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Women in science

Women in science and engineering



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The Energy White Paper

On Monday 24 February this year the UK Government issued the much awaited White Paper, *Our Energy Future – Creating a Low Carbon Economy*. The contents had been the subject of much speculation and lobbying, as discussed in two FST meetings summarised in *FST Journal* issue 8 (Sustainability, pages 3–8; and Energy Policy, pages 9–13). The main points of the White Paper can be summarised:

- Carbon dioxide emission to be cut by 60 per cent by 2050, with ‘real progress’ towards that goal by 2020.
- £350 million to be invested in renewable energy.
- An ‘aspiration’ for 10 per cent of energy to be renewable by 2010 and 20 per cent by 2020 — if costs are ‘acceptable to the customer’.
- Britain’s 16 nuclear power stations are now due reach the end of their working lives in about 30 years. There are to be no new nuclear power stations in the near future, but policy review is scheduled for 2005.
- The next revision of building regulations to raise standards for energy efficiency in new buildings and refurbishments is to be brought forward to 2005.
- New policies will add between 5 and 15 per cent to household electricity prices, up to 25 per cent to industrial electricity prices and up to 30 per cent to industrial gas prices by 2020.
- Britain already has more than 1,000 offshore and onshore wind turbines, generating more than 550 megawatts of energy, enough to power nearly 400,000 homes.

The low priority given to nuclear power certainly went down well with the green lobby. David Toke, energy spokesperson for the Green Party welcomed plans to ditch the “nuclear option”, and was surprised and pleased to see the 60 per cent carbon dioxide reduction target, but complained that there was little detail on how these targets will be achieved. Toke concluded: “It is doubtful if any of the targets will be met unless the Government gets practical measures into gear”.

The British Nuclear Energy Society, lobby group for the nuclear industry, argued that renewable sources and conservation will be not be sufficient to enable the emissions reduction goals to be achieved without replacing the existing nuclear stations with modern equivalents.

In a statement released three weeks before the publication of the White Paper, the Royal Society had called on the Government to show the “political courage” to replace the ageing nuclear power stations. Royal Society president, Lord May of Oxford, said that “In the short to medium term, it is difficult to see how we can reduce our dependence on fossil fuels without the help of nuclear power”.

The white paper, *Our Energy Future – Creating a Low Carbon Economy* can be downloaded from www.dti.gov.uk/energy/whitepaper/index.shtml

A tale of two committees

In the *FST Journal*’s report on a discussion on radioactive waste management (issue 7, pages 9–14; 2002) environment minister Michael Meacher assured critics that the Government would soon be acting on the question of what to do with the 20,000 tonnes of solid, long-lived radioactive waste in long-term storage across the country. Lord Howie of Troon, a member of the House of Lords Select Committee that had reported in March 1999, had called for a more urgent approach from Government.

Speaking at the FST meeting on radioactive waste Michael Meacher said the intention was to set up a “strong, independent and authoritative body to advise on what information is needed, how it should be gathered and, when there is enough information, to advise on the best option.”

Government action has since followed, and a new body is to

come into being. Readers of the appointments pages of the *Daily Telegraph*, *Economist*, *Guardian*, *Sunday Times* and some regional newspapers will have seen advertisements for a chairperson and members to serve on a new Committee on Radioactive Waste Management (CoRWM). The new committee is to review the options for safe management of the waste so far accrued, and recommend a strategy to the UK Government and the devolved administrations for Scotland, Wales and Northern Ireland.

What of the Radioactive Waste Management Advisory Committee? The RWMAC acted as an independent watchdog for 24 years before being controversially shut down in March this year, not long after having reported the discovery of a ‘missing’ 3 million cubic metres of nuclear waste that had not been accounted for by the Department for Environment, Food and Rural Affairs (DEFRA), British Nuclear Fuels, or by the United Kingdom Atomic Energy Authority. RWMAC complained that the Government had no plans and no capacity to deal with it.

In a letter to Michael Meacher, RWMAC chairman, Charles Curtis of Manchester University, is reported as saying that the abolition of the committee by the DEFRA “will leave a gaping hole in the structures for independent scrutiny of current radioactive waste management and regulatory practices”.

CoRWM will be launching a programme of research and debate involving the public and interested parties across the UK, in the words of the job advertisements “to ensure that its strategy is sound, can win public confidence, and can be implemented”.

Salt targets for children

In May 2002 we reported on an FST meeting on salt and diet (*FST Journal* issue 5, pages 14–16), where different interpretations and conclusions were gleaned from the same studies on the effect of salt in our diet on hypertension. At that time the Committee on Medical Aspects of Food and Nutrition Policy (COMA) was recommending a reduction in the average intake of salt in the adult population from the current average level of 9 grams to day to 6 grams a day.

This month (May 2003), the Food Standards Agency (FSA) has issued salt intake targets for children for the first time. The advice is based on a new report¹ from the Scientific Advisory Committee on Nutrition (SACN), the new UK-wide advisory committee set up to replace COMA. It advises the UK Health Departments as well as the FSA, and is supported by a joint secretariat of the Department of Health and the FSA.

The new advice recommends: 0–6 months, less than 1 gram/day; 7–12 months, 1 gram/day; 1–3 years, 2 grams/day; 4–6 years, 3 grams/day; 7–10 years, 5 grams/day; 11–14 years, 6 grams/day.

The levels of current average intake for children of four and above are almost certainly higher than these targets. Children’s salt consumption is relatively higher than that of adults for their weight. The SACN report also confirms previous advice that reducing current salt consumption by one-third for adults would have significant public health benefits by reducing average population blood pressure levels.

Parents are being advised to cut the levels of salt they use. But about three-quarters of the salt we eat is from processed food, so parents will have to check the salt content on food labels when buying for their children.

Sir John Krebs FRS, chairman of the Food Standards Agency, said: “There are important health benefits from reducing salt intake... While consumers can add less salt at the table and in cooking, they cannot change the amounts of salt in processed foods, which make up, by far, the highest proportion of our salt intake.”

