fst journal

The Journal of the Foundation for Science and Technology
(formerly Technology, Innovation and Society)

Volume 19, Number 10, April 2009

Science strategy

The Scottish economy

Food security

Physics review

Obituaries

THE FOUNDATION FOR SCIENCE AND TECHNOLOGY

THE FOUNDATION FOR SCIENCE AND TECHNOLOGY

The Foundation for Science and Technology
10 Carlton House Terrace
London
SW1Y 5AH

Telephone
020 7321 2220

Fax
020 7321 2221

e-mail
fstjournal@foundation.org.uk

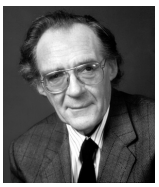
Editor
Sir John Maddox FRS

Production Editor
Simon Napper

Sub-editors
Judy McBride, Charles Wenz

Design and layout
James McQuat

www.foundation.org.uk



The Council of the Foundation for Science and Technology is sad to record the death of Sir John Maddox FRS, Editor of FST Journal, on 12 April 2009. A full obituary will be included in the next issue.

fst journal
Volume 19, Number 10, April 2009

contents

Science – making a difference

A campaign to create a more science literate society, highlighting the science and technology based industries of the future has been launched. *Science So What? So Everything* aims to show people how science benefits them in their everyday lives, is crucial in strengthening the UK economy and is vital to meeting some of the major challenges of our time.

Science Minister Lord Drayson said: "There is a perception among many of our people that science is too clever for them or elitist in some way. We must challenge myths like these if we are to build a prosperous, science-literate society, able to tackle the difficult issues that modern science presents and work them through to create the jobs and growth of the future."

The campaign builds on work started by the Government's Science and Society Consultation in 2008.

A poll published at the time of the launch shows a high proportion of people have faith in science to make positive changes in the future. Of those polled, 48 per cent said they expected science to find a cure for cancer in the next 30 years with 38 per cent expecting drought-resistant crops over the same period.

Asked what would have the most impact in shaping their futures, 26 per cent said science, putting it ahead of politics, family and religion. However, the sample poll showed that, when asked to choose from a selection which group of people has the most effect on our daily lives, only 3 per cent selected scientists. ❒

www.direct.gov.uk/sciencesowhat

The value of higher education

An evaluation published at the beginning of April by the Higher Education Funding Council for England (HEFCE) shows that the money put into higher education institutions in England for working with businesses and the community has yielded benefits worth many times the investment over the past seven years.

The evaluation calculates for the first time the value for money achieved by long-term public investment in higher education institutions (HEIs) working with the economy and society. The evaluation states that nearly £600 million has been put into higher education (HE), primarily through the Higher Education Innovation Fund (HEIF), and estimates that this has generated a minimum of between £2.9 and £4.2 billion in value. ❒

www.hefce.ac.uk/pubs/rdreports/2009/rd05_09

Prime Minister pledges support for science research

In a major speech in Oxford at the end of February, Prime Minister Gordon Brown pledged his support for scientific research in the UK. Delivering the Romanes Lecture at the Sheldonian Theatre, he said that the Government would invest more money in scientific research "than at any time in the country's history".

He also announced a 'national ambition' to offer classes in the three sciences, rather than a combined science course, in 90 per cent of all state schools within five years. It is hoped that the move will boost the number of youngsters who continue to study science after leaving school.

The Prime Minister confirmed that the Foreign & Commonwealth Office (FCO) is to appoint its first Chief Scientific Adviser (CSA) to work closely with the Chief Science Adviser of US Secretary of State Hillary Clinton. As *FST Journal* went to press, the post was being advertised.

He said that ministers would look for new ways of working with the American Government to take advantage of investment from President Barack Obama's economic stimulus package. ❒

www.number10.gov.uk/Page18472

Office of Life Sciences

A new Office for Life Sciences (OLS) has been created to address key issues affecting the pharmaceutical, medical, biotech and devices sectors. By the end of July 2009, the Office is due to have taken action to "produce a real difference to the operating environment" for life sciences companies by working across Government to address a range of key issues, including those raised in *The Review and Refresh of Bioscience 2015*.

Working with departments responsible for these areas, the Office will coordinate national policy, undertaking work to build a sustainable and integrated life sciences industry in the future. It will look at what steps can be taken to improve access to finance for SMEs and to stimulate investment in the life sciences industry.

It will also be considering how the NHS can be more effective as a champion of innovation, possible ways of getting medicines onto the market faster, how the UK can become a more attractive base for clinical trials, and how to effectively market the industry globally.

Announced by the Prime Minister at an industry summit in January, the Office is led by Science and Innovation Minister Lord Drayson. Dr Robert Sullivan has been appointed Director of the Office for Life Sciences, which is part of the Department for Innovation, Universities and Skills. ❒

www.dius.gov.uk

Low carbon strategy

A 'new industrial activism' is to be put at the heart of the Government's emerging Low Carbon Industrial Strategy as figures show the UK green goods and services sector is already the sixth biggest in the world.

Prime Minister Gordon Brown, Business Secretary Peter Mandelson and Energy Secretary Ed Miliband met business leaders at a Low Carbon Industrial Summit in London at the beginning of March to map out the UK's industrial priorities for taking advantage of the new global low carbon economy – currently estimated to be worth £3 trillion globally and employing over 880,000 people in the UK.

A pamphlet published at the launch, entitled *Low Carbon Industrial Strategy: a Vision*, highlights a range of companies in the UK already taking advantage of low carbon opportunities and sets out the scope and ambition of the Government's plans. Businesses and others with an interest are being asked for their input through an interactive website to inform a final Strategy to be published by the summer.

The Government's Low Carbon Industrial Strategy aims for a step change in four key areas:

- Energy efficiency to save businesses, consumers and the public services money;
- Putting in place the energy infrastructure for the UK's low carbon future – in renewables, nuclear, Carbon Capture & Storage and a 'smart' grid;
- Making the UK a global leader in the development and production of low carbon vehicles;
- Ensuring our skills, infrastructure, procurement, research and development, demonstration and deployment policies make the UK the best place to locate and develop a low carbon business and to make sure international business recognises that. ❒

www.berr.gov.uk/whatwedo/sectors/low-carbon/lowcarbonstrategy/page50105.html

A meeting of the Foundation for Science and Technology on 4 February 2009 heard Science and Innovation Minister Lord Drayson issue his challenge on the UK's future science strategy.

The future strategy for science and innovation in the UK

Paul Drayson

I want to stimulate a debate on our national science and innovation strategy, and whether it is adequately geared up to cope with the future.

Since day one in this job, the global economic downturn has dominated. With its origins firmly linked to systemic problems in the global financial system, the current downturn has been more severe and more rapid than anything we have seen in recent memory. The nasty combination of a recession with a global credit crunch is affecting every sector and every market.

I can relate personally to the impact of recession on businesses and on people. As an undergraduate apprentice sponsored by British Leyland in 1979, I well remember Red Robbo's picket lines ranged in front of K Gate at Longbridge and saw a once-great business collapsing before my eyes. As a science entrepreneur after my PhD, during the difficult period of the early '90s, I had to make colleagues redundant and I had the bank manager threaten to put my company into receivership if I was not able to pay off the business overdraft.

I got through those tough times, but those experiences taught me some lessons. Like the importance of having a broad portfolio of products and services; not relying too much on one area which can expose you to sudden risk; of knowing what your strengths are – and of playing to them. And being aware of limited resources – and investing them wisely.

Applying the lessons

I mention these lessons because I believe we should ask ourselves – in the midst of this global economic downturn – are we applying these lessons well enough to our science and innovation policy? I believe that, right now, people, businesses and indeed countries are asking themselves essentially two questions.

The first is about the here and now: how are we going to get through these tough times? The second, though, is about the future: how do we get ourselves in the best position to exploit the upturn when it comes?

Now, from a science and innovation perspective, we in this country start from a very strong position. We have transformed the science base over the last 10 years – a more-than-double, real-terms increase in science spending, rising to almost £6 billion a year by 2010-11. And among the most positive changes over the past 10 years has been the way in which the science base has forged productive links with business. Universities have been growing their external income – reaching around £1.8 billion in 2007. And I believe – I have seen for myself – that we have seen effectively a renaissance in science and innovation in this country.

And it is at times like these – when there is a squeeze on Government revenue – that the virtue of a ring-fenced science budget really becomes apparent. The ring-fence protects money for science from competing demands in the short-term. In the long term, it provides the reliable support that the research community needs to deliver top results. As a result, the quality and number of science innovations from our universities have never been higher, and the investment opportunities for spin-outs, and for technologies from our science, have never been better – as I have been told very recently by the venture capital industry.

However, the growth over the last few years in financial services has sucked talent and investment from high-tech manufacturing industry. Despite a strong nascent high-tech industry and strength in the number of university spin-outs, not enough of them have grown into large high added-value manufacturers. Now the current lack of capital and credit is threatening to choke off growth in the high-tech sector – just when we need it most. So, the current downturn makes these issues pressing and demands action to rebalance our economy.

The Lord Drayson of Kensington is Minister of State for Science and Innovation at DIUS. After completing a PhD in robotics, he successfully grew a biotechnology company, Powderject Pharmaceuticals, into a leading manufacturer of vaccines. On his appointment as Minister he was invited to attend Cabinet meetings and to participate in the National Economic Council. He chairs a Cabinet Committee focussing on science and innovation across Government.

Future growth

What are the future growth areas? Where will future jobs and wealth come from? Where does the UK really have the potential to take world-class science and build world-class business from it? What is the Government's role in facilitating this transition?

Peter Mandelson has argued for what he calls 'a new industrial activism', where Government sets out a strategic framework as a bridge to the future; where investors and business have, as a result, confidence in the long-term direction.

What is the role of science policy here? I believe it is important for me to set out some key principles.

First, it is vital we maintain the investment in science that we have made over the past 10 years. As the Prime Minister has said, we will maintain our investment in science: Britain's future depends on it.

Second, it is vital we maintain our focus on excellence. Four out of the top ten universities in the world are British. Our science is the most productive and efficient in the G8.

Third, it is vital we maintain our investment in pure, fundamental science as well as in applied science. Because science is serendipitous, we cannot predict where the breakthroughs will come from. It is also what attracts people and investment to science and underpins the UK's international science reputation.

Fourth, we need to maintain a broad base in science, because we do not know where the challenges are going to come from – for example, who would have predicted the recent collapse of bee populations (we really do need to understand that better now) – and because the

synergies from a broad-based excellence in science promote world class leadership and interdisciplinary breakthroughs. Only with a diverse range of skills and deep reservoirs of knowledge will we have the flexibility to provide the expertise required in different fields.

Take the STEM agenda, for example. We still need larger cohorts of young people studying maths, physics, chemistry and biology post-16 at A-level, before going on to both pure and applied degrees. And we know that the best preparation for this involves boosting the numbers of pupils taking triple science at GCSE. Between 2002-3 and 2006-7, there was an 11 per cent increase in the number of students taking first degrees in the STEM subjects, and a 35 per cent increase in students getting masters degrees.

And yet, at the moment, just one in 10 pupils from maintained schools achieve a single pass in an A-level science subject. I am determined to address the situation – and to build public support for, and engagement with, science in this country. That is what lies behind the 'Science So What: So Everything' media campaign that the Prime Minister launched last week.

