advantage for the Scottish fleet is that it has fewer vessels: your white-fish fleet has decreased by almost a half in two

years. That means that there are more kilowatt days available per vessel.

I turn to the human implications of the white-fish crisis. I have read Lord Selborne's report on the CFP and I understand that you are demanding a more substantial package of transitional aid for the Scottish industry. We in the commission have urged member states to re-orient priorities in their fisheries structural fund and to allocate more money for social efforts.

But one thing is clear: the EU fisheries structural fund has much less money than, for example, the EU olive oil organisation, which has €800 million a year. Whatever financial package is available, it cannot completely solve the fishermen's problem. EU budgets beyond 2006 are now being debated; it is already clear that fisheries will not have more money in future. On the contrary, we have to be careful that money is not diverted to other priorities.

My last topic is that of including fishermen in the decision process. The CFP has often, in the past, been criticised for being too "top down", for being too centralised. We have turned that around and are working towards a "bottom up" approach.

We want to involve local and regional stakeholders more and earlier in the management process. In putting this into practice, we have taken up an idea from Scotland and England, namely zonal management. The outcome is the concept of the RACs. What does that mean in practice? Take the North Sea as an example. The advisory council will be estab-

lished on the initiative of the fishing industries and member states. Fishermen from all countries bordering the North Sea will need to be represented — not only the catching sector but the processing sector and consumers.

The council will have an executive committee that would take decisions by consensus, if possible; otherwise, dissenting opinions would be recorded. So what will the regional advisory councils actually do in practice? They can act on their own initiative, giving governments and the EU Commission advice on management questions. They can also give us advice when we ask them, when we plan particular management measures, for example. Another example of what could be done by a council is this: a few weeks ago, fishermen told us about an increase in the monkfish stock. We have looked into this, taken scientific advice and have been able to increase the quota.

The RAC for the North Sea would cover the Scottish sea area down to the southern part of the North Sea and the Skaggerak and the Kattegat. Other members, scientists for example, could be co-opted onto councils. Some of you believe that the regions that we have chosen are too large, but regional advisory councils will be able to set up sub-groups.

The question of the funding of the RACs came up this morning. We have received initial funding for the first year from the council of €400,000. In subsequent years, each RAC will receive up to €200,000 from the EU's budget. Of course, these sums can be supplemented from other sources. □

Attention sustained on fisheries

The December (2003) meeting of the Council of Ministers on fisheries policy appears to have been a relatively peaceable occasion. Total Allowable Catches (TAQs) appear to have been agreed without flagrant horse-trading.

The process was eased by a recognition that cod adventitiously caught in the pursuit of haddock could be legally landed at ports. As things are, cod is considered the most endangered of all species in the northwestern fisheries of the EU and there have been calls for a complete prohibition of cod landings.

As yet, however, there seems to have been little tangible progress towards the devolution of fisheries management to regional advisory committees, which was agreed, in principle, in December 2002. Several speakers at the foundation's Edinburgh symposium emphasised the importance of regional management in the preservation of fish stocks, but the

constitutional impediments in their creation are formidable.

Meanwhile, the future of the UK fisheries industry has been illuminated by a paper prepared by the prime minister's Strategy Unit and published on 25 March (www.strategy.gov.uk). In contrast with most other documents on the subject, the paper, entitled *Net Benefits*, is up-beat in tone, declaring that the UK fishing industry could have a "bright and prosperous future" if only it takes a realistic view of the problems it faces.

One striking proposal is that there should be a further reduction of the size of the British white-fish fleet of 13 per cent, funded by £40 to 50 million of public funds. The paper also argues for a four-year "tie-up" of a third of the fleet remaining, on the grounds that such a step would allow currently hard-pressed stocks to river in size. (The paper argues that the tie-up should be funded by the fishing industry itself.) These proposals are likely

to be resisted by the UK industry.