1. Scientific Advisory Committee on Nutrition *Salt and Health* (May 2003). www.sacn.gov.uk

Prospectus for a revolution

Nick Sanders

The Funding of UK Universities – Increased Fees or Grant-In-Aid? The White Paper The Future of Higher Education, which sets out the Government's plans for radical reform and investment in universities and HE colleges, was published on 22 January 2003. The issue of funding through fees and grants was debated at an FST discussion meeting on 4 February at the Royal Society. The debate was led by Nick Sanders, Director of the HE group at the DfES, followed by Sir Richard Sykes, Lord Oxburgh and Peter Johnson. The general discussion was summarised by Sir Geoffrey Chipperfield.



Nick Saunders, who has been Director of the Higher Education Group at the Department for Education and Skills, is a scientist by training. His Civil Service career has been mostly in the education department. He is one of the principal authors of the white paper on higher education.

My task is to describe the contents of the Government's White Paper on the future of higher education, published in January 2003, and to raise the question, 'funding for what?'

The White Paper acknowledges the great strengths of the British university system in teaching, research and knowledge transfer. It applauds the place of British universities in international competition, but goes on to say that there is now a real threat of decline relative to leading international competitors.

The most conspicuous issue in the White Paper, around which most press comment has so far concentrated, is that of how students should contribute to the cost. Ministers, who have thought about the question for a long time, have decided that it is right that those who benefit most from higher education should contribute more of the cost. Although public support per student (in real terms) has been declining since 1989, the total cost of public support has been growing quickly. I shall return to this question later.

The White Paper also supports diversity in higher education. While there is excellence in many institutions in teaching, research and knowledge transfer, not every institution can or should focus on all three. The White Paper urges that institutions should play to their strengths and have a clear vision of what they are.

On research, the cross-cutting studies accompanying the three successive spending reviews have provided a wealth of information of how the system works. The most recent settlement is generous, both on capital and recurrent spending. The White Paper asks that the significant new resources should be spent wisely. It argues for selectivity, concentration and effective collaboration, not least between institutions, as well as for the explicit support of emerging research areas. The current review of research assessment procedures [due in May] will be very important in these respects.

On knowledge transfer, which the DfES considers crucial, the White Paper calls for intensive activity, nationally and regionally, in schools and in further and higher education.

The regional dimension is especially interesting. The White Paper argues that the Regional Development Agencies (RDAs) should act as channels of communication not only among industry and employers but also from universities to employers as well as the other way

around. On teaching, we make the case that student choice, if properly informed, will help to drive quality and have proposed further improvements to the information available to students. We make proposals about professional standards for university teachers, who should receive further recognition and reward, both individually and by means of centres of excellence within institutions.

The White Paper also considers the criteria that universities must satisfy. Many existing universities have gained their titles after being university colleges or colleges of technology. Their hallmark is that they have powers to award degrees, both taught and by research. The grant of the title hangs, of course, on their having a sufficient range and scale of endeavour. We are now working out criteria that will enable institutions to be called universities without having the power to award research degrees, although we do not propose taking away those powers from universities that already have them.

On the pace of expansion, the Government is committed to moving towards 50 per cent participation in higher education by 2010, compared with the present ratio for 18-30 year olds of 43 per cent. But the Government says, in relatively strong terms as White Papers go, that it does not want more of the same. Instead, it argues that expansion beyond 43 per cent should be concentrated on 2-year foundation degrees with a firm vocational orientation in conjunction with employers. The White Paper emphasises the importance of more flexible ways of studying, especially when many students will be part-timers or will want to study using new forms of educational technology.

Our ministers are also passionate about widening participation. If we are to secure fairer participation across society, a huge amount of effort is needed in schools and further education colleges to encourage achievement and aspirations. So we are sponsoring work on raising aspirations alongside the department's existing policies on achievement.

The White Paper also urges more work to ensure that admissions procedures are fair and that they reach out to people who can benefit from the opportunities available at particular institutions. Indeed, it proposes that there should be an access regulator who makes agreements with individual institutions, including targets they set themselves. This proposal has already attracted a good deal of comment.

I simply remark that between 1960 and 2000 the gap in access to higher education between the top three social classes and the bottom three widened in percentage terms. That is true for all age groups.

I conclude with the proposals on funding and on the freedom of academic institutions. The White Paper argues that, in the long run, true independence can be secured only by endowment; it encourages institutions to do what they can to raise their own endowment funds. I note that Harvard may have more than 200 fundraisers; I doubt that British institu-

tions are yet thinking in those terms.

My last point is about fees. What the White Paper proposes is that, from 2006/7, institutions that have secured access agreements should be able to charge undergraduate tuition fees of up to £3,000 per student per year. Government would continue to offer, on a means-tested basis, fee remission of the standard undergraduate fee of £1,100 p.a. It is also proposed that enhancements of the standard fee would be paid by the Government and recovered from graduates through the income tax system, just as maintenance loans are now

recovered. (The income threshold is also to be increased.) It is also proposed that students from the most disadvantaged backgrounds will receive grants of £1,000 a year.

This prospectus is a demanding one, embracing a large number of initiatives. They cry out for successful leadership and good management at all levels in all institutions. We welcome the initiative of Universities UK, the funding councils and others to set up a leadership foundation. We shall try to play our part and look forward to seeing how it works out. □

The case for greater diversity

Sir Richard Sykes



Sir Richard Sykes, FRS, a microbiologist by training, was appointed Research and Development Director of Glaxo plc in 1987, Chief Executive of the same company in 1993, Chairman and Chief Executive of Glaxo Wellcome plc in 1995 and Chairman of GalxoSmithKlein in 2000. He became Rector of Imperial College in 2001.

What do we want from higher education? There are three main needs. First, ways of helping people maximise their potential through education. Second, for society in general, improved skills for its citizens. Third, of course, we need the specialist knowledge and expertise for industry, commerce, healthcare and so on.

The potential and the needs of individuals differ, so that the means of providing higher education must differ, within the university sector and elsewhere. I fully support differentiation in tertiary education. If you cast your minds back, something like that was advocated in 1987 by the Chairman of the Advisory Board of the Research Councils, Sir David (later Lord) Phillips, who argued that there should be three types of universities — research universities, teaching universities and hybrids. But the idea got nowhere and people have forgotten about it.