Fifth, it is vital that we stick to the Haldane Principle in setting our research priorities. Peer review, the judgements of the science community and the independence of the Research Councils, are all key to our continued success.

Starting a debate

So far, I imagine we are all in broad agreement. However, I want to spark a debate about whether we need to go further than the five principles I have listed above. Given that this global economic downturn is radically and dramatically reshaping the relative and absolute economic strength of nations – and that other nations are making choices about which areas to focus on in order to drive future growth – should we not do the same to boost the economic impact of our science base?

Has the time come for the UK – as part of a clear economic strategy – to make choices about the balance of investment in science and innovation to favour those areas in which the UK has clear competitive advantage? As Peter Mandelson has said, "Science is not only the ladder by which we will climb out of the downturn – it is also critical to our success in the upturn."

I know that the Research Councils and the Technology Strategy Board have already begun to do this. Indeed, a key feature of the budget settlement covering the current spending period was the announcement of a cross-council grand challenge. These grand challenges adopt a multi-disciplinary approach to the most pressing issues facing our society and our economy: the consequences of an aging population, global warming, the search for renewable energy and solutions for global insecurity. The Research Councils are now working together on an unprecedented scale.

The same goes for the Technology Strategy Board, whose innovation platforms are financing collaborative ventures in the same areas – on low-carbon vehicles, intelligent transport and assisted living – and whose knowledge transfer partnerships are supporting business doing cutting-edge work with universities.

We have made a start. My question is whether we need to go further and – while maintaining our overall investment in science – shift a greater balance of our investment toward those areas.

Perhaps we could consider three criteria for identifying those areas for greater focus:

- where the UK has a clear competitive advantage;
- where the growth opportunity over the next 20 years is significant; and
- where the UK has a realistic prospect of being No1 or No2 in the world.

It is important that any decision should not be taken by Government ministers alone but would be based firstly upon a debate concluding that such a choice makes sense and then the emergence of a consensus about what those areas are – between the private and public sector; between academia, Government and business.

The global environment

It is also important that any assessment is done in the context of the global environment – taking account of what other nations are doing. So much of science is collaborative. Take the United States: the Obama administration has signalled its intent to massively increase science spending as part of its economic stimulus package. The President has pledged to double the research budgets of the National Institutes of Health, the National Science Foundation and other key agencies over the next decade – with a focus on such fields as computing and nanotech. He wants to increase investment in the US space programme and in the Pentagon's Defence Advanced Research Projects Agency. And we all know about the new willingness in the United States to engage with genetic research, particularly stem cells.

The likely revival in US science has to be an additional spur for the UK to strengthen its position too. They are raising their game: we must identify where our competitive advantage lies and play to our strengths.

Now, I do not intend to provide you with my views on what those areas may be – that is Step 2, once we have determined that the identification of priority fields is necessary and important. But I am prepared to talk about one area – which I believe to be a candidate – to illustrate my point, to show how this analysis could work in practice, and the difference it could make.

Medical research has long been a strength of the UK. We accorded it the highest priority in the most recent spending review, and – last June – approved the £200 million rebuild of the Laboratory of Molecular Biology in Cambridge. It has long been supported by the British public, most notably through sustained and generous giving to our medical research charities. We have a rich history of Nobel laureates and scientific breakthroughs which have had a global impact.

The demand for medical research to deliver improved healthcare is both global and infinite – presenting governments across the world with increasingly difficult resource allocation decisions as medical science presents ever more complex and expensive treatments based upon our accelerating understanding of the science. Aging populations and long term global trends such as obesity further exacerbate demand.

We have a strong industrial base in life sciences – No 2 to the United States with both big pharma and biotech resident here, although they are presently facing tough challenges: big pharma experiencing declining R&D productivity; biotech suffering a capital funding drought.

So that makes two out of three of my criteria. What is the third – our clear competitive advantage? The National Health Service: an amazing resource for fostering research and innovation in patient care, drug discovery, medical devices and services – a resource that we have only just begun to realise.

Take one area of medical science, albeit a very important one: genomics – where the study of the genetic basis of disease may be advanced hugely through access to large and well documented patient databases – such as those generated by the NHS since its inception in 1948.

No other country has this. Nor does it have a healthcare system so universally appreciated by its people as does the UK. This is a major advantage for us as a nation, not just in providing a 21st century healthcare system for all – free at the point of use – but at the same time providing the lever to create a world lead in medical research and from this a world lead in the life sciences industry: both pharma and biotech. In turn, they can provide the growth and jobs that will help to rebalance our economy and fund future public investments, such as in scientific research.

We have already done it in cancer. We are now arguably the leading country in

the world when it comes to cancer trials. The UK is recruiting more people to trials than the United States, which has five times our population. That state of affairs is based upon a long term commitment to science and clinical research. We could do the same in stem cells, thanks to the excellent debate in this country which led to thoughtful and effective legislation.

Following a recent meeting at No10 between the Government and the life sciences industry, it was agreed that a new Government Office for Life Sciences would be set up – to implement a strategic plan of action to ensure we fully realise our leadership position in this area.

To do so we are going to have to find answers to problems over finance, IP and procurement, and these will not be easy. But we do have the 'To Do' list – and a combined commitment from Government and industry to work our way through it.

But this is not the only area that Government is working to develop such a strategic framework. My colleague Stephen Carter has launched his interim report on Digital Britain that scopes out the choices facing us in the creative, digital and communications sectors. Ed Miliband is doing the same for green energy.

I believe we need to complement these strategic initiatives in life and earth sciences, in the digital and communications sectors, with an analysis and a debate on whether our science research focus is where it needs to be. For example, are we spending enough on the science behind medical research? And if we need to spend more, what are we going to spend less on?

Let me be quite clear. I know that medical science requires strength in many disciplines – statisticians and physicists as well as biologists and chemists, for example. It is not, I believe, just a debate about disciplines. Often the best research is inter-disciplinary and our leading facilities, like the Diamond synchrotron, are used by scientists in many different fields. It is a debate about our focus and the alignment of this focus to ensure that the UK continues to prosper as the world accelerates into the new century.

I am confident that we are up to the challenge – and I look forward to debating these issues with you. ❐

A webcast of Lord Drayson's speech and the responses, together with full presentations, are available on the FST website at www.foundation.org.uk.

Following Lord Drayson's speech, the meeting heard a number of responses to his challenge.

Consider *all* the candidates for investment

Martin Rees

As a scientific nation, the UK is, by most indicators, second only to the USA. This is largely because of our strong research universities. We are the only country outside the US to have several in the 'premier league'. The most readily measurable economic benefit of academic research is direct knowledge transfer from university labs to industry.

But research universities fulfil other key roles which are harder to quantify. They are networked with the whole world's research. Their core mission is to educate outstanding graduates who will spread expertise throughout the private and public sector, people who can recognise how to exploit a new idea from anywhere in the world.

In the USA, the exemplars are Harvard and Stanford. They are esteemed as major national assets because of the way they attract international talent, the collective expertise of their faculty and the consequent quality of their graduates. They are embedded in a 'cluster' of research laboratories, small companies, NGOs, and so forth. But they remain primarily academic, rather than 'applied', institutions.

The same is true in the UK. In places like Cambridge, a dynamic and interactive high-tech community has developed that offers, in the words of the *Financial Times*, a "low risk place to do high risk things".

To ensure that our universities stay competitive, it is crucial that they attract and retain outstanding faculty. Once quality is lost, it is very hard to recover it. So it would be a real 'own goal' to erode the availability of 'responsive mode' funding, which comes mainly from Research Councils.

The Lord Rees of Ludlow OM Kt PRS is President of The Royal Society, Master of Trinity College, Cambridge, and Astronomer Royal. He is also Visiting Professor at Leicester University and Imperial College London. He was appointed Astronomer Royal in 1995, and was nominated to the House of Lords in 2005 as a cross-bench peer. He was appointed a member of the Order of Merit in 2007.

There is a symbiosis between applied and pure science – one of my Royal Society predecessors, George Porter, averred that there were two kinds of science; applied and not yet applied. A broad constituency is now urging sustained public support for physical sciences (mathematics, all of physics, materials science, chemistry and engineering), even for a rebalancing of public funding to allow a 'catch up' by these subjects after the prioritising of medical research in recent years. These academic subjects are vulnerable because they cannot draw on supplementary sources that match the Wellcome Trust.

In making the necessary hard choices, we should plainly do all we can to sustain and exploit our areas of current excellence such as biotechnology. But what of other sectors based on physical sciences? Peter Mansfield's Nobel Prizewinning work on MRI was carried out in Nottingham's physics department. The exciting new field of synthetic biology involves physics and engineering. Computer science pervades biology.

There is a paucity of major high-tech manufacturing in the UK. Surely we should redress this – and seize new opportunities as well. R&D on energy is currently, worldwide, at far too low a level to meet the global challenge. It is a strategic area where we could align with the expanding US effort to mutual benefit. And I cannot think of anything that would attract young people into physical sciences more than a proclaimed national aim to lead the quest to find clean energy for the world.

The UK's relative standing will sink unless we keep our competitive edge as discoverers and innovators – and unless some of the key creative ideas of the 21st century germinate and are exploited here in the UK. ❐

Do not forget nearer term goals

Peter Gershon

I welcome the focus on encouraging more children to study STEM subjects (recently supported by the Government's campaign to support awareness of science) not only at GCSE but through to A level and beyond.

But the 'core' of your challenge was about scientific research and emerging technologies. We strongly welcome your reaffirmation that the science budget is ring-fenced and that the spending plans and the growth envisaged in the Spending Review 2007 will be maintained to the end of the spending review period. The grand challenges that the Government has put in place also provide a very helpful way of focussing innovation and helping to harness the tremendous brainpower of this country on some of the biggest challenges we face. I also welcome the affirmation that scientific research is a fundamental enabler of growth in the long-term.

Yet to get to the long-term we have to get through the short and medium-term – at least the next one to five years. What will power us out of the recession is not necessarily the results of long-term scientific research: it will be more innovation in business through the development of new products, new services; it will be greater innovation in processes, tools and techniques; innovation in business models and in the very skills that businesses employ.

Rolls-Royce is a world-class supplier of engines. Yet Rolls-Royce is a great company today not just because it produces and utilises great engine technology, but also because it has changed and innovated its business model. It has moved to a 'power by the hour' arrangement – and entered into much more profitable relationships with its customers.

Sir Peter Gershon represented The Royal Academy of Engineering at the meeting. His career has been spent mainly in the private sector where he has held senior executive positions in both the ICT and defence industries. Between 2000 and 2004 he was the first Chief Executive of the Office of Government Commerce. He also led a review of public sector efficiency for the Government between 2003 and 2004.

So there has to be a balance between the Government's support of longer term, fundamental research and of R&D-intensive industries such as pharmaceuticals on the one hand, and a much broader swathe of industries (less R&D-intensive but nevertheless still dependent on technology and science) on the other. This latter group can do things in the shorter and medium-term to power us out of this recession.

It would be a tragedy if, in the pursuit of the science agenda, disciplines such as manufacturing engineering did not receive an appropriate amount of funding. It is through these disciplines that many British companies today can improve their performance.

Take the humble rivet. Manufacturing engineering, if it can shave fractions of a penny off each rivet, can help aerospace companies reduce their product costs since millions of these are used per aircraft. We do not need long-term R&D to help improve the short-term cost profile of the rivet, but we need both for strong and viable industrial and scientific bases.