More radical still, the paper argues that Britain should embark on a process of replacing the current regime of quotas to one in which fishermen have individual quotas which can be traded (called ITQs). The objective is to give fishermen a sense of ownership of the fish stocks and thus an interest in their conservation.

The document says the Government should aim at completing this process by 2006, making a start with the inshore sector of the fishing industry (which harvests mostly shellfish).

The authors of the study are also alarmed at the scale on which the industry at present fails to comply with the rules. Of necessity, it cannot estimate the scale of illegal landings of fish, but is correct in saying that the practice undermines attempts to estimate the sizes of existing stocks correctly. □

John Maddox

Managing urban traffic congestion

On 18 June 2003, three months after the introduction of the London congestion charge, the FST held a meeting to discuss how road congestion might be managed effectively in the urban environment.

Malcolm Murray-Clark

Director of congestion charging at Transport for London.

Three months after London's mayor Ken Livingstone introduced congestion charging, road traffic in the centre of the city has eased considerably more than supporters and critics of the scheme predicted when it was launched in February 2003. Under the scheme, private car drivers entering central London pay a daily fee of £5. Early indications are that 16 per cent fewer motor vehicles are entering the charge zone.

Politicians and officials from many other capital cities are eagerly watching what is happening here in London. I will explain how the scheme got off the ground, the lessons we have learnt and where we might go next.

By the late 1990s London's traffic problems had become a major worry for business and general public alike. The Government initiated a study, the Review of Charging Options for London (ROCOL). The ROCOL report, published in March 2000, provided a basis for advice to the new mayoral candidates. It included a recommendation for congestion charging in Central London.

An important part of the legislation that supported the scheme was hypothecation whereby people could see that surplus income arising from the charges would go back into improving public transport.

From the beginning it was recognised that congestion charging will only work as part of a wider transportation strategy, which includes improvement in public transport. A commitment was made, early on, to monitor the impacts carefully so that Transport for London (TfL) could understand the consequences and make changes based on facts wherever possible.

When Mayor Livingstone was elected, he came to TfL and said "I'd like you to introduce congestion charging in two and a half years". This was a tall order; the ROCOL study had said it would take some three years.

The first public information message that we needed to get across was that congestion charging would not affect the vast majority of Londoners. Of the million people who travel daily into Central London, 85 per cent come in by public transport; our influence is on the remaining 15 per cent. The second message related to what people who might be affected needed to do and when.

Map of the congestion area



TfL tried to make the charge payment — a £5-a-day flat rate during weekdays — as easy as possible. Retail has proved to be the most popular payment channel, with 35 per cent of the 100,000 people who pay daily using this option. Text messaging has proved popular, used by 19 per cent.

Enforcement is based on proven technology — cameras and number-plate readers — which was extensively tested before we went live. The legislation also allows clamping and removal of those vehicles belonging to people who persistently evade payment of the charge. There is no point in having a scheme that is not well enforced.

TfL predicted that congestion would reduce by 20 to 30 per cent inside the zone. We anticipated an increase in traffic speeds and, generally, an improvement in bus journey times and reliability. We have always said that it would take six months to get an indication of the effect on traffic and a year for business, environmental and social impacts.

After three months, the overall reduction in vehicles entering the charging zone is 16 per cent, while for cars the reduction is 30 per cent. Traffic inside the zone is down 16 per cent (our forecast was 10–15 per cent). Average traffic speeds are now 17 k.p.h. compared to 13 k.p.h. Congestion during charging hours is down 30 per cent, while journey times from the rest of London to the central area are down by some 14 per cent.

We have set up a five-year monitoring programme to look at traffic and transport, and the wider sociological, environmental and business impacts.

About 150,000 fewer car trips are being made in and out of or through the zone. What has happened to all these people, these ex-car commuters? Some 20 to 30 per

cent are diverting round the area, although traffic speeds and volumes haven't changed much on the Inner Ring Road, the boundary route.