In 1997, the Dearing Report¹ — which should have been more widely read by people in higher education — put forward the concept of regional, national and international universities. Nick Sanders's point about regional activity and the RDAs echoes that. But that again was never really taken up until it re-surfaced in this White Paper.

Plainly, we have to have a very different view of universities. We also need to recognise that differentiation exists already. Currently, we have a very strange paradox: research funding in our universities differentiates them very clearly: of all the research funding from the funding and research councils, 25 per cent goes to four universities. The top ten universities take 44 per cent, yet nobody bats an eyelid.

It is quite different with tuition fees. There, differentiation seems to make people uneasy. They believe that all courses are, or should be, of the same quality the same standard and that they are equally attractive to employers. But the pursuit of excellence gets tarred with the elitism brush. Tony Blair, the Prime Minister, made an interesting comment the other day when he said, "It gives me great sadness when people describe the pursuit of excellence as elitism".

But there is a problem about funding. British universities have no endowments to speak of; it is naive to believe that endowments are going to rescue British research universities. Harvard may have 200 fundraisers only because they have \$17 billion in the bank. Where are we going to get the money to front 200 people? We skimp and scrape and have a few people, but fund-raising is difficult in Britain. Anybody who has tried it knows that. To believe that endowments will be major drivers of the competitive universities in this country is a joke. We should recognise that.

Our activities need to be funded properly. The scale and complexity of the problem that we face today is one that cannot be solved by an increase in public money for university teaching. In a mass higher education system, which we are moving to, no government is going to be able to fund Imperial College or similar universities at the level required to maintain the necessary standards.

We need today the brightest people to work on the world's most difficult problems. How many will be prepared to do so with the prospect of a salary of £30,000 a year ten years after compulsory education? Between 1981 and 2000, academic

pay rose by 5 per cent in real terms, compared with an average 44 per cent for those in other full-time employment.

We need to charge fees that reflect the full cost and quality of the education we provide. The fees quoted in discussions like this are based on the fact that academics are grossly underpaid and work, most of the time, in inadequate environments.

The current approach to funding is an attempt at compromises that deny academic differentiation. The resulting uncomfortable compromise will still leave institutions like Imperial College short of necessary funds. The prospect of an unworldly blunt instrument called an access regulator to address the social inclusion issue adds insult to injury. Allowing for differences of entry requirements, British universities compare well with those in the rest of Europe and the United States.

We should put the fee debate into perspective. Today, families earning less than, say, £10,000 a year pay none of the compulsory £1,100 tuition fee up front; and for family incomes up to, say, £20,000, there is a sliding scale. Remember that maintenance grants have been abolished (in England). So the up-front annual cost of a university education is a maximum of £1,100 plus maintenance.

In 2006/7, the earliest date at which these plans could be implemented, students whose family income is below the threshold will still be forgiven the £1,100 and will also get an additional £1,000 for maintenance (which may change: it is too little). They take loan money at no interest and after three years or four years they can pay that money back if they are earning £15,000 a year; if they are not earning £15,000 a year they don't pay it. If they go into public services like teaching, if they go into the NHS, then they are probably going to get a lot of that payment wiped out anyway. So there is an enormous amount of fuss about a small amount of money.

Let me give you an example of what it means to Imperial College. By 2006, we shall have a turnover of £0.5 billion a year. By 2010, when we have gone through four of these annual cycles, we will have an additional £11 million a year from student fees.

The current approach to funding seeks a compromise that denies academic diversity. What we have to recognise is that if you charge a maximum of £3,000 for tuition fees, it is too small to create a market. Every institution will charge £3,000 for everything. The annual fee will automatically go to £3,000 from the present £1,100, everyone will charge £3,000, so we

shall be back where we are now. There is no differentiation. If the figure had been £5,000, there might be the beginnings of a market, with some charging nothing, some £1,000 or £2,000 and some the full £5,000. I think that then would have started to create a market and so a sustainable basis for diversity.

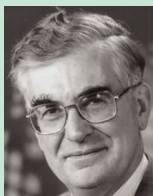
As you know, in the past few months several figures have been bandied about on the true cost of tuition at leading universities. Figures of £10,000 or £15,000 a year have been quoted. But these are a bit of a myth. For one thing, they would apply only at the top end of the university spectrum. Then the figures assume no scholarships, no bursaries, no funding from companies (which I am sure there would be), no funding from public services such as the NHS and so on. If there were effective differentiation, many schemes would come in.

But until the government stops regulating the universities, until people in this country see that universities have some independence, they are not going to part with their money and give it to the universities for higher education. Because they believe they would be letting the treasury of the hook. That is what people in this country do not like. □

1. National Committee of Inquiry into Higher Education
The Dearing Report July 1997.

Towards a moderated market

Lord Oxburgh KBE FRS



Following a distinguished career as an earth scientist at universities in Britain and North America, Lord Oxburgh was for six years Chief Scientific Adviser at the Ministry of Defence and Rector of Imperial College until his succession by Sir Richard Sykes, the previous speaker. He is also Chairman of the House of Lords Select Committee on Science and Technology.

The present situation of British universities is best understood in its historical context. Our universities were founded at different times, for different purposes and with different financial structures; what they have in common is that they produce graduates. Of course, they have other functions – research and knowledge-transfer have been mentioned already. I shall concentrate on the teaching side and on teaching money.

For most universities in this country, teaching accounts for 70-80 per cent of income. The Government pays most of the cost because it believes that a well-educated workforce is essential. That also explains the Government's aim of 50 per cent participation in higher education.

All governments, not just in Britain, have understandably retained one important power: that of telling an institution whether it may or may not call itself a university. Once so named, a university can award its own degrees and set its own standards. Over the past decade and a half

this power has been exercised generously in Britain, immensely widening the meaning of the term 'university'.

Some say this is a bad thing. I believe it is not necessarily either bad or good. It has happened, while the meaning of 'university' in this country is now no wider than, for example, in the United States. What it does mean is that we now have an extremely diverse group of institutions, all of which are legitimately universities.