I also wish to address Government procurement. This can play a very important role in sustaining the innovation agenda but the Government is advancing a number of different policy agendas on the back of public procurement. These include: innovation, sustainability, equality, the use of the third sector, inner-city regeneration, small and medium-size enterprises, black and minority ethnic businesses, the rural agenda, efficiency – not to mention, for many public sector organisations, a desire to find the cheapest solution in a world of increasingly demanding cash targets.

These agendas are not necessarily in conflict, but they are not being prioritised. In addition, implementation is patchy as well-intentioned public officials struggle to deal with different agendas emanating from different Whitehall departments, as well as their own local priorities.

If the Government is going to use innovation as an integral part of public procurement, efforts must be made to produce a more integrated approach to procurement policy. Clear prioritisation is necessary if the full power of the £175 billion a year public sector spend is really to be harnessed in the support of innovation. ❐

Translating products into products and employment

Peter Ringrose

It is criticially important that during times of recession and tight budgets basic science should not drop off the Government's agenda. Some analyses show that long term basic research ultimately has a greater return on investment than shorter term directed research.

In many scientific disciplines, the UK is second in excellence only to the US, and in some it is the world leader. The G8 citation index for the biosciences puts the UK at number one. It is this excellence in the basic sciences that is so critical for the next generation of scientists and technological entrepreneurs.

It has been exactly this excellence and skills base that has spawned the pharmaceutical and biotech companies in the UK, which today employ 67,000 scientists and other staff, attracting almost £4 billion in R&D investment and contributing £8.4 billion to Britain's GDP in 2007.

However, during these difficult economic times industry is cutting back on R&D. This is being felt particularly in large pharmaceutical companies. For emerging biotech companies, the situation is dire, with many due to run out of cash in the next 12 months.

Government has a responsibility to – where possible – maintain science funding in its universities and institutes in order to ensure that innovation will ultimately drive us out of recession. In addition, the translation of science into new products and the emerging industries of the future is critical. We need to be much more aware of the likely economic and societal impact of the scientific research that we fund. Impact can of course be broader than direct commercialisation and wealth creation.

Being able to prepare for and minimise threats is, in one sense, an 'invisible' impact. Scientists at the Institute of Animal Health accurately predicted the time and location of the arrival of Blue Tongue disease in the UK last year. This enabled effective preparation and preventative vaccination, saving the UK economy an estimated £485 million and 10,000 jobs.

Between the Technology Strategy Board and the Funding Councils there are now a number of initiatives to facilitate interaction with industry and aid start-up companies. We now need to demonstrate that these initiatives are indeed stimulating innovation and wealth creation.

Dr Peter Ringrose is Chairman of the Biotechnology and Biosciences Research Council (BBSRC) and a member of the Technology Strategy Board. He was formerly Chief Scientific Officer of Bristol-Myers Squibb and President of the Pharmaceutical Research Institute based in Princeton, USA. Dr Ringrose is a non-executive director on the boards of Astex Therapeutics Ltd, Cambridge; Rigel Pharmaceuticals Inc, San Fransisco; and Biotica Technology, Cambridge.

Studies of innovation, however, tend to show that removal of inhibitors can have more impact. Government clearly has a role to play in the removal of cumbersome regulatory barriers and unhelpful taxes on investment in new companies. The recently updated Cooksey report from the Biotechnology Innovation and Growth Team (BIGT) on *Bioscience 2015* emphasised the need for tax incentives, particularly for the pharmaceutical industry to invest in biotechnology development. It also stressed the need for Government to catalyse the redesign of new medicines regulation on a worldwide basis and argued for an independent review of the long term impact of NICE.

It is unfortunate, to say the least, that the NHS has been one of slowest adopters of innovative new drugs and health technologies in the Western World. This is hardly encouraging for the large pharmaceutical companies when it comes to investing further in UK science. However, I very much welcome the new Executive Office for the Life Sciences.

Future wealth creation and recovery in the UK economy is closely linked to a continued strong Government investment in science and innovation, both at the strategic level but also at the basic science level. A balanced portfolio of high and low risk, short and long term, science and technology will provide the basis of our nation's competitive place in an increasingly technology-driven, post-recession world. ❐

Revisiting our business models

Trudy Norris-Grey

Now is the time for business transformation. Companies and countries that see research and development as an investment are likely to prosper. Those that see them as costs are likely not to prosper and in the long run have an unsustainable business model.

For many, business is tough and declining at this time – but some are growing and prospering, particularly in sectors such as agriculture, energy, food sciences and low carbon technologies. We have a growing world population, so we need more – and different – types of food and energy. The population is ageing, so we will need more medicines and more medical equipment. The companies that are growing today are benefiting from prior investment and prior focus: they have made choices and focussed on what they want to be good at.

Businesses – but I think it is true for countries too – want to be number one or number two in their chosen fields. So, let's have some choices, let's go with the areas of growth and let's be ambitious for leadership on the global stage.

Trudy Norris-Grey is Chair of the Innovation and Science Committee of the Confederation of British Industry (CBI). She is Managing Director of Strategy, Portfolio & Transformation in BT Wholesale. Previously she has held the positions of President & Managing Director of Sun Microsystems UK & Ireland, Vice President of Channels & Alliances at Oracle UK & Ireland, and Marketing Director for Kodak Professional, Europe, Middle East & Africa.

We need clarity on the research and development agenda, but we also need clarity about the fiscal stimuli, about innovative and entrepreneurial agenda – and yes, we do need some help from the capital markets too.

I think of Switzerland at times like this. Back in 1541, Calvin banned the wearing of jewellery. It led to the automatic and immediate collapse of the jewellery industry in Switzerland. But the goldsmiths and metallurgists and craftsmen had skills that could be applied elsewhere. They focussed on their strategic strengths, they focussed on a growth opportunity and the watch industry was born. They have been world-leaders in watches and clocks for three centuries.

They have had an absolute focus on innovation and they have never stood still, even in times of difficulty. In the 1970s, when the watch industry was going to the Asian markets, they focussed on the cost structure and transformed their business model in a different way. The Swatch was invented and Switzerland continues to lead the watch industry.

We are in a period of scarce resources, it is a difficult time. We have no choice but to focus, but I would like to see us focus around a chosen set of priorities where *we* lead on the global stage. ❐

Does innovation in products and services have a role to play in stimulating the Scottish economy? A meeting of the Foundation for Science and Technology, held at the Royal Society of Edinburgh on 24 September 2008, examined the question.

Establishing a coherent vision for Scotland

Jim Mather

Growing the Scottish economy is the aim of the Scottish Government and was highlighted in November 2007 by the publication of the *Government Economic Strategy* (GES). After 30 years of low growth, it was very clear that something needed to change. Successive economic strategies and governments have tried and failed to lift Scotland's economic performance. Yet other small, advanced independent countries have flourished, while Scotland has lagged behind, despite its significant advantages. These include a world-class science base and a highly qualified, well educated workforce as well as a record of invention and innovation that is second to none.

There are many definitions of innovation but one of the simplest is 'the successful exploitation of new ideas'. I think that sums up the contribution innovation makes to economic growth.

The GES identifies the main challenges we face: increasing productivity, economic participation and population growth. Innovation has a key role to play in the first two. They are mutually reinforcing and together they define our competitiveness as a nation. In terms of productivity, there is much room for improvement. The UK's labour productivity is currently 2.8 per cent higher than in Scotland; in the USA, France and small Scandinavian nations productivity is also significantly higher. All the evidence tells us that higher levels of investment, skills, innovation and enterprise can generate improvements in productivity.

Meanwhile, Scotland's total gross expenditure on R&D as a proportion of gross domestic product is slightly lower than in the UK as a whole and considerably below the levels found in Finland and Denmark. Furthermore, business expenditure on R&D in Scotland is less than half that in the UK. However, R&D statistics provide only a partial view of Scotland's performance in innovation, as their focus is on 'technical R&D' and they do not include process and service design innovation.

If we take those into account, we see that Scotland ranks in the second quartile of EU members in the *Community Innovation Survey*, which reported that 56 per cent of Scottish companies were engaged in some form of innovation activity during 2002-2004 – broadly in line with the UK average.

Jim Mather is Minister for Enterprise, Energy and Tourism in the Scottish Parliament. He has been the Scottish National Party treasurer, director of a number of companies, including Startech Partners Ltd and Computers for Business (Scotland), and was marketing manager for IBM UK. He trained as an accountant.

The private sector

So Scotland does well in areas that are significantly affected by public sector spend, but in areas affected by private sector spend, less so. This is a crucial point. We say in the GES that Scotland's businesses are the primary drivers of sustainable economic growth. Our national competitiveness depends critically on the competitiveness of our individual businesses. So how can we – and I mean all of us together – increase growth in the private sector?

In the current climate and with the current constitutional settlement, Scottish Enterprise is spreading the message of the importance of innovation as widely as possible. At the same time, it is restructuring its support for business to work on a one-to-one basis with companies and help them understand how innovation can increase their productivity and profit.

In the public sector, we have already adopted an outcome-focused, systems-based approach in our concordat with local authorities. We encourage them to use their autonomy to deliver these outcomes as effectively and innovatively as they can. Similarly, we need to look at how we can be more innovative in the ways we deliver public services. One way is to encourage innovation through public procurement. The McClelland report on public procurement embodies much of the thinking we are applying in our approach to public services and there is some excellent work going on to introduce greater transparency in procurement and encourage innovation.

The National Endowment for Science, Technology and the Arts (NESTA) has brought a new approach to innovation policy, one which recognises that innovation is not solely the domain of science and technology. This approach recognises the importance of other types of innovation such as incremental innovation, open innovation, user-led innovation and business model innovation, to name just a few. NESTA's work has influenced the GES and the recent Department for Innovation, Universities and Skills (DIUS) White Paper *Innovation Nation*.

One of NESTA's key messages is that innovation applies just as much in the service sector as in manufacturing. The service sector accounts for over 80 per

discussion

Involving artisans in product development. The efforts of the Scottish Government to bring about a better understanding of innovation were applauded, but more needs to be done. There is a particular weakness in training and skills at the artisan level, where practical innovation is important. In Germany, for example, artisans have the training and skills not only to do their jobs, but to think about and work on developments, and are encouraged to do so by management.

discussion

The place of research. Concern was expressed that an emphasis on aspects of innovation other than initial research risked devaluing the importance of developing new ideas through research. While it was important to ensure that anything in the pot was properly cooked and served, the pot would 'soon be empty if not continuously refilled'. Others suggested this concern was misplaced, though. New ideas stemming from research are crucial; but academia and business will produce them, even if they do not at first sight appear to have a commercial application. It is an understanding of what customers want, and the process of knowledge transfer, which will determine which ideas go forward.

cent of our economy and we cannot ignore it if we are to achieve the kind of growth we are aiming for. We need to look at the work that has been done in Ireland, for example, on support for the service sector and see how that can be translated into the Scottish system.

Just as manufacturing may have different support needs from services, so different sectors such as life sciences and software, for example, will need different types of support. One size rarely fits all and certainly not in the area of business support. We need to ensure that we understand the demands of different sectors and design our support accordingly.

Longer term, the gaining of tax powers is critical for that would offer increased national autonomy and an increasing number of more autonomous businesses in Scotland, able to manage their own commercial destiny and their R&D and innovation strategies in a Scottish context.