Some 50–60 per cent of the ex-drivers have started to travel on buses, some on the Tube. There are knock-on effects to confuse the statistics: some of the people from the Tube have gone on to the buses. Some 15–25 per cent have switched to alternative modes, for example, taxis, motor cycle and bicycle. Overall activity on the public transport network has only increased by some 3 per cent. The increase in bus use has been catered for by the provision of extra buses and, overall, public transport is coping well with the pressure.

The amount of time that buses are held up as a result of congestion has been reduced by 50 per cent. In the first few weeks of operation, the bus drivers found that they were arriving at the bus garages or at bus stands too early because there wasn't the congestion that they were used to. Generally, bus passengers are getting a more reliable and faster journey.

What are the key lessons? First, there has been a clear and single-minded commitment from the mayor. That single-mindedness has been needed for such a scheme to be implemented.

Second, a clear policy objective — reduced congestion — has been vital to successful design and implementation. Other key elements are an integrated and committed TfL team, close management of the contractor and effective proving and integration of the IT systems and delivery of the bus improvements.

Finally, the importance of public information campaigns should not be underestimated. We spent a lot of money on a focused, well-targeted public information campaign and the work we have done since indicates this was a success in ensuring that people knew about the scheme.

For the future, the mayor has asked us look at the feasibility of an extension to the scheme. We would also like to be moving towards the trialling of new technology. □

Mike Talbot

Head of the Transport Management Division at the Department of Transport.

Malcolm Murray-Clark has focused on one way of tackling traffic problems, the London congestion charge. I'd like to paint a broader picture from a central

government perspective and look at other options for managing congestion in urban areas.

In terms of national transport, the aims set out by the Department for Transport (DfT) are to tackle congestion, improve accessibility, reduce road casualties, respect the environment and support the economy. Congestion charges are significant in making progress on the first priority and can also contribute in other areas — stimulating the economy, for instance.

Government policy is based on three pillars: policy, powers and investment. Policy was outlined in the 1998 transport white paper and the Ten Year Plan published in 2000. Policy has since been refined by subsequent announcements and recommendations. The powers to back these policies up came in under the Transport Act 2000 and also the Greater London Authority Act 2000. Funding increases were announced in 2000, with significant investment going into transport over a long period of time. Taken together, the funding commitments and long-term policy objectives mean that more resources are being invested in transport now than for some long time.

The DfT agrees a public service agreement with the Treasury, which provides the funding. In that agreement, the DfT's target for urban areas is to reduce congestion to below 2000 levels by 2010. The target for local public transport, which is significant in towns, is to increase use by 12 per cent from 2000 to 2010 and to improve accessibility, punctuality and reliability of buses and light rail in urban areas.

As a department we are committed to achieve certain things though we have little *direct* control over what happens on most of the road network. About 4 per cent of the network is looked after by the Highways Agency. The other 96 per cent is managed by the local authorities who are key players.

Nationally, road congestion is being driven by the increase in traffic volume, which has risen in urban areas by 12 per cent over the past 10 years. As in London, peak traffic speeds across the country have fallen by 2 per cent in just over two years.

Congestion is a widespread problem. It is fuelled by the "school run", superstores and local events. We need to find local solutions within a national framework; local authorities produce local transport plans.

So we need to make the most of the existing capacity. There is a continuing search for new ways of coping with roadworks for instance. A number of ways of tackling these problems are being considered, but I will just mention two on the utilities side that have received quite a bit of attention. First, is the idea of charging a penalty where a company takes longer than

they agreed to carry out works and, second, as an alternative to that, is the "lane rental" approach that charges the utility for occupying the road space while it does its work.

When accidents and incidents happen, they need to be dealt with quickly. We need to improve the coordination between the highway authorities, the police and other parties that need to be involved, such as recovery organisations. The Highways Agency is focusing on these problems on the inter-urban network but there needs to be focus in urban areas also.

Pro-active, advance management of events is also important.