Over the past 25 years there has also been a great expansion of higher education: the number of UK universities has roughly doubled; the number of university places has increased by a factor of three. When the Government created universities from the polytechnics in 1992 it also introduced a new method of allocating funds.

Today we have a formulaic funding system that has some characteristics of which Joseph Stalin would have been proud. For UK students, the Government determines how much it pays the university to teach each student, how many

there will be at each university and, within broad limits, what they may study.

That is an enormous degree of central control of the university system. It suits the Treasury because it provides overall control of university expenditure. But over time there has been increasing discontent over these arrangements; this is partly because of the overall funding level and partly because some believed that the formula does not adequately take account of institutional differences.

There is an international market for leading researchers. Sir Richard Sykes, Rector of Imperial College, faces the same problems that I, his immediate predecessor, faced: how to prevent leading researchers being tempted away by better facilities elsewhere and higher salaries, not exclusively by North American institutions?

Institutions competing internationally as research universities have much higher salary costs than others. Furthermore salary alone is not enough - what attracts outstanding research workers are the facilities, the students, and the environment and working conditions. These have to be right as well.

By contrast – and it is hard but true – there is no national, let alone international, market for outstanding university teachers (and little recognition of their qualities outside their own institutions). All in all this means that market forces make leading research universities disproportionately expensive in a way that is not compensated by current formula-driven funding.

How has this worked out? The unit of resource is the average annual sum the Government pays to institutions for educating a single student. The average payment is about £5,000 at current prices. In real terms, it has been reduced by a half since 1976. That interval also encompasses the great expansion I have described, when the participation rate went from 14 to 40 per cent – a threefold growth.

How did the universities cope with the cost implications of growth? They did several things to save money. First, they deferred maintenance: so now many universities are in shabby buildings. They also maximised their income from other sources, for example full cost fees paid by overseas students, and by hiring out their facilities for conferences and so on. University salaries also fell behind.

Richard Sykes explained how academic salaries suffered during this period, but students suffered as well: the staff/student ratio went from 1 to 10 in the early 1980s to about 1 to 18 in 2000.

I accept that none of this tells you the real costs of running a university. It is easy to say that in 1974 the universities were fat and that they have since been forced to become lean. But by any international

Teaching remuneration. There was considerable concern about the comparatively

small additional funding for teaching: indeed, it was confirmed that the increase in funding for teaching would be flat over the next three years. This would affect, in particular, those middle-ranking HEIs who would be squeezed out of research, because of the emphasis on concentration, but whose contribution to the development of a well-educated population was essential. Lecturers in such HEIs find themselves being paid less than 6th form teachers. It was important to recognise that teaching excellence was not restricted, or even principally found at, the elite research HEIs. There was no evidence (unlike that for research) that excellence in teaching improved with concentration. It should be assessed on the added value that it produced, and it might frequently be found that the best teaching happened at very different types of institutions. If good information were available to students about the value added by such teaching, these institutions would benefit substantially from differential fees – which even those from poor backgrounds would be willing to pay.

discussion

comparison, British universities in general are very lean and, indeed, some of the bones are now showing.

In 1997 the Dearing Report signalled a halt to this decline by declaring that the continuing decline was unacceptable and damaging and must stop. Eighteen months later, the decline was halted. Now the discussion is about who will pay for the further improvement in the unit of resource foreseen by the White Paper: students, student families, alumni, universities (through scholarships), the state (because of public benefit), employers (public and private) or what have you?

But that is not the real question: the policy choice is between a central decision on mission differentiation and related funding, or what I call a moderated free market. The first choice corresponds to the three-layer Californian state system – the campuses of the University of California, the State Colleges and the Community Colleges. Each layer has a clearly defined mission and is funded in a different way.

There is not the remotest chance that Britain will go back to such a system. The distinction between the universities and the polytechnics was abolished a decade ago; recreating it is not feasible. So the second choice, a moderated market, is the way forward.

A moderated market is one in which institutions are free to set their own fees with one proviso – that they guarantee means-blind admissions. That means that decisions about who comes to university are made simply on the basis of applicants' qualifications. Only when that decision has been made are the financial circumstances considered; the university then helps put together a financial package for student support. The US universi-

ties operating this system — which include, Harvard, Yale, Princeton, Stanford and Chicago, claim that students, once offered a place, are not prevented from taking it up for lack of funds.

In the long run, we will have to do something like that. Indeed, the White Paper is a step in that direction. And I must say this: whoever persuaded the Treasury to put the money up front for fees before recouping it through the tax system a decade or more later, pulled off the coup of a lifetime. The Dearing finance working group thought that impossible!

I should at this stage flag an important quibble about the White Paper's proposals. I would like to see the system modified in such a way that women who take three, four or five years off to have a family should not meanwhile accumulate debt. Indeed, some legitimate number of years should just be wiped out. But this is the fine print; these things are still to be discussed.

Universities may receive more fee income but, as Richard Sykes has pointed out, it will not be much more. In any case that extra income is subject to agreement by an access regulator who must approve admissions policies and practices for social balance. However, the White Paper clearly shows that students from lower socio-economic groups with good A levels are as likely to go to university as similarly qualified students from better-off backgrounds. So the implication of the White Paper is that it is the universities' job to put right the failures of the school system.

I did 12 years as an Oxford college admissions tutor. The selection of people for places at university is a complicated and sophisticated business. For all the flack that Oxford and Cambridge (but

particularly Oxford) have recently taken over admissions, I know of no other institutions in the world that pay as much attention to admitting the right people. That is not to say they get it right, but they certainly try.

What you are looking for in potential students is a combination of commitment, ability and preparation. You can have trade-offs between them, but there has to be a certain level of each. One of the hard lessons I learned as an admissions tutor is that there is nothing more unkind than to admit a student to a course with which it turns out they cannot cope. The student is miserable, people around them are miserable and everyone is miserable. Manipulating access is a dangerous game.