The Scottish system

I have mentioned the 'Scottish system'. The principle that a policy must be appropriate to Scottish conditions is vital. It might seem obvious, but I think we are all aware of times in the past when we have seen something interesting in another country and assumed that we could lift it lock, stock and barrel and then replicate it in Scotland. We have to be much more attuned to Scotland's sectoral strengths, institutional structures and industrial base before we introduce new measures. Most of all, we have to ensure that any new measures fit within the overall system and do not maximise one area to the detriment of others.

I also want to mention the need for a greater clarity regarding the outcomes of innovation. Focusing on outcomes rather than inputs is key for this Government. It would be easy to say that there is complete clarity in our approach: we have a single purpose; a national performance framework that identifies 15 national outcomes; and 45 national indicators. Everything we do has to be designed to achieve these outcomes. But there is more to it than that. This is not a blueprint handed down from on high that everyone has to follow without question. The outcomes are the ones that we have established with our key stakeholders as a coherent vision of the Scotland we want to see. The concordat with the local authorities was reached in partnership with them. The high-level outcomes are a shared vision that we can only achieve by working collaboratively. By doing so, we share a clear vision.

To sum up, increased sustainable economic growth is critical to Scotland's future prosperity. Innovation in products and services plays a crucial part in that growth but there is more. We need to stimulate greater demand for innovation across a broader spectrum, we need to design our system to meet that greater demand as effectively as possible and we need to work in partnership to create a shared vision of the successful Scotland we are all working towards. ❐

Innovation is not rocket science

John McClelland

One of the issues in dealing with a subject like innovation is understanding how we turn innovation into something else, for example added value, economic growth, profits or cash – and it is one of the major challenges that nations such as ours face. We do not have the dynamism of some of the newer economies and therefore we face the challenge of trying to understand how we turn our traditional talents – and inventiveness is certainly one of those – into economic growth.

I like the description of innovation as a progressive, incremental improvement process. In other words, innovation is not about inventing something completely new, it is concerned with making what you have developed or created into something that can be improved incrementally over time. One of the most innovative developments in recent times in the aviation industry did not involve any new inventions. Easyjet's idea was to stop doing what other airlines did and have passengers carry their own bags between flights, and find their own seats on the plane. This was a profitable and highly competitive strategy. The point is that innovation need not involve rocket science – it can take many forms.

The innovation treadmill

The 'innovation treadmill', a term I like to use, sounds a long way from 'eureka' but is a very important factor in converting inventiveness into economic growth. The first steps on the treadmill are those you would expect: funding, research, market research, product development, managing and marketing products. Although these may seem to be mundane functions, Scotland is not good at some of them.

It is important not to have the wrong

John McClelland CBE is chairman of the Scottish Further and Higher Education Funding Council and chair of Technology Ventures Scotland Ltd. He was Vice President, Worldwide Operations, for IBM's personal computer company before joining Digital Equipment Corporation as a senior vice president in 1995 where he was responsible for all of Digital's worldwide operational activities. Latterly, he was President of 3Com Corporation's Business Networks Company. In 2006 he completed a review of public sector procurement in Scotland on behalf of the Scottish Executive.

discussion

Anti-entrepreneurial bias in Scotland. A number of participants agreed that there are features of the Scottish culture that do not favour innovation. First, and most important, is the lack of enthusiasm for entrepreneurship – that is, for taking risks and accepting that, in some cases, there is bound to be failure. Unlike in the US culture, failure is regarded as shameful, not as a basis for trying again. A risk-averse culture is at the root of unsatisfactory Scottish economic performance. However, other aspects of Scottish culture – intellectual endeavour, hard work and the ability to work in teams for common goals – must not be lost.

products in the wrong place at the wrong time, or to have products launching too late. I know of some electronics companies that failed simply because they got their products to market too late and their competitors had beaten them there.

Further along on the treadmill are the steps of quality management and customer relations. I have to say that some of our companies, particularly some of the smaller ones, have difficulty embracing the art of customer management – and it is an art, not a science. It involves understanding and responding to customers, analysing the market and knowing where the next product should come from.

If companies do not start innovating and driving new products and services early enough, they end up going out of business. In the electronics industry, at the beginning of any year, 20 per cent of revenue is expected to come from products that have not yet been announced. Looking forward two years, 50 per cent of the revenue is expected to come from products that have not at that stage been announced. Miss a beat and your company will disappear.

Managing the phase-out of products is an important part of this process. 'EOL' – end of life management – is one of the most exciting job titles I have created during my career (the wife of one of my EOL appointments wrote to me saying: "Could you please give my husband a new job title – it's frightening our children!").

The entrepreneur

Another step on the innovation treadmill, and one that is especially important in Scotland, is entrepreneurship. Although we in Scotland are exciting inventors – as shown by our results in the Research Assessment Exercise (RAE) exercise and by sizeable public and private investment from outside Scotland – being entrepreneurs does not come naturally to us. I have two anecdotes that illustrate this. The first concerns a visit I paid to a college, where I had a round-robin chat with 12 students. Asked about their hopes for the future, 11 said they wanted 'to get a job'. The last student, an American, said that when he returned to the United States he wanted to start his own business.

The second anecdote is from the days when I would work one week in the States and the next here. I had two PAs, one in Boston and one in Ayr. When I called the PA in Ayr from Boston I would say: "How are things, Fiona?" and she would say: "The weather's fine" or "It's raining." When I was in Ayr and I called the PA in Boston I would say: "Sharon, how are things?" and she would reply: "Great, the stock's up 50 cents." We do lack the entrepreneurial culture of our transatlantic colleagues and competitors. You can call it greed, you can call it thirst, you can call it motivation – but whatever it is, that spark is missing at times.

I think we also lack business management and communication skills. That is not a criticism; there are many business managers, including in small businesses, who are outstanding in both areas but in general we could do better.

So I think we have a lot to do, but I also think we are very capable of tackling some of these issues. We can be disciplined and organised, and we can keep innovation treadmills turning. Our public sector can contribute by purchasing advanced technology rather than old and established products. This will help our businesses to run fast and create new products before last year's product dies on the vine. Through our education system we can make sure that we have graduates who are not only polished in their subjects, but who are capable of being entrepreneurs, of understanding and managing businesses and also of communicating effectively in order to improve areas such as marketing and customer management.

I will leave you with one simple message: innovation is not rocket science. ❐

Review of Public Procurement in Scotland: www.scotland.gov.uk/Publications/2006/03/14105448/24

More sophisticated models of innovation

Michael Harris

Our understanding of innovation, including policy, is becoming much more sophisticated. We no longer subscribe to a simple linear model of innovation in which pure research is followed by applied research, product development and marketing. Academic research over the past 30 to 40 years has overturned that model. This has important implications for the way we make innovation policy.

For example, we now understand that it is the broader capabilities of a company or organisation, rather than just its R&D, that determine its capacity for innovation. Understanding the needs of customers and how the capabilities of the organisation can be marshalled to meet them is what drives innovation. Thus, innovation demands multidisciplinary skills, expertise and the ability to draw together teams with different strengths and different areas of expertise. It goes beyond the boundaries of the organisation and increasingly involves global partnerships. The problem is that the complex process of innovation is very difficult to capture in a simple way for policymaking purposes.

Understanding and measuring innovation is the first challenge. We know from

looking at businesses that R&D spend is not a very meaningful measure. Apple and Toyota are not the biggest spenders on R&D in their sectors, yet they are generally acknowledged to be the most innovative companies in their fields. Toyota is a world-class example of a company that knows how to draw on the broader capabilities of all its employees in order to continuously improve its business.

Where does innovation take place?

The second challenge is finding out where innovation takes place. Traditionally, we have focused on R&D-intensive sectors, for understandable reasons. Innovation policy has developed out of science and technology policy, so it is a natural focus. However, we also know that our economy is dominated by services and that innovation in the service sector can be very different from what we would traditionally expect in R&D-intensive sectors. Are there interventions that are relevant, appropriate and efficient in stimulating and supporting innovation in the service sector, and if so, what are they?

More broadly, we need to think about innovation in the public services. How can we reform and improve our public services so they meet the needs of clients and customers better? What role can the third sector play in stimulating, supporting and delivering that innovation? How can we marshal a fuller range of innovations to respond to the major social challenges we face, such as climate change and an aging population? New technology is going to play an important role in meeting these major social challenges, but we know that it is not going to be the only form of innovation necessary. How do we coordinate a much broader range of innovations in the face of those challenges?

Competition

The third challenge is competition. When innovation was acknowledged as a key driver of productivity, it emerged from the margins into the mainstream of economic policymaking. Paradoxically, the impact has been a convergence in innovation policies across different countries, so where you might have expected diversity there is actually a large amount of similarity. There is now a strong desire among policymakers for distinctive innovation policies tailored to national conditions.

This is something we are grappling with while facing rapidly increasing competition from other countries. The electronics sector in China accounted for 4 per cent of global electronics output in 1997 but 20 per cent in 2007 and it is still growing. The Indian pharmaceutical industry has 13 per cent of global pharmaceutical output and is growing by some 30 per cent every year. These are no longer economies based purely on lower wage costs – they are rapidly moving up the highly skilled, value-added scale. Furthermore, their growth is being led by very ambitious, aggressive national strategies. We have tended to rely on a generic, horizontal innovation policy, supporting research and so on: but in those countries, in addition to generic research support, there are very specific aims for the development of innovation-intensive sectors. We need to work out how to respond to that.

Dr Michael Harris is Research Director, Innovation Policy at the National Endowment for Science, Technology and the Arts (NESTA), where he has led research work on innovation policy and 'hidden innovation' in the economy. He has also managed research projects on the creative industries and science education. Before joining NESTA, he worked in local government, educational technology and higher education.

Innovation as a system

I want to consider the value of thinking of innovation as a system. We have tended to take a somewhat static approach that involves intervening at certain points – to improve the commercialisation of university research, for example. However useful that might have been, I think that future innovation policy will be based on understanding innovation within a system.

That kind of thinking now informs policy in Scotland. We are starting to examine systems of innovation in particular sectors. For example, if we look at electronics we can begin to identify where intelligent, appropriate and efficient interventions can be made by public agencies to stimulate innovation. This is going to be the new agenda for innovation policy. It will require a much more sophisticated understanding on the part of policymakers about how an innovation system is operating and how the various organisations and individuals come together to develop innovation. It is particularly encouraging to hear about the engagement with business at that level in Scotland, because it is crucial to get that type of business intelligence into the conversation.

Policymaking cannot be removed from business. Both major multinationals and smaller companies need to be included in discussions about what the role of Government should be in the new agenda for innovation.

Understanding innovation in terms of systems makes us more modest about the role of policy, because it is clear that there is no simple lever that policymakers can pull to magically transform the performance of that system.

The time for a debate about industrial strategy seems to have arrived. The heads of both the CBI and Rolls Royce have expressed their opinion that Britain needs such a strategy. It is not about picking winners, but about placing bets in particular areas by identifying sectors of strategic national importance and responding to our competitors in other countries. We need to make sure that potential growth sectors receive our full support and that the system of innovation in those sectors is working to its utmost.

The heart of innovation policy is human resources because the biggest impact that Government and the public sector can have is in education and training. Investment here can ensure that we have highly skilled, creative and capable people. It is no coincidence that the countries that invest the most in the development of highly skilled workers are also the countries with the best record of creating highly skilled jobs. ❐

discussion

Improving knowledge transfer between academia and business.