The Secretary of State for Transport, Alistair Darling, has talked about the concept of the "traffic manager" who would have responsibility for keeping the network moving. This would involve getting all the different departments within an authority to communicate, so that all the activities hang together in a coherent way.

Also we must not forget that streets are not just about vehicles; they are also about places for people to meet, to talk, to shop, to live, they are for cyclists and pedestrians too. They exist to access the needs of society.

The other side of the equation is what we can do to influence demand. Planning policies can be crucial, determining the location of housing, shops and other developments. Public transport policies, including improved bus routes, convenient ticketing and light rail links are also vital.

New technologies are now emerging that enable us to achieve much more in these areas. Traffic management authorities monitor performance using CCTV cameras to detect incidents, for example, and rapidly adjust traffic signals to control traffic build-up. Information is delivered to drivers using variable message signs; in the medium-term future this could be delivered through in-vehicle systems.

Technological advances will also make alternatives to the car more attractive. Bus services can be made more reliable by linking GPS devices on buses to the traffic signals to bring the green up earlier. The system can feed into a screen at the bus stop that tells you when the bus is due.

Ticketing systems on public transport can make multiple journeys easier. Cyclists and pedestrians can also benefit from these advances, in the form of intelligent road crossings, for example.

The message from national government is that urban congestion management needs local solutions within a national framework that will provide policy, legislation, advice and funds. Congestion charging has had a dramatic effect in London but it won't be appropriate everywhere; each area will need to be looked at individually.

There is certainly no "one size fits all"

solution to traffic congestion. We need to look at each area to see what the problems are and what combination of approaches can be put together to create a package that will deliver an improvement in the way that the network operates. Local authorities also need the powers and the resources to do this job. □

Jerry England

*Director of Water Operations,
Thames Water Utilities.*

It is becoming increasingly difficult for utility companies to balance the needs of customers with those of road users. Thames Water has more than 100,000 km of pipes, the majority of which are under the streets of London. Many are old and must be repaired or replaced if we are going to protect our increasingly scarce water resource and maintain supplies to customers.

Streetworks to repair and maintain pipes are therefore unavoidable and disruptive. To minimise the impact, the needs of all stakeholders must be understood and a robust controlling framework developed.

Thames Water carries out approximately 80,000 streetworks activities every year. The majority of these take only a few hours. For the larger works we always consider the use of "no dig" techniques to minimise disruption. The recently built London Water Ring Main, the "M25" for water, is an example. The construction of the main itself also caused little surface and traffic impact as it was carried out almost entirely in tunnels. The ring main is 80 km long — the longest tunnel in the country — and it distributes water to Central London from treatment plants in the west and north while also reducing pressure on the shallow distribution mains under many major roads. It has been very successful in stopping disruptive bursts, thus reducing streetwork activity.

For most works, an excavation is required to an existing main to make a repair or connection. We are constantly looking for less intrusive techniques that can be used to reduce the impact. However, the use of trenchless technology to renew existing mains and service pipes is often hindered by "congestion" of pipes and cables below the streets. Directional drilling is often impossible because of the risk of hitting other pipes.

Unfortunately there is little scope for coordination with other utilities, particularly for emergency work. Often the various utilities are not located in the same places. But we are investigating the prospect of more trench sharing with Transco for major renewal projects. We both have large underground pipe networks, many of which will need to be

replaced in the coming years.

Despite our efforts to use “no dig” methods and trench sharing, we expect that in the next few years we will need to carry out significantly more major streetworks than in the past. More than half the water mains in London are over 100 years old. The network has around 10 million joints and the loss of water through leakage continues to be an issue. Leakage represents around 30 per cent of our total supply. The aggressive nature of the soil is eroding the pipe walls, while traffic volume subjects the pipes to forces they were not designed for.

There are frequent calls for tighter control of streetworks as a solution to traffic congestion. However, there is a rigid regulatory framework already in place, the new Roads and Streetworks Act that defines when and how we can do work. However, this Act does not apply to the highway authorities themselves who carry out the majority of streetworks.