There is now a whole range of selection tools available, but I am not going to go into them. I simply remark that probably the fairest way of choosing people for higher education is what I call the first year cull. It is widely used in North American state universities. You admit everyone who graduates from high school with a minimum level of performance; you see how they get on in the first year and at the end you lose 50 per cent or more. It is expensive and I do not believe there a chance of doing that in Britain, even though I am one who believes that spending a year in an academic environment is not necessarily wasted even if there is no piece of paper at the end.

The White Paper, as I said, implies that each university must have the right social

balance. But universities can admit only from those who apply, from among whom they do their best to choose fairly. I know of no university teacher who would willingly choose to teach less rather than more able students. In the Oxford system, the competition between colleges to show up well in the degree lists creates enormous pressure to pick the brightest students. In any case, the aim of social balance may be frustrated by students' choice and their wish to attend local universities with their friends. I would be the last to suggest that Oxford or Cambridge or Imperial College was the ideal place for every bright student. There are bright students who simply do not flourish in such environments but who flourish in others. □

How to fund continued growth

Peter Johnson



Peter Johnson is Chief Executive of George Wimpey, the international construction company, as well as a member of the Council for Industry and Higher Education. He is a graduate of the University of Oxford, where he read Politics, Philosophy and Economics 30 years ago.

As a businessman who has worked for 30 years in international companies, I have seen the difference well-qualified management and staff, as well as capable public servants, make to economic success. Top quality higher education is a critical factor in improving this country's productivity.

I have also learnt that achieving results requires clarity about objectives and priorities. Perfect solutions do not exist.

So my first task is to set out my primary objectives for higher education.

The first objective of higher education is to raise the skill base of our economy by developing in the same way new generations of graduates able to fulfil their own potential and society's employment needs.

Those needs are about quality, quantity, relevance and diversity.

By quality I mean fit for purpose not an educational Rolls Royce. Many industrialists complain that some 'soft option' degree subjects lack rigour and do not qualify those graduating for the jobs they seek. Courses with 45 per cent drop-out rates show that students too recognise the waste of time and money.

Much has been said about quantity. A changed work place demands a better informed and better-qualified work force. An economy based on service and knowledge-based industries requires more people with higher level general and specialist skills than did traditional manufacturing. Even traditional industry has changed. In George Wimpey, with a turnover of £3 billion, there are at most three or four levels of management between the boardroom and site management. Each level must be able to make decisions, lead change, run a

business. The younger site manager is more often a graduate than a bricklayer. Such delayering is typical of modern industry.

To meet these needs, degree courses must be relevant. Graduates' skills should match society's needs, which change over time. Too many courses today are irrelevant to employers' needs.

These needs are diverse. We need graduates to run multinationals, replace hips, build bridges, draft legislation, produce television programmes and even run building sites. Even specialist needs vary. A geologist testing clay reserves for a brick manufacturer needs different abilities from one exploring for new oil reserves under the oceans.

Students have different skills and aptitudes and need different types of courses and teaching methods. Some will wish to develop practical skills, but in an environment where they gain a broader understanding of how they might apply that skill. Why shouldn't a plumber learn how to become a businessman as well?

So higher education must offer diversity – of subject, of teaching method and of application.

The second priority is to raise the economy's intellectual property capacity by maintaining internationally competitive research and graduate facilities, not just in the sciences but in all branches of learning. As western economies become more dependent on knowledge-based industries, intellectual property becomes a greater determinant of long-term relative economic performance.

There are of course other objectives and benefits of higher education, such as enhancing our international influence

through attracting overseas students. But the funding of higher education must enable these two priorities to be met.

So why is a change in policy needed? Some 40 years ago 5 per cent of those leaving school went on to university; today that number is over 40 per cent.

To support this growth, whilst maintaining quality and diversity, we must devote a higher proportion of GDP to higher education. The need to develop internationally competitive research resources requires even greater investment.

This gets to the nub of the current debate. It is not about how we fund the proportion of GDP going to higher education today but how we increase it.

Over the past 25 years we have failed to match resources to our aims. Funding per student fell 38 per cent in real terms from 1989 to 1999, following a 29 per cent decrease between 1976 and 1989. This decline was halted only by the introduction of student fees.

By 1999, the UK was 15th out of 26 OECD countries in expenditure on tertiary education as a percentage of GDP, with a proportion less than half that in the United States.

Of 21 OECD countries in 2000, only 4 had a worse ratio of students to teaching staff. We had over 30 per cent more students per teacher than the USA. And we have paid them less and less: there is now a 40 per cent pay differential between academic and other non-manual pay.

Governments of all political persuasions have been unprepared to sustain investment in higher education when faced with more urgent political and economic choices. It is commendable that the Government is now addressing this subject.

There has been another change. When I graduated, I expected to pay high and progressively higher marginal rates of income tax, thereby paying back an increasing proportion of my private financial benefits to the State. My point is simply that the idea of paying back some of the private benefit gained from a university education is nothing new.

Although the increase in university funding now announced is welcome, there is no political consensus to enable higher education to gain a sufficiently higher share of GDP through Government expenditure alone. We must therefore look to increase the proportion of private income devoted to higher education.

This could come from graduates themselves through loan repayment, their families through upfront fees, from all taxpayers or from employers. Who gets the greatest benefit should surely pay.

A recent London School of Economics study using data from 1993 to 2000 showed that men with a first degree earned on aver-

Endowments. Speakers were sceptical about the prospect of HEIs attracting substantial endowments. As an example of the cultural differences between US and UK citizens, 40 per cent of gifting to Oxbridge came from US alumni, but they formed only 5 per cent of the alumnus body. There was also concern about the precise role and function of RDAs. While it was important to collaborate with them in ensuring that their resources were well spent in helping HEIs to meet regional needs, RDAs themselves needed to recognise that the aims and priorities of individual HEIs would differ and must be respected.

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age 49 per cent more than men without formal qualifications and 15 per cent more than men with only A levels. The corresponding figures for women graduates are 44 per cent and 19 per cent, respectively.