Some participants believed that it was unreasonable to expect academics to be experts in business or to be interested in areas such as product development and marketing. However, others thought that universities could be much more open and approachable to business. It would be particularly valuable if it were easier for people in the private or public sector to become more involved in academia, perhaps through part-time posts. This would lead to a better understanding of what universities could contribute, and how they could organise themselves to do so.

The spectre of famine has been a feature of human existence since the earliest times. Can science and technology help to banish this threat? A meeting of the Foundation on 15 October 2008 examined the possibilities.

The global balance of supply and demand

John Beddington

There is an intrinsic link between the challenge we face to ensure food security through the twenty-first century and other global issues, most notably the interdependent factors of poverty, population growth, urbanisation, water supply, energy use and climate change.

Studies by the UN Food and Agriculture Organisation (FAO) and the World Bank estimate that more than 900 million people globally are undernourished, and a further 100 million people risk falling into extreme poverty. The world population will be around 9 billion by mid-century, with Africa's population doubling to 2 billion. This will impact alongside the transition from rural livelihoods to life in cities, and the resulting cities will need to be serviced with food, water and energy. Total world water demand is projected to increase by about 30 per cent by 2030, and energy demand by some 50 per cent.

Economic advances projected for the developing world will help lift people from poverty, but in other ways will actually add to the challenges. Driven by population increases and growing prosperity, world food production must increase by some 50 per cent by 2030 to meet this increasing demand.

The backdrop against which this must be met is one of rising global temperatures – impacting on water, food and ecosystems in all regions – with extreme weather events becoming both more severe and more frequent. Rising sea levels and flooding will hit hardest in the mega-deltas which are important for food production, and will impact too on water quality for many.

The need to mitigate climate change, and to adapt where it is too late to avoid it, is clear. Global greenhouse gas emissions must be reduced by at least 50-60 per cent by 2050 compared to current levels. The United Kingdom has taken the lead by agreeing to an 80 per cent domestic reduction.

What does this mean for agriculture? The world must produce 50 per cent more food, on less land, with less water, using less energy, fertiliser and pesticide – by 2030 – while at the same time bringing down sharply the level of greenhouse gas emissions emitted globally. It is not a trivial challenge, but one that we can meet.

Professor John Beddington CMG FRS is Government Chief Scientific Adviser, Government Office of Science, Department for Innovation, Universities and Skills (DIUS). He has acted as a senior adviser to several government and international bodies, including the the European Commission and the UN Food and Agriculture Organisation.

We need a new and greener revolution, which science and technology will help deliver. History shows the huge increases in yield growth that were possible in Asia during the latter half of the twentieth century, made possible by modern farming practices, including irrigation, use of fertilisers and pesticides, and the development of high-yield crop varieties. The contrast with Africa is marked, where the absence of such approaches has contributed to a stagnation in yields that has endured for several decades.

Crop protection is crucial. Around 30 per cent of crops are lost before harvesting due to pests and disease, while substantial further losses are experienced post-harvest. Pesticides play a vital role in safeguarding yields, a fact that must be recognised as new EU regulations are considered. The withdrawal of pesticides without alternatives to replace them would reduce crop yields across Europe, with the potential also to impact beyond Europe's boundaries. The scientific approach is to consider the risk of a given product in real world use, not the theoretical hazard in unfeasible or laboratory conditions.

Genomics has a major contribution to make, improving crop varieties for yield, sustainability and quality. Successes to date have included salt-resistant durum wheat and more disease-resistant oil seed cassava. Genetic modification will be one of the technologies to offer solutions, such as for drought and saline resistance, as well as resistance to pests and disease.

Another technology at the forefront of science is the development of nano-scale sensors, capable of relaying real-time information about the precise requirements of crops in the field for water and nutrients, with the potential to bring both economic and environmental gains.

In summary, the key question is, can 9 billion people be fed equitably, healthily and sustainably? The answer is yes, but we must act.

Science has contributed greatly in the past to finding solutions, and with sufficient investment it can do so in the future, helping to satisfy the growing demand for water and supplying the energy that a growing population emerging from poverty will consume. To do all this, we will need to invest in science and technology and, at the same time, to mitigate and adapt to climate change. ❐

discussion

Anti-science. A major concern is the widespread anti-science bias in the public mind and in the media, leading to a slow take-up of new technologies, a nostalgic view of traditional and inefficient practices, and a shortage of courses and students taking agricultural science subjects. It is an over-simplification to see sharp divisions between pro- and anti-science groups; it is more a matter of attending to evidence. Everyone has a belief system, and that could well lead to one preferring certain modes of life; but the danger comes when the belief system forces one to ignore or downplay evidence.

The dangers of protectionism

Christopher Haskins

Speaking as a farmer, I run for cover when I hear politicians use the word 'security' in the context of food supplies. It often leads to protectionist policies, promoted as a way of stimulating home production. In fact, trade barriers encourage inefficiency and trade conflicts.

During the past 50 years free trade has been a major contribution to unprecedented global prosperity. Protectionism made the great depression in the 1930s worse, not better. For 40 years Ireland applied huge tariffs on all its imports in order to grow the domestic economy; as a result the economy stagnated and millions like myself emigrated from the Irish countryside to somewhere better. Over the past 30 years Ireland has prospered as a member of the greatest free trade zone in the world, the European Union, even if her banks have put this all in jeopardy in recent months.

An obvious route to food security is to increase the proportion of our food needs that can be produced within our own borders. Britain was self-sufficient in food until 1846, but the next century was one of agricultural decline. Following the Second World War, the Labour Government introduced modestly protectionist policies to promote British agriculture. For a time farmers prospered, but not because of protectionism: the reason was that supplies were tight and prices were firm.

In 1973 we joined the EEC, with its system of tariffs and subsidies. There was a massive increase in UK farm production and by the mid-1970s we were 75 per cent self-sufficient in food. In 2003 we saw a dramatic reduction in tariff barriers, replaced by direct payment to farmers according to the size of their enterprise. The indications are that production has dropped but there have been weather factors, and total farm incomes are indeed better than might have been expected.

The Lord Haskins, Chairman of Northern Foods from 1986 to 2002, has served on many House of Lords including European Committee D, covering environment, agriculture, public health and consumer protection. He farms in East Yorkshire.

But overall, it is not helpful to talk about British food security in isolation. As a member of the EU we are largely self-sufficient in food, and are likely to remain so for the next 20 years. And until recently problems were of surpluses rather than deficits.

Limitations

What are the limitations of Britain's capacity to increase agricultural output? Even after set-aside, the amount of land available to be brought into production is limited. British agriculture has severe competitive disadvantages; for example, we do not have the indigenous labour to harvest our intensive labour crops. Without migrant workers coming from Eastern Europe over the past five years, we would have seen a massive decline in those industries.

In a densely populated island, farmers have high operational overheads. Our climate puts severe climatic restrictions on the range of crops we can grow. The beef, dairy and sugar industries face severe competition from abroad; we can buy these products better from other places if we want to, with the exception of liquid milk. However, climate change could widen the range of crops available to British farmers; we could be able to grow peaches and sunflowers one day.

We have a growing population and demand is rising fast. Unfortunately, we also have a powerful anti-science lobby. But given the chance, crop scientists could further increase crop yields after several static years: if they can produce a blight-free King Edward, the British public would be rewarded with a wonderful harvest of high quality potatoes.

The future

Membership of the EU prevents us from creating national tariff barriers and the EU pesticide directive is a threat. If allowed to go through, it would seriously reduce our ability to protect our crops: it is important that legislation should not be allowed to withdraw pesticides unless practical alternatives are available.

We have pollution and animal welfare concerns, but what about renewable energy crops? There are increasing doubts about the value of the first phase of agricultural biofuels: in converting food crops to energy they have skewed the supply and demand balance and caused price hikes for staple foods such as maize. And their environmental benefits are also being questioned.

But for the next few years, economics and the turmoil in international markets will be dominant factors. We may be spared the worst effects of protectionist policies as it is widely recognised that the current banking crisis can only be resolved by greater international cooperation. Even America is dependent on international markets, and it is to be hoped that President Obama puts his weight behind attempts to revive the World Trade Organisation (WTO) talks on reducing tariffs, particularly tariffs on food.

In Europe, there is the possibility that the EU will phase out the subsidies by 2013; what would this mean for Britain? I suspect that our farmers would do better than the average because they are larger and they should therefore increase their share of the market. But there will be problems for farmers on marginal land and concerns about the dairy and beef farmers' ability to cope in a free trade world.

But whatever we do in Europe, the

discussion

The role of NGOs. There was sharp criticism of the role of Non-Governmental Organisations (NGOs), who preach organic farming to Africans and demonise large scale production. This completely ignores the evidence that many countries can only be lifted out of poverty if they accept that population increase, changing diets and urbanisation mean that the past may not be a good guide to the future. Large scale farming is not the answer in every society – it is not necessary, for example, in Asian countries like China and India, where better irrigation and improved seeds and practices have led to higher productivity within the traditional farming structure. The use of technology and science is essential, though.

real problem to the world's food security lies in the developing world. We need to encourage farming to develop in Africa and in the developing world in the way that it has elsewhere, enabling small farmers to become larger farmers with access to the benefits of existing science and technology. This necessary modernisation is not helped by the activities of some NGOs, intent on preserving traditional land use patterns and practices. They would condemn developing countries to stagnation. Slowing population growth and managing the growth of cities at the expense of rural populations are also important.

To sum up: we must enable food to be traded freely from region to region, from those in surplus to those in deficit, because if we do not, we will be letting down Mankind. ❐

Food security in the developing world

Dr Derek Byerlee

The latest figures from the UN's Food and Agriculture Organisation (FAO) show that 920 million people in the world suffer from hunger and malnutrition and during the past eighteen months particularly, when rice and maize prices more than doubled, these are the people who have been most affected by the global food price shock.

Food prices have since fallen, but we must anticipate more frequent and sharper market stresses in the future. And the developing countries, where food security is most precarious, will be hit most severely by the recent economic downturn, as well as climate change, energy shocks, drought and water shortages. Of these various hazards, water supply is perhaps the most critical problem. Competition from urbanisation and non-agricultural demands mean that the amount of water available for agriculture in developing countries is unlikely to increase.

These factors, then, are threatening the supply side of the balance of global food supply and demand. There is, too, a slowing trend in the growth of cereal yields in the developing world. Yields jumped during the 'green revolution' into the 1980s. Since then growth of yields of cereals in developing countries has fallen to 1-1.5 per cent year. Sub-Saharan Africa is the worst-hit region where yields of food staples have been stagnant for four decades.

Energy costs

Another factor on the supply side is the cost of energy. The manufacture of the nitrogen fertiliser that has been a major source of growth in world agriculture over recent decades is an energy intensive process. More than half the nitrogen fertiliser production is now being used in developing countries (China is the largest consumer). A rising price for energy — and short-term scarcity in fertiliser markets — means that prices will continue to increase.

Dr Derek Byerlee was co-director of the World Bank 2008 report *World Development Report: Agriculture for Development*. He has been a teacher, researcher, administrator and policy advisor for 40 years in Africa, Asia and Latin America. He is a member of the Science Council of the Consultative Group on International Agricultural Research.