There are heavy penalties built into the legislation for non-compliance with the

Act. The highway authorities also have a statutory right to inspect all our works and charge us the cost of these inspections. I would not argue that these measures are unreasonable, as clearly we need to do our works in a timely way and to the required standard. However, there are now a number of further changes being considered by government. These include lane rental charges where we are charged for the whole period of our works. This is a charge for work that must be done and as such is a tax on us, and ultimately on our customers.

We often stand accused of not coordinating our works. But we do work closely with highway authorities and other utilities to share our plans to enable coordination. More often, coordination is about ensuring we are not all working in the same area at the same time, or ensuring that appropriate traffic management is agreed and implemented.

The population of London is forecast to grow by 700,000 by the year 2016 and the demand for water continues to rise, with

increasing use of appliances such as dishwashers and power showers, and potentially drier summers leading to more use of hose pipes. Climate change may mean more extremes: drought and flood conditions impacting the subsoils of London and stressing the pipes further.

We need to be more creative in finding ways to reduce the time we spend digging up the streets. Where we have to dig holes we need to change our approach to working at off peak times, but this may mean more noise in the evenings and weekends if traffic congestion is also to be minimised.

We recognise the implications of our activities and the need to minimise the impact on road users and customers, but we cannot avoid the need to undertake these essential works to maintain services. Thames Water is committed to maintaining a continuous supply of water to our customers and to minimising the impact of our works through working with other utilities, and highway authorities, for the common good. □

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The second part of the public debate was what we called “the narrow but deep strand”, an attempt to use selected groups of people to be exposed to and discuss the issues, do their own research between meetings and return to engage in further debates on GM issues. Was there a silent majority that was different from the people who had come to the main meetings? The answer was no.

We reported to the secretary of state at the end of September, giving the Government a snapshot of public opinion. That opinion is not homogeneous, nor is it implacably opposed to GM; you should regard it as an expression of view of uncertainty and of precaution about a technology.

The Government now has a better basis of data, intelligence and analysis on GM than any other government in the world. The exercise has yielded a powerful study of the science, the economics and public opinion. It has subsequently been complemented by the AEBC's report on Coexistence and Liability for GM Crops. This is a solid foundation upon which to base its future policy around the potential commercialisation of GM crops. □

Background Information

www.gmsciencedebate.org.uk
www.number-10.gov.uk/su/gm/index.htm
www.gmpublicdebate.org
www.defra.gov.uk/environment/gm/index.htm
www.royalsoc.ac.uk/gmplants

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25 February 2004

University funding – a long-term fundamental review?

The Lord May of Oxford OM ACKt FRS FMedSci, President, The Royal Society
Professor Sir Graeme Davies, Vice-Chancellor, university of London
Dr Mark Walport FMedSci, Director, the Wellcome Trust
Professor Nick Cumpsty FEng, Chief Technologist Rolls Royce
Engineering and Physical Sciences Research Council, QinetiQ, Rolls-Royce and The Royal Commission for the Exhibition of 1851

02 December 2003

The Lambert Review and the DTI Innovation Review

Mr Richard Lambert, Chairman, HM Treasury - Lambert Review
Dr David Hughes, Director General, Innovation, Department of Trade and Industry
Sir Colin Lucas, Vice-Chancellor, University of Oxford
The Lord May of Oxford OM AC FRS FMedSci, President, The Royal Society
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25 November 2003

Energy policy: the renewables targets

Dr Bernie Bulkin, Chief Scientist, BP
Dr Malcolm Kennedy, Chair, Energy Working Group, The Royal Academy of Engineering
Ms Claire Durkin, Director, Energy Innovation and Business Unit, Department of Trade and Industry
BRIT, National Environment Research Council, The Royal Academy of Engineering

18 November 2003

Nanotechnology: threats and opportunities

The Lord Sainsbury of Turville, Minister for Science and Innovation, Department of Trade and Industry
Professor Sam Stupp, Professor of Materials Science, Chemistry and Medicine, Northwestern University, USA
Professor Stephen Holgate FMedSci, MRC Clinical Professor of Immunopharmacology, School of Medicine, University of Southampton
Professor Ann Dowling CBE FRS FEng, Chair, Royal Society and Royal Academy of Engineering Study of Nanotechnology, University of Cambridge
Council for the Central Laboratory of the Research Councils and QinetiQ

11 November 2003

Does manufacturing have a future in the UK?