These premiums vary by subject. Men with degrees in mathematics, engineering, economics and law earned 22-27 per cent more than those with A levels only, but men with an Arts degree received earnings 4 per cent less. Women with degrees in 'health', mathematics, architecture, economics and law earned 39 to 44 per cent more than those with A levels, while even those with an Arts degree achieved a premium of 17 per cent.

These variations demonstrate the benefits to individuals. Many courses offer high personal economic value and it is surely equitable to ask that those who gain such benefits bear the cost, especially if the costs are incurred only when the benefits are realised.

However, some end up no better or even worse off. It could be thought unfair that they should pay towards the cost of their degree – but it is equally unfair for taxpayers to fund such a wasted investment. It is clearly equitable and economically efficient that different students should pay different fees for different courses from different universities.

I see no case for either the family or the employer providing this funding. Whilst most families will value the educational attainment of their offspring, there is no case in equity or efficiency for the family to fund that investment through upfront fees. These would further deter those from poorer families who need the greatest support for access.

The employer already pays through the higher salaries graduates earn. In many cases the cost of repaying fees will fall on the employer as recruitment salaries for skills where there remains a shortage will be increased.

If differential fees are charged for different courses the student should understand the benefits of each university and degree course. Then they will increasingly apply for courses where the private gain is greatest, which our economy values most highly.

Where the public good exceeds the private value (for example teachers) the Government can intervene to subsidise those through waiving or reducing fee repayments.

More resources will flow to those universities offering courses with the highest 'value added'. Such universities should allocate more resources to subjects where they can charge higher fees. Universities unable to attract enough students for courses with poor returns should drop those courses and reallocate resources to more valued areas or merge with more efficient bodies.

Giving universities the scope to charge fees and provide information on the returns to different courses would gain some of the resource allocation benefits of a normal market. Quality, relevance and diversity would improve.

In conclusion, I welcome the thrust of the White Paper. It represents a major step forward and is better than the alternatives. But I have one or two reservations.

The repayment of fees once income has reached a target level is fair and efficient. The sums involved are not massive alongside the benefits gained or the other commitments graduates often undertake. But repayment is justified only when the graduate is earning above average, (not merely average) earnings.

A £3,000 cap on fees no doubt reflects political reality. But it should be reviewed and increased or ideally eliminated in the light of experience. The greater the cap, the better resources will be allocated.

Universities must provide information to applicants on the value of different courses and must adjust and widen provision, including more 2-year and part-time courses.

Encouragement of bursaries and better primary and secondary education are surely better ways to widen access than yet another regulator.

Finally let us put a stop to complaints that this approach will lead to first- and second-class universities. Let us talk instead about assuring enough first-class graduates from first-class universities, graduates and universities whose skills and expertise vary, offering quality with diversity. □

Science strategy in a nutshell

Sir Muir Russell KCB

A science strategy for Scotland

At an FST dinner discussion meeting held at The Royal Society of Edinburgh on 24 October 2002 the development of a science strategy for Scotland and comparison of the process in Scotland to the development of the UK strategy for science was debated. Sir Muir Russell, Permanent Secretary to the Scottish Executive, Professor Wilson Sibbett, Chairman of the Scottish Science Advisory Committee and Dr Chris Henshall, Group Director at the Office of Science and Technology at the DTI in London led the debate. The discussion was summarised by Gerry Wilson CB.



Sir Muir Russell KCB is Permanent Secretary, Scottish Executive and Principal Designate of the University of Glasgow. Sir Muir spent his early career in the former Scottish Office including a period as secretary to the Scottish Development Agency and principal private secretary to the Secretary of State for Scotland.

A lot has happened since I last addressed the Foundation in November 1998, six months before the Scottish elections to the Scottish Parliament. Soon after the Parliament was established a Science Strategy Review Group was set up, chaired by head of the Enterprise and Lifelong Learning Department, Eddie Frizzell, and drawn from distinguished scientists from academia, business and public bodies. The Review Group produced its report in April 2000, outlining the main issues that needed to be addressed in forming a science strategy. The next stage was for the Executive to establish a dedicated Science Strategy Team, leading to publication of the final Science Strategy Document in August 2001.

We tried to capture in a single document what Whitehall splits up amongst its numerous departments. It encapsulates a set of firm aspirations to enhance the beneficial uses of science in our society. We have stated that Scotland's future economic success is rooted in developing and exploiting our science base, and that improving our quality of life depends fundamentally on this, particularly on health and environment issues.

The Science Strategy Document also contains a set of some 55 commitments, grouped under five key objectives:

- to maintain a strong science base;
- to increase the effective exploitation of scientific research;
- to ensure that enough people study science to meet the future needs of Scotland;
- to promote the awareness, appreciation and understanding of science across society; and
- to ensure the effective use of scientific evidence in policy formulation and resource allocation by Government.

As with most documents of this kind it will be easy for us to track progress on some commitments, but on others the action is diffuse and putting it into effect will require a very real effort of co-ordination.

The Strategy does not establish an integrated budget for science within the Executive for Science. We recognised that securing additional funding for science was something that would have to be worked at as the Executive's spending plans were developed and I am pleased to say that, in the recent spending round, the Strategy has had an important influence on determining priorities. That is where the Scottish Science Advisory Committee comes in.

What has happened since the launch of the Science Strategy? An early task was to designate a Minister for Science. This responsibility now sits with the Minister for Enterprise and Lifelong Learning, a combination that emphasises the link between science and the economy.

In the recent Spending Review, the Scottish Higher Education Funding Council's resources for spending on science and research have been increased by around 20 per cent in real terms over the next three years. This complements the increases for science announced by the Chancellor of the Exchequer in July and enables us to participate fully in UK-wide research funding programmes such as the Science Research Investment Fund (SRIF), a two-year fund that is run jointly by the Scottish Higher Education Funding Council, the Office of Science and Technology (OST) in Whitehall and the Scottish Executive. The purpose of the Fund is to invest in the physical science infrastructure in higher education institutions and thereby to strengthen the international competitiveness of the science base in Scotland.