Turning to the demand side, agriculture can be extremely important as a means of generating the incomes and the livelihoods which allow poor people to access food. Remember that globally, 75 per cent of the poor people surviving on $1 a day live in rural areas. Despite the urbanisation that is taking place in India and China, the majority of the poor continue to depend on agriculture for their livelihoods. One of the major conclusions of the recent World Development Report on agriculture is that broad-based productivity growth in smallholder agriculture is one of the most effective means of increasing incomes and reducing poverty.

Several trends are accelerating food demand: urbanisation and changing diets are increasing the rate of consumption of 'high value' products, particularly livestock products and horticulture – and with an increase in meat consumption comes a greater demand for feed grains for livestock. In countries like China and India, the amount of land for agriculture is actually falling.

The use of grains and oil seeds as biofuels is also driving up prices. There has been a rapid rise in demand for maize in the USA in recent years, and in the EU rapeseed is being used for biodiesel.

If food security is to be increased, much depends on investing more – and more effectively – especially in science

Figure 1. Percentage of population in absolute water scarcity.

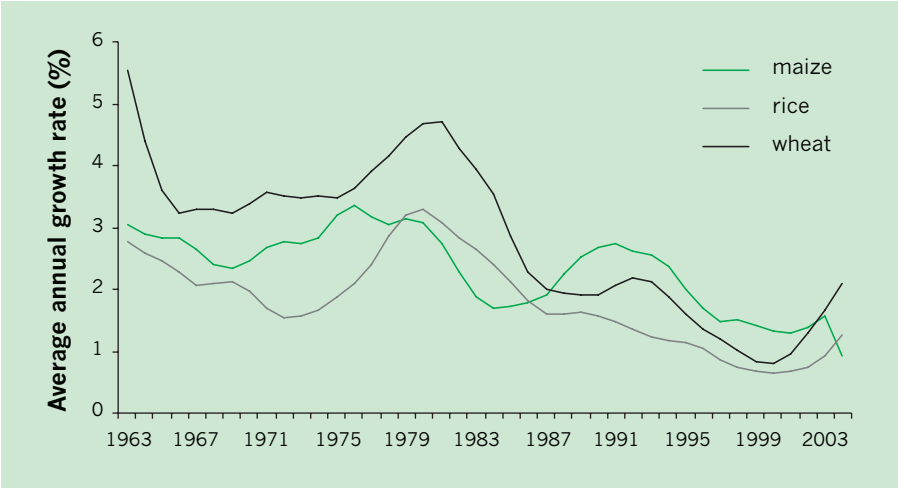


Figure 2. Increase in global crop yields.

and technology to support the agricultural sector. This is most important in developing countries, where smallholder agriculture is one of the most effective means of increasing incomes and reducing poverty.

Yet this investment is just not happening: the industrialised countries are spending around 5 per cent of the value of their agricultural production on agricultural research and development while the corresponding figure for the developing countries is only 0.6 per cent. A large part of that investment is due to the private sector, which is a big player in the richer countries but is all but absent in much of the developing world. However the public sector — at both the national level and the international level — also lags behind in terms of investment in agricultural research.

Again the biggest problem is in Sub-Saharan Africa. This region is investing very little in agriculture — only about 4 per cent of the total value of agricultural production — and of that only a very small share is on science and technology. Worryingly, spending on agricultural R&D has actually been declining in about half of Sub-Saharan African countries. We need to sharply turn that around if we are to make the needed impact on the food security problem over the next 30 or 40 years.

Until quite recently, the industrialised OECD countries have also been reducing their spending on agriculture in the form of official development assistance. Recent figures indicate that less than 3 per cent of the donor aid budget was going into agriculture. This too must be turned around if we are going to invest adequately in this sector.

Ethiopia

This situation can be understood by looking at Ethiopia, a country in Sub-Saharan Africa that has had continuing problems of food security, and even famines as recently as the 1980s. It is a very large country with a population of 85 million, more than 80 per cent of whom are dependent on agriculture — most of them small-scale farmers with about 1 hectare of land. For the past 10 years or more, Ethiopia has been one of the largest recipients of food aid. About 7 million people depend on food aid in a normal year, and this can rise to 12 million in a poor year.

Ethiopia has responded by investing heavily in the agricultural sector. There is very little opportunity to expand the area under cultivation — particularly in the highlands — so the goal is to obtain higher yields through improved seeds, fertiliser, water management and so on. During the past few years, Ethiopia has actually made progress: for 20 years per capita production in the agricultural sector was falling, but the trend has been reversed and since 2007 it has been increasing.

During 2007 and 2008, cereal prices increased sharply – by about 170 per cent. Much of this increase was generated internally; there has been 10 per cent economic growth in Ethiopia which translates into very rapid growth in demand for food. On top of that there was a drought in the minor season which affected production. Ethiopia has long depended on food aid but that has been in short supply because of very high prices in international markets. The country also faces an acute shortage of foreign exchange – the export revenues do not even cover the oil import bill which gives some idea of the foreign exchange challenge. So, with a shortage of food aid, the country had to resort to commercial food imports for 2008, again at very high prices.

The immediate prospects were bleak. Global fertiliser prices have quadrupled over the last year or so, and Ethiopia had to buy fertiliser during 2008 for the 2009 crop. With little foreign exchange available, it was difficult to see where the next harvest was coming from. Fortunately, with international assistance to purchase fertiliser, a rapid response by the government of Ethiopia, and a fall in the price of fertiliser, a major crisis seems to have been averted.

The global response

What can we do to help as a global community? Our guiding principle must be 'to do no harm'. That seems a sensible approach, but in fact it is often quite difficult in practice. Farm subsidies should be reformed. In particular, subsidies for the use of biofuels make no sense: we are protecting and heavily subsidising biofuel producers in the rich countries, which have negative impacts on developing countries.

Mitigation of climate change is also vital. And here again it is the rich countries, in the main, who have caused the problem, but it is poor people in poor countries who are most affected.

We need to be prepared to support emergency responses through safety nets, targeted food subsidies and food aid; and then some countries will still need significant budget and foreign exchange support to get through these types of shock.

We must invest in global public goods, especially agricultural research and development. The Consultative Group on International Agricultural Research (CGIAR) system – I serve on its Science Council – has been one of the best investments we have made as a global community. It is an alliance of members, partners and international agricultural centres that mobilises science to benefit the poor. Yet in terms of real budgets, we have seen a decline over the past 10 years; this is not just a decline in budgets, but more restricted budgets targeted on the pet projects of donors. We need to revitalise that system and step up the investment in international agricultural research.

Finally, we must get agriculture back onto the foreign assistance agenda. We need to reverse recent trends and increase the percentage of foreign assistance going to agriculture: a good target would figure be for 10 per cent of foreign assistance to go to agriculture.

There are big challenges ahead of us, and the current economic downturn will add to the pressures. But I remain optimistic; if we get away from the 'business as usual' mindset and do the right things now, we can look forward to a period of improved global food security. ❐

http://siteresources.worldbank.org/INTWDR2008/Resources/WDR_00_book.pdf

A meeting of the Foundation for Science and Technology on 19 November 2008 considered the findings of the Wakeham Review into the health of physics.

The state of physics in the UK

Bill Wakeham

My first point concerns the research base in physics. We commissioned a considerable study of the literature published by UK and other country's physicists. Our initial aim was to compare outputs and inputs in competitor countries in order to establish whether we were spending a comparable sum on the various sub-disciplines of physics. We hoped that would enable us to draw some conclusions about UK output in the area, relative to its input.

Despite an enormous amount of effort by the Department for Innovation, Universities and Skills (DIUS), the Foreign Office and Research Councils UK (RCUK), we were unable to obtain any useful information from other countries; this is, in fact, not so surprising since the structure of science funding is quite different from the UK, and it is difficult to define 'physics' in a way that translates easily between one country and another. For example, the European Union does not fund physics, but it does fund programmes in which physics features.

Citations

So instead, we focussed on outputs and citations to outputs. This revealed that the UK does remarkably well in most sub-disciplines of physics – it is always in the top five for the volume of outputs. When normalised with respective to GDP or population, we are often number two. That is a remarkable achievement.

In addition, the pattern of outputs is broadly the same, when normalised across a number of countries. This must reflect common choices about the important fields to study.

Now there are enormous numbers of papers which never receive citations – typically more than 50 per cent. While not special to physics, it is true of physics. A rather small fraction earns an enormous number of citations. We do very well in the 'highly cited papers' category. Again, this strengthens our belief that the performance of the UK's research base in physics has been tremendous.

I think it follows that, to have achieved that level of success, we must have been funding physics at about the right level. We have argued in the report that we should maintain that level of funding to remain competitive in physics.

Professor Bill Wakeham FREng was Chair of the Wakeham Review into the health of physics in the UK. He is Vice-Chancellor of Southampton University. Professor Wakeham has overseen a major restructuring of the university to ensure its ongoing success. He is a member of the Engineering and Physical Sciences Research Council (EPSRC) Council and Chair of its Resource Audit Committee.

Schools and physics education present a complex challenge. It is evident that over the last 15 to 20 years there was a significant drop in the number of people doing A-level physics. Recently this has levelled off and the rate is now slightly increasing – but only slightly. I think the real problem is that, at the other end of the pipeline, physicists are not highly valued for their subject-specific training.

The employers we spoke to heaped praise on physicists for their analytic skills, their numerical skills, their modelling skills and their ability to disentangle complicated problems and then knit together sensible solutions. That praise came from a huge range of industrial and business backgrounds. So these people are in demand, but not necessarily to work in physics. Even within universities, but certainly outside, physicists can be found in many different kinds of jobs.

Secondary schools

At secondary school level, simply too few teachers have a physics degree. Teaching has become an unattractive career for physicists given all these other wonderful opportunities. That dearth of physics teachers has been getting worse over a long period. Adrian Smith's review of mathematics teaching came to the conclusion that "something has been done in the case of mathematics teaching", and we advocate that something similar must be done for physics teaching. We would much prefer that physics teachers had physics degrees, but in the short-term the retraining of other scientists may provide an answer. It remains a problem, though.

Although the number of people taking A-level physics has fallen, the number of undergraduates has actually slightly increased. The question therefore arises of whether we are maintaining standards when we are 'fishing in a decreasing pool' and yet acquiring more people. There is no evidence of declining standards, but this could be a concern in the future.

At A-level there are many students from ethnic minorities taking A-level physics but very few go on to degree courses; an issue that surely needs attention. Also the number of women who take up physics A-level and then subsequently do a degree is decreasing. Given that a disproportionate number of teachers are drawn from women graduates there is a vicious circle feeding the lack of school teachers.

While an absence of physicists would cause problems for a large number of industries, in several cases our employer group was concerned about the practical skills of those who were coming into the workforce. Practical work has become increasingly expensive, leading a number of physics departments to reduce the amount of laboratory time and equipment available (this is not unique to physics). We are strongly of the view that we must maintain additional funding in laboratory-based disciplines until a review of undergraduate teaching costs is completed – and I believe the Higher Education Funding Council is now committed to this. I would not attribute all the decrease in laboratory activity to money; I think changes in the subject require less such activity. Nevertheless, this was a problem identified by our industrial group.