The Lord Haskel, House of Lords
Mr Simon Edmonds, Director, Material and Engineering Sector Unit, Department of Trade and Industry
Mr Tim Woodbridge, Chief Executive, Web Dynamics
Professor Mike Gregory, Director, Institute for Manufacturing, University of Cambridge
Aerial Facilities Limited, SEMTA and the Textile Institute

06 November 2003

Visit to Addenbrooke's Hospital

Sir Keith Peters FRS PMedSci, President, The Academy of Medical Sciences
Dr Mary Archer, Chairman, Addenbrooke's NHS Trust Hospital
Professor Krishna Catterjee FMedSci, Professor of Endocrinology and Director of Wellcome Trust Clinical Research Facility
Professor Alastair Compston, Professor of Neurology
Professor Bruce Ponder, Professor of Oncology
Professor John Pickard FMedSci, Professor of Neurosurgery and Chairman and Clinical Director of Wolfson Brain Imaging Centre
Dr Robert Winter, Medical Director, Addenbrooke's NHS Trust
Dr Richard Henderson FRS FMedSci, Director MRC Laboratory of Molecular Biology

28 October 2003

The GM debate

Professor Howard Dalton FRS, Chief Scientific Adviser, Department of Environment,

Food and Rural Affairs

Mr Ian Coates, Strategy Unit, Cabinet Office
Professor Malcolm Grant CBE, Chair, GM Public Debate
Biotechnology and Biological Sciences Research Council, Natural Environment Research Council and the Natural History Museum

23 October 2003

Fish stock assessment and the CFP

Sir David Smith FRS FRSE, Chair, RSE Inquiry into the crisis in the Scottish fishing Industry
The Earl of Selborne KBE FRS, House of Lords
Ms Maja Kirchner, Member of Cabinet of Commissioner Fischler, European Commission, Brussels
Sir David Smith FRS FRSE, Chair, RSE Inquiry into the crisis in the Scottish fishing Industry, Royal Society of Edinburgh
Fishmongers' Company and The Royal Society of Edinburgh

07 October 2003

The Lord Lloyd of Kilgerran Lecture

Mr Tim Smit, Chief Executive, The Eden Project
Aerial Facilities Limited and Southampton Oceanography Centre

16 July 2003

The Research Assessment Exercise Review: how should university research quality be measured?

Sir Gareth Roberts FRS FEng, Chairman, RAE Review
Sir David Watson, Vice Chancellor, University of Brighton
Dr Chris Henshall, Group Director, SEB, Office of Science and Technology, DTI
OST and HEFCE

09 July 2003

The sustainability of university research: the dual support system

Dr Chris Henshall, Group Director, SEB, Office of Science and Technology, DTI
OST and HEFCE

18 June 2003

Congestion management in London: traffic and roadworks

Mr Malcolm Murray-Clark, Director, Congestion Charging, Transport for London
Mr Mike Talbot, Head, Traffic Management Division, Department for Transport
Mr Jerry England, Director, Water Operations, Thames Water
Department for Transport

10 June 2003

Adding value to research & development

Professor Gordon Edge CBE, Chairman, Generics Group
Sir Peter Williams CBE FRS FEng, Chairman, ETB
Professor John O'Reilly, Chief Executive, EPSRC
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03 June 2003

Horizon scanning

Professor Sir David King KB ScD FRS, Chief Scientific Adviser to the UK Government and Head, Office of Science and Technology
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Dr William Harris, Director General, Science Foundation Ireland
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