We have increased funding for schemes such as the Proof of Concept Fund and Enterprise Fellowships through the Royal Society of Edinburgh (RSE), which help Scottish scientists commercialise their discoveries -- more than £70 million in new funding since devolution. We have increased funding to build capacity and expertise in biomedical, environmental and land use research within the Scottish Agricultural and Biological Research Institutes and Scottish Agricultural College. We have plans to establish a technology transfer office in Scotland to ensure that intellectual property within NHS Scotland is exploited for the public benefit.

We have increased collaborations with scientific and R&D partners with our Global Connections Strategy with initiatives such as the £12 million fund to develop transatlantic higher education collaborations. We have given £8 million to education authorities to support science education in schools to allow teachers to improve their science skills and also for equipment and accommodation.

I cannot claim that these initiatives are all attributable solely to the Science Strategy, but they do illustrate the range of activity around the Executive.

The establishment of the Scottish Science Advisory Committee (SSAC), with the help of the RSE, was one of the specific commitments in the Strategy Document.

This has been delivered. We now have, for the first time in Scotland, a completely independent panel drawn from across the science community, which can advise the Executive on strategic science matters.

SSAC Chairman Professor Wilson Sibbett outlines the aims of the Committee next (see below). The Executive will look to the Committee to help answer questions such as "what are currently the main strengths of the Scottish science base?" and "what should be the priority scientific areas that should be built up to reflect new scientific advances and new opportunities?" And "what quality of life issues are important for Scottish science to address?"

Answers to such questions will help us prioritise funding and so are absolutely critical to Scotland's economic and social future.

To coordinate our own science strategy activity, we have formed an internal Science Cross-Cutting Group from the various departments in the Executive. This group also acts as an interface with the Advisory Committee. However, it is a 'hands-off' relationship and we expect the Committee to report without fear or favour.

What's next? Over the next year the Executive will be ensuring that the money won as a result of the Whitehall Spending Review cascades through to Scotland and that this, and the money allocated in our

Collaboration. The absence in the audience of an adequate representation of scientists from industry was noted. Doubts were expressed about whether increased funding for basic science would lead to more commercial exploitation. On the other hand, there were good examples in some sectors of effective collaboration between the research base and industry, particularly involving new high-tech businesses and companies from abroad.

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own review, is delivered to maximum effect.

It seems we have already come a long way on the journey of getting our science better focused, but this is not a journey with a predefined destination. We may only be able to tell in hindsight whether things have got better and by how much, but we'll never be able to say that we've arrived. We're in this for the long haul and the input of the Committee will remain important in keeping up the momentum.

In conclusion, I would like to leave you with some questions for debate. The Science Strategy provides in the main a framework for further debate, so it is quite right that we should continue to ask questions and to consult the science community, although in many ways, that consultation is now the role of the Advisory Committee. I will therefore leave you with

a few ideas for discussion.

We have a positive story to tell about Scottish science. About 1 per cent of all the research publications in the world are produced in Scotland and we rank third in the world in research output per capita. Is our profile right? Should we be improving it and, if so, how? We already win around 12 per cent of the funding from the research councils. What should we be doing to maintain and improve that success rate? How can we inspire young people to take up science? Does the network of science centres have any special role? Are we doing the right things in terms of school science to get people started? Our rate of commercial research and development is improving but how can we become better at that, better at turning ideas into production? □

www.scotland.gov.uk/library3/education/ssfs-00.asp

Excellence, education and society

Professor Wilson Sibbett CBE FRS FRSE



Professor Wilson Sibbett is Chairman of the Scottish Science Advisory Committee. He is also Wardlaw Professor of Physics at the University of St Andrews.

When the Scottish Science Advisory Committee (SSAC) was established by the RSE earlier this year it was asked to address a number of ambitious objectives by the Scottish Executive. The Committee itself also has its own agenda but, overall, we are trying to help shape the future of science in Scotland. Key to this, is for us to determine how differently Scotland might want to do things from the rest of the UK. Also, are there areas where Scotland can act within European and global contexts that are different or complementary to the rest of the UK? We need to understand where Scotland is now in relation to science and where it could be in 10 or 15 years.

The SSAC is an independent body with 18 members, representing a breadth of expertise and knowledge across a wide range of disciplines and interests including school, further and higher education, business, engineering and medicine. Given the breadth of our remit, we made an early decision to form three working groups to consider the three areas that we believed to

be particularly important for science in Scotland: science education, excellence in the science base and science in society.

I believe that science education is fundamental to achieving many of our objectives in relation to science, be it stimulating the economy, improving the quality of life or protecting our environment. Getting children interested in science from a young age is crucial to the future of science and technology in Scotland.

We have to ensure that we are providing effective, challenging and engaging science education, we have to harness and secure the fascination that young children in particular have for science. We need more role models in the classroom and in general we need to raise the status of science, engineering and technology as well as the profiles of scientists, engineers and technologists. Teachers and lecturers interacting with pupils and students on a daily basis are of vital importance, while established scientists and technologists have much to contribute by re-engaging with our schools, colleges of further education

and universities to share their experiences and to act as inspirational role models. Those who have achieved success through science and engineering and technology should be not be reluctant to turn up at schools in the latest up-market car, to demonstrate that science is at the heart of wealth creation and that it can contribute directly to improving the quality of life. We have scientists with a great story to tell and if our leading scientists were to engage more with pupils and students it could help change things significantly within the Scottish scene.

Scotland has world-leading science in some areas but we should not mislead ourselves into thinking that we have excellence across all of science. Nor should we believe that what is world-leading today will remain world leading in 5 or 10 years time. Our best ideas and our areas of cutting-edge science are liable to be picked up by other countries, especially those with developing economies, that we know are investing heavily in their science and technology bases.

Scotland is seeking to create a well-developed, knowledge-based economy that can be internationally competitive. Being at the forefront of scientific research is one way of ensuring that we can compete in this global context. Can we promote the new science that will drive the knowledge economy and lead to high growth, high technology companies? It is wrong to think that leading edge science that might lead to Nobel Prizes will not lead to wealth creation or quality of life improvements. Some of our best scientists within Scotland, who are strong contenders for Nobel Prizes,

are also developing spin-off technologies, establishing and running highly successful companies, and demonstrating the positive correlation between excellent science and intellectual property generation and implementation. Scotland has to make more of these opportunities.