Physics as a discipline

As we went through the Review we were very clear in distinguishing between physics as a discipline and the work of physics departments in universities. Physics departments are rather narrow in their discipline base: indeed, a great deal of physics takes place in other departments such as geology, engineering, mathematics and electronics. Now at first sight that may not seem a problem, but because of the way physics is funded and Higher Education Funding Council money is distributed, this narrowness causes great reliance on research council income alone. That can be dangerous for a department

– one hiccup in a research council allocation can cause real difficulty.

Several other research councils other than EPSRC fund physics – the National Environment Research Council (NERC), the Biotechnology and Biological Sciences Research Council (BBSRC) and the Medical Research Council (MRC) – but very little of that is spent in physics departments. Something like 95 per cent of their physics funding is spent on the discipline, but not in departments. I think our panel evolved a worry that perhaps physicists had abandoned the areas of physics that we really needed them to be working on and perhaps abandoned intellectual leadership of the field to other disciplines. Perhaps physicists need to reclaim some of these areas.

By narrowing the discipline base we have restricted our funding sources. The future, then, might include broadening the base of physics, recognising that physics is done in many more places than just physics departments. Universities must look at total activity rather than just the work of the physics department.

Finally, we need to encourage A-level student to study physics at university, not just as a discipline in its own right, but as a training for satisfying and worthwhile employment. ❐

www.rcuk.ac.uk/review/physics.htm

Encouraging greater inter-disciplinary engagement

David Delpy

I think the most important conclusion from the Wakeham Review is that physics on the whole is in a healthy state. While there are some problems, we have to communicate to potential students (those still at school) and to school teachers that physics is very healthy in the UK and that career prospects are very positive.

How will EPSRC respond to the recommendations? We recognise the breadth and diversity of physics research because many of the engineering, life science and mathematics departments where it is taking place fall within EPSRC's remit. The report highlights the need for better engagement between 'pure' physics and other disciplines.

EPSRC spent £136.9 million on physics in 2006-7, virtually 24 per cent of the total. Of that, only £64.3 million went to physics departments. MRC calculated that in the same year, it was providing £50 million – but not directly to departments. The figure for BBSRC was £40 million and for NERC nearly £15 million. That represents a great deal of funding for physics research, but not predominantly for physics departments.

Professor Wakeham has cited evidence that physics departments are not engaging with industry. From the 2006-7 expenditure focussed in departments, we achieved a grand total of nine patents, licences and spin-outs – I think that indicates the degree to which some core physics research is not relating to industry. Given the pressure from Government to demonstrate the impact of – and the potential return on – investment, I was surprised how low this figure was.

The EPSRC Council noted that grant proposals which are not for pure physics struggle in the peer-review process. In fact, all inter-disciplinary applications struggle, but we observed a particular problem with the physics community: it is to some extent a self-perpetuating group of academics which, in general, is not prepared to fund work that does not fall into a narrow definition of 'pure' physics.

Professor David Delpy FRS FREng is Chief Executive of the Engineering and Physical Sciences Research Council. He joined EPSRC from University College London, where he had been Vice-Provost for Research since 1999. He was Head of the Medical Physics and Bioengineering Department at University College London from 1992 to 1999.

In our own restructuring as a funding council, we have created a single physical sciences programme. We currently still have physics, chemistry and materials panels, but we are considering whether to establish a broader review panel that more adequately represents today's mix of physical sciences.

We want physicists to bid for funding in the major cross-council programmes: in energy (which is funded to nearly £220 million); environmental change; the digital economy; nanoscience; and aging. Every physics department as well as individual physicists should be bidding for these.

Training

We are directing an increasing amount of postgraduate training into doctoral training centres. These allow students to experience a broad mix of subjects outside their own PhD discipline. We have extended our EngD concept, calling it an 'industrial doctorate', because physicists and chemists do not want to be called 'engineers' – although as an applied physicist I am proud to be called an engineer.

RCUK has been asked to conduct a review of nuclear physics. We believe that nuclear physics cannot be separated from nuclear engineering. So in 2009 EPSRC and STFC together will undertake the review of the nuclear physics/nuclear engineering area in order to ensure that the required breadth and depth is available both for UK academia and for the new build nuclear industry that awaits. ❐

discussion

Economic impact. Some felt that scientists should not be distracted by the need to justify their contribution to the community at large. Others argued that scientific research itself should not be distorted by too much attention to applications and financial benefits. A counter argument was put forward that there is no intrinsic conflict between curiosity-driven research and applications-based research – the current emphasis on 'economic impact' has only existed in science policy for the past 50 years. It was also pointed out that good publicity given to the positive results flowing from science can lead to big increases in funding for basic research, as the extra funding for the Medical Research Council has shown.

Delivering real results to the wider community

Keith Mason

STFC's role within the research council family is to supervise the provision of large-scale facilities across the full research base, from the investigation of the very small to the very large (and all things in between). At the two extremes lie the subatomic world of particle physics and the vastness of space. In the intermediate scale of the world around us, our physics-based facilities support studies funded by all the Research Councils, for topics as diverse as new drug development, the design of new materials, and archaeology. STFC embodies a multi-disciplinary approach to research. Yet at the heart of everything we do lies a common set of core skills and technology firmly rooted in physics.

Providing cutting-edge facilities for the research base – for example the Diamond Light Source (DLS) and the Large Hadron Collider at CERN – is an essential part of our long term strategy to retain and grow the UK's competitiveness in the global economy.

But *building* facilities in itself is not sufficient. Many of these national and international facilities have a lifetime measured in decades, so we also need to provide continuing investment in their operation if they are to deliver their potential. Some 85 per cent of the cost of a facility like DLS comes in keeping the machine maintained and safe, and providing the skilled staff to operate it: that outlay comes before you use it for scientific research. A long term view is absolutely essential if we are to be a competitive, knowledge- and skills-based economy.

Machines themselves are useless without sufficient skilled scientists, engineers and technicians to operate and exploit them. Maintaining and expanding investment in physics education also requires a long-term commitment. It takes 13 years of formal education before a secondary student is capable of undertaking an undergraduate degree in physics, with further years of effort being necessary to achieve a post-graduate qualification.

So why do we do this? Why do we go to all this effort and expense to build up our scientific infrastructure and train people to use it? It is based on the conviction that scientific research is now central to the future prospects for our society, for driving forward the economy, dealing with global threats to security and the environment, enhancing the quality of life and in making the UK an attractive place to live, and invest in the economic case The mission of DIUS, our sponsoring department, is to create economic prosperity and social justice through a combination of research and skills – and innovation. To ensure that taxpayers feel the benefit of the investment they are making, we must pay careful attention to the need for innovation. Ultimately, only if we do this effectively and communicate the results to the public, can we justify continued and increased investment in science. This process of innovation is already happening and is, in fact, gathering pace.

Professor Keith Mason is Chief Executive of the Science and Technology Facilities Council (STFC). He was previously the Chief Executive of the Particle Physics and Astronomy Research Council (PPARC), a post he held from August 2005 until April 2007. Professor Mason is an astronomer and was Head of UCL's Department of Space and Climate Physics and Director of the Mullard Space Science Laboratory.

Thruvision is a physics-based spin-out company from STFC Rutherford Appleton Laboratory. It uses Terahertz radiation technology, originally developed for space research, for security applications such as spotting explosives hidden under clothing (something not previously possible). It is now providing commercial systems to airports, sporting arenas and Canary Wharf.

A technique called SORS (Spatially Offset Raman Spectroscopy) was created at STFC's Central Laser Facility to study the contents of a bottle or packet without opening it. This is now being developed by a spin-out company called Lite Thru and can simplify the quality control of pharmaceuticals, or the search for illegal drugs. Its potential as a non-invasive medical technique to study cancer is also being examined.

Atmos Technologies, based at our Daresbury Laboratory, have developed a new, non-toxic photo-voltaic diode. This is based on technology that has the same efficiency as current silicon devices but only needs one-sixtieth of the energy for production. As a result, the company is developing clean and efficient methods to produce hydrogen from seawater, with potentially huge implications for clean fuel.

It is important that we record these examples and publicise them. Yet it is also important that we assess the impact of our large facilities overall. Many of you will be aware that we recently closed the second generation synchrotron machine 'SRS' at Daresbury after 28 years of operation. We are taking the opportunity to assess the overall impact of that machine.

To give just one example: the total investment in SRS over its lifetime was approximately £500 million. One company has created a business worth £250 million simply from a relatively small piece of technology that it developed for SRS. The economic impact of the research itself is massive – just unravelling the structure of the foot and mouth virus has a potential economic impact of billions.

We have to remain conscious of the 'business case' for investing in science and the wider research base. It is very clear to all of us involved that continued investment is vitally important, particularly in times of economic downturn. Only in this way can the nation be ready to take full advantage of an economic recovery. This is a message that we should all be promoting vigorously.

Communicating with the wider world

We are very good at promoting our scientific successes to fellow scientists – after all, the peer review system operates to enhance that process. We are not as good at explaining to the broader community (those who fund us) how we use their money to make their lives better. I have heard leading particle physicists and astronomers defend the importance of their fundamental science because of its impacts – things like the ability to attract students into STEM subjects, the development of MRI, the world wide web, as well as the contribution of scientists in the financial sector. However, many of these same people express suspicion when the Government judges them in part by these impacts – and asks for more. Yet, if these are such important benefits from science, how can it be so bad to ask for more?

The fact is that the reason most scientists chose their career is not the same reason that society funds it. If we are honest, most of us carry out our research because we enjoy it: understanding the universe is deeply fulfilling and it taps into something basic in the human psyche. There is nothing wrong with that. The key challenges of this century – climate change, aging, third world food shortages, HIV – need scientific advances if they are to be successfully addressed. These global challenges form a strong and compelling case for the importance of science, and it is a case that we should make with enthusiasm. So, if Government and society want to see relevant impacts from our science, we should embrace that challenge, and not recoil from it.

To give just one example, if we believe that attracting and training students who then go on to have an impact in industry is an important impact of astronomy, then we should accept that getting a postdoctoral post and then a faculty job is not the only measure of success. The social and economic impact of science may not be why we do research, but it is a large part of what we promise society in return for support – and that support not unreasonably comes with an expectation that we will deliver. It follows therefore that we have a responsibility to provide tangible evidence that we are serious about those issues and that we are indeed delivering on those promises.

STFC's programmes will continue to support curiosity-driven science, as well as the application of that science. To ensure we have the funds to do so, we must give Government more ammunition to fight off moves to reduce the science budget. This is not a call to deliberately skew science investment toward commercial outcomes. Time and again history shows us that the most far-reaching advances stem from curiosity-driven research. However, we must put in place structures to extract the maximum benefit from the research that we do.

This is high on the priority list of all the Research Councils. In STFC we are developing the Daresbury and Harwell Science & Innovation Campuses to do just that. These campuses will facilitate more, and better, fundamental research as well as delivering greater impact.

Yes, science should and must be funded. But this is not a right, and I think it is beholden on all of us in these tough economic times to do more to demonstrate to the wider community that we appreciate our money comes at the expense of something else, but that we are worth it! ❐

Challenges for the future

Jocelyn Bell Burnell

I want to comment on three areas: future decision-making; the continuity of funding for physics research; and improving the take-up of physics for 16 year olds and upwards.

The Institute of Physics welcomes the proposal to broaden the membership of STFC's Council. A scientific expert group to advise on the Comprehensive Spending Review allocations is also an excellent idea. We were disappointed though that RCUK has not accepted the separation of the funding streams in STFC.

There was one curious omission from the Wakeham report. Has the physics community abandoned the intellectual leadership of its subject to the Research Councils? Who draws up the road map for future physics? I think there is a real issue here and I am sorry it was not addressed.

Funding

Moving onto funding: what is the right balance between fundamental and applied research? It is tempting for governments with a short time between elections to emphasise applied research and expect results before the next election but physics does not always work like that. The Institue of Physics is commissioning a study to analyse UK and overseas funding for physicists and physics and we would welcome support from RCUK.

Fundamental research has to be driven by intellectual curiosity. It is unpredictable, so it is impossible to say in advance what will deliver and what will not. However, it is certain that its timescales are much longer than people expect – take the examples of quantum information technology, climate change forecasting, the development of superconductors and the world wide web, among many others. So we must take the long view. This may be difficult when money is tight; the temptation is to cut back on pure research, but that is not advisable.

Improving the take-up of physics would help to educate a scientifically literate public that could then engage sensibly in discussions about nuclear energy for example, but training in physics would also mean that people had analytic skills that could be used generally.

Part of the challenge is to find enough specialist teachers: in the city of Hull there is just one qualified specialist physics teacher! The situation is dire. The Government has recognised the problem, but it has to be solved very quickly if the current generation of students is not to miss out. The IOP estimates that to compensate for those retiring while also providing sufficient qualified teachers for the future, we need 750 students a year training as physics teachers – that is a quarter of the total graduating class. So there is a very serious issue there.

Diversity

The need for increased diversity is also an issue. The proportion of female undergraduate remains consistently around 20 per cent. I believe there is a cultural influence here because other countries have much higher ratios. In Malaysia at the Science University the undergraduate class is 60/40 female/male. Here, though, the ratio remains stubbornly low.

There are other dimensions to this problem. Physics is still predominantly a white, male, middle-class subject – just think of the loss of talent that implies. I am very glad the review recognises this issue; the Institute will give all the support it can.

The Institute of Physics strongly supports the recommendations of the review. We hope RCUK will carry them forward, but in this case the devil is in the implementation, so I think this needs watching. ❐

Professor Dame Jocelyn Bell Burnell DBE FRS is President of the Institute of Physics (IOP). As a graduate student surveying quasars with a radio telescope at Cambridge University that she had helped build, Professor Bell recognised that a periodic radio signal had too short a period and was too regular to come from any known astronomical phenomenon. The sources were named pulsars, all of which would later be recognised as neutron stars.

Sir Hugh Laddie

15 April 1946 — 28 November 2008

Professor Sir Hugh Laddie, a member of the Council of the Foundation for Science and Technology, was perhaps best known in the public eye as the judge who resigned from the High Court in 2005 claiming the job was "unstimulating". But his own impact on the legal system – particularly in the area of intellectual property (IP) – was certainly not 'unstimulating'.

He was born in 1946 in London and studied at St Catharine's College, Cambridge – first medicine and then law. After being called to the Bar, he spent 25 years as a barrister representing clients in intellectual property cases. Although patent law was commonly considered a boring backwater of the legal profession, he once commented that it had given him "25 years of laughter, normally at the expense of the judiciary". He was a junior treasury counsel in patent matters from 1981 till 1986. He acted in some of the early disputes in medical biotechnology and was later, as a judge, to make important judgements in this field.

With Peter Prescott and Mary Vitoria, he wrote *The Modern Law of Copyright* in 1980, which became a standard and highly influential text.

As a young attorney in the early 1970s, he was credited with inventing what became known as a Piller Order (from the case of Anton Piller KG v Manufacturing Process Ltd, 1976). In those days, record pirates were copying discs but were able to destroy evidence before being apprehended. Laddie asked for *ex parte* orders that required immediate access to premises and an instant search – the aim being to prevent destruction of the evidence. This avenue was eventually tested in the Court of Appeal – and Laddie won the case. Lord Denning later referred to him as the 'enterprising' Mr Laddie.

He was made a High Court judge in 1995, one of two patent judges in the Chancery Division. His innovative and insightful approach to the law – and his desire that the law should deliver justice – meant his courtroom was never a staid procession of legal procedure. Daniel Alexander noted that in Mr Laddie's court, "no-one worried about what the other side would do to one's case. The real concern was what he would do to it. Counsel with a weak position particularly feared those moments when he would push back his wig, lower his voice and invite their opponent to sit down, while he delivered a volley of unanswerable questions". Mr Justice Laddie was also very active in introducing innovations to cut the cost of patent litigation in England, which he argued was too expensive.

However, over a period of 10 years he found the restrictions of the system increasingly frustrating and so in 2005 he resigned from the Bench – the first judge to do so since Sir Henry Fisher in 1970.

The public way in which this was announced – and his decision to join a firm of solicitors as a consultant – caused some irritation amongst some of his peers. However, others privately applauded his integrity.

He became Professor of Intellectual Property Law at University College London. From this base, he created the new Institute of Brand and Innovation Law. A few weeks before his death, while quite ill, he introduced a major seminar at UCL on intellectual property enforcement which was attended by hundreds of practitioners, academics and students.

Sir Hugh Laddie became a member of the Council of the Foundation for Science and Technology in 2001.

Although he had a fearsome reputation in the courtroom, his court was acknowledged to be a place of humour and fairness. Colleagues that worked with him described him as "an innately friendly, fun-loving individual with an easy and engaging manner that never failed to bring a smile to one's face".

Professor Sir Hugh Laddie died on 28 November 2008, aged 62. ❒

Sir Richard (Dick) Morris CBE

20 November 1925 — 1 July 2008

Richard Morris packed into his life an extremely wide-ranging series of senior appointments in industry and public service. Following a spell as a commissioned officer in the Welsh Guards, he joined Courtaulds the fabrics and textiles firm. His talent was recognised by Sir Alan Wilson who sent him to study Chemical Engineering at Birmingham, where he took a First and won the vice-chancellor's prize in 1955 – and this as a 30-year old mature student.

He was soon a key player in the development of the British plastics industry and became Courtauld's youngest main board director in 1967. However, when he realised that someone else was being prepared for the top job at Courtaulds, he left to become deputy chairman of the National Enterprise Board, the Government agency for industrial intervention. As a result he came to the attention of the American owners of engineering firm Brown & Root and was appointed head of its British operations. The company, since bought by Halliburton, was a major builder of drilling platforms and rigs for oil and gas.

He also had responsibility for operations in Africa and led the Great Manmade River Project in Libya. The biggest man-made river in the world ran through 1,000 km of underground pipes, transporting water beneath the Sahara Desert to several destinations including the Libyan capital of Tripoli. The project provided the means for Morris to help begin the restoration of diplomatic relations between the UK and Libya, which had been severed following the shooting of a policewoman outside the Libyan embassy in London.

1n 1987, a consortium led by Brown & Root took over the newly privatised Devonport Royal Dockyard and Morris became chairman until 1991.

In 1989, Richard Morris became chairman of Nirex, writing an influential report on nuclear waste storage and drawing up plans for an underground repository of such waste at Sellafield in Cumbria. His proposals were rejected by the Government, though, and he resigned from the post. He later became chairman of Chiltern Railways and of Derby Cathedral Council.

Appointed CBE in 1985, he was knighted in 1992 for services to industry and science. He was President of the Institution of Chemical Engineers and a vice-president of the Royal Academy of Engineering. He died on 1 July 2008, aged 82.

The Foundation is grateful to the following companies, departments, research bodies and charities for their support for the dinner/discussion programme.

Advanced Research Advisory Group (ARAG), MoD
Advantage West Midlands
ALSTOM
ARM
Arts and Humanities Research Council
Arup
Association for Science Education
Association of the British Pharmaceutical Industry
AstraZeneca
BAE Systems
Biotechnology and Biological Sciences Research Council
Blackwell Publishing
BP
British Antarctic Survey (NERC)
British Council, Science Section
Brunel University
BSI
Business Innovation Group LLP
Calderwood Han Limited
Cancer Research UK
Carbon Trust
Carron Energy
CIRIA
City & Guilds of London Institute
Comino Foundation
Council for Industry & Higher Education
Council of Heads of Medical Schools
CPNI
Department for Business, Enterprise and Regulatory Reform
Department for Communities and Local Government
Department for Environment, Food and Rural Affairs
Department for Innovation, Universities and Skills
Department for International Development
Department for Transport
Department of Health
Detica
Economic and Social Research Council
E.ON UK
Engineering & Physical Sciences Research Council
Engineering and Technology Board
Environment Agency
Faber Maunsell
Foreign and Commonwealth Office
Gatsby Foundation
GlaxoSmithKline
Harley Street Holdings
Heads of University Biological Sciences
Health Protection Agency
Higher Education Funding Council for England
Home Office
Hospital Saturday Fund
House of Commons Select Committee on Innovation, Universities, Science and Skills
House of Lords Select Committee on Science and Technology
HR Wallingford
IBM(UK)
Imperial College
Innovation Norway/Royal Norwegian Embassy
Institute of Biology
Institute of Marine Engineering, Science and Technology
Institute of Physics
Institution of Mechanical Engineers
Ipsos MORI
Japan Society for the Promotion of Science
Johnson Matthey plc
King's College London
Kohn Foundation
Lloyd's of London
Lloyd's Register
London & Continental Railways
London Development Agency
London School of Hygiene & Tropical Medicine
London South Bank University
Medical Research Council
Mewburn Ellis LLP
Michael John Trust
Middlesex University
National Endowment for Science, Technology and the Arts
National Grid Transco
National Oceanography Centre, Southampton
National Physical Laboratory
National Police Improvement Agency
Natural Environment Research Council
Natural History Museum
Newcastle University
North East Science & Industry Council
Nottingham Trent University
Oxford Innovation Ltd
Pitchill Consulting
Premmit Associates Limited
QinetiQ
Reed Exhibitions
Research Councils UK
Risk Management Solutions
Risk Solutions
Rolls Royce
Royal Botanic Gardens, Kew
Royal Holloway, University of London
Science & Technology Facilities Council
Scottish Funding Council for Further and Higher Education
Scottish Government
Sharp Laboratories of Europe Ltd
Shell UK Ltd
Sir William Francis
Society of Maritime Industries
South East England Development Agency
STEMNET
Technology Strategy Board
The British Academy
The Institute for Statecraft and Governance
The Institution of Engineering and Technology
The Learning Grid
The Leverhulme Trust
The Open University
The Royal Academy of Engineering
The Royal Commission for the Exhibition of 1851
The Royal Commission on Environmental Pollution
The Royal Society
The Royal Society of Edinburgh
The Smallpeice Trust
The Training Gateway, University of York
The Wellcome Trust
University College London
University of Aberdeen
University of Birmingham
University of Bristol
University of Cambridge
University of Cardiff
University of Durham
University of Edinburgh
University of Glasgow
University of Hull
University of Kent
University of Leeds
University of Leicester
University of Liverpool
University of Nottingham
University of Reading
University of Southampton
University of Teesside
University of Warwick
University of Westminster
Winsafe

The Foundation for Science and Technology
10 Carlton House Terrace
London
SW1Y 5AH

Telephone: 020 7321 2220
Fax: 020 7321 2221
e-mail: fstjournal@foundation.org.uk

www.foundation.org.uk

THE FOUNDATION
FOR SCIENCE AND
TECHNOLOGY