I believe that one way of strengthening our science base would be to improve the connections between groups and individuals across the different sectors of our science base. We must also improve links between our science base and industry. The SSAC will aim to identify groups across Scotland that could benefit from working together more closely.

Some of the most innovative science, over the next decade, is likely to occur at the interfaces of apparently disparate disciplines. Scotland's scientific communities have a huge opportunity to lead the way on multidisciplinary endeavours. I do acknowledge, however, that much has to be done to facilitate and incentivise multidisciplinary science, given that a number of developments, for example the Research Assessment Exercise, have not assisted this process.

Science in society is a big issue, and one that the SSAC recognises as crucially important for the future development of science. We would like to see society engaging with science and scientists in a meaningful way, but also that we as scientists engage with non-scientists in society. I was recently made aware of a major research programme, directed by the Economic and Social Research Council (ESRC), that is focusing on science and society. We would want to make sure that a lot of our social

scientists are involved with that programme to ensure that Scottish dimensions are explored. To quote from the programme, we are looking for scientific connoisseurship, "the capacity to make informed judgments about scientific claims, and to judge the competence and credibility of the individuals and institutions who are presented as scientific experts or arbiters of scientific expertise." If we can achieve this objective within society, or even within the scientific community, I think that we will have a great opportunity of moving forward our considerations of the entire spectrum of science and society issues.

To summarise, I believe that we can have a significant impact on science in Scotland. Fundamentally, we have to improve and enhance our science education starting at primary-school or even pre-school levels. We have to identify our strengths and prioritise the areas where we wish to make the greatest impact. We must identify global opportunities and ask if Scotland really can earn its place in international partnerships and set the global agenda in the areas of our greatest strengths. We can do this only if we attract the best people, create state-of-the-art infrastructure and if we can sustain ourselves with a good circulation of international players.

Does Scotland really have the courage to redirect some of its resources to new priority objectives? That is a key question and that is exactly where we wish to be making robust and well-justified recommendations to the Scottish Executive. It will not be easy, but I am confident that in working together we can secure even greater achievements for Scotland in the future. □

The UK context of science

Dr Chris Henshall



Dr Chris Henshall is Group Director at the Office of Science and Technology at the Department of Trade and Industry in London. He was a member of the joint Government-industry task force that reported on ways to ensure the UK remains a competitive location for clinical research on pharmaceuticals.

My role this evening is to put the recent developments in Scotland into the United Kingdom context. First I will sketch out the policy framework for science and innovation work in Whitehall.

The shape of the current framework for the UK-based research council system was established in 1993 with the White Paper *Realising our Potential*. The year 2000 saw the publication of *Excellence and Opportunity: a Science and Innovation Policy for the 21st Century*, establishing a coherent strategy for science and innovation for Westminster. In 2001 these structures were revisited in more detail, particularly for skills, education and enterprise. As part of the 2002 Spending Review, we undertook a cross-cutting

review of science and research, which was published on the Treasury's website. A second publication, *Investing in Innovation*, built upon this, is an up-to-date statement of thinking on science and its exploitation in a knowledge economy.

Whitehall's activities in this field fall into five main areas: science in Government, science in society (including educational issues), excellence in the science/engineering base; the exploitation of the science and engineering base; and improvements in the coordination across all these activities and throughout the UK.

First, an outline of the basic structure of the Office of Science and Technology (OST) within the Department of Trade and Industry (DTI). There are two key

advisory bodies. The Council for Science and Technology, chaired by Lord Sainsbury, Minister for Science and Innovation, brings together leading scientists from industry and academia and also other people with relevant expertise. Like the Scottish Science Advisory Committee, this advises on any aspect of science and its uptake. We also have the Science and Engineering Base Coordinating Committee which is a UK-wide body chaired by Sir David King, Chief Scientific Adviser. Its purpose is to bring together the research councils, funding councils from across the UK, OST, education departments and the Department of Health to discuss how they are each approaching the science funding so that we end up with a coordinated system.

Alongside these, the Chief Scientific Advisers' Committee brings together Chief Scientific Advisers or their equivalents from across Government departments to review progress on the support for, and use of science in Government. We have produced a range of publications, including The Chief Scientific Adviser's Guidelines for the use of scientific advice and policy, a Code of Practice for running scientific advisory committees and a whole range of issues around public engagement and confidence in science.

The report *Science and Society*, produced by the House of Lords' Science and Technology Committee three years ago, has proved highly influential, and many of the ideas in it are now being put into action. Particularly important are issues around the licence of scientists to practise.

There is also perhaps a 'licence to govern'. If the public is not convinced that we are using science correctly in our policy making processes, they might challenge our licence to govern as well as scientists' licence to practise.

To help us develop our policy on engaging with the public in science and its application we have commissioned a study to be carried out by the British Association. An important experiment in public consultation is already underway,

Know how. The importance of engineering and technology was stressed and it was recognised that institutions, particularly those that did not have a strong science base, could make an important contribution through the supply of graduates and know-how into industry. It was important to promote a spectrum of research capability, from blue skies to applied. There was also potential value in the exchange of personnel between academia and industry. It was emphasised that SSAC was concerned, not only with the science base, but also with engineering and technology and technology transfer.

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in the form of the public debate on genetic modification, particularly of crops. Then there are issues of public concern around the proper representation of women and the interests of ethnic minorities in science on which we also have work in hand.

We have two main areas of activity that relate to the excellence in the science and engineering base — funding new and existing projects and ensuring sustainability of the excellence that we have already. As far as funding is concerned, the Government's science budget will have effectively doubled in the period from 1997/98 to 2005/6. The Spending Review 2002 brought a particularly encouraging outcome. There was 10 per cent per annum real-term growth in each of the three years, with half of that increase for what we might call new science and half for sustainability of the excellence of what we do already. New areas in which we plan new science include proteomics, brain science, stem cells, sustainable energy, rural economy and land use.

The trend since the early 1990s has been for the research councils to forge better links with users. The same theme was picked up by the Foresight Programme that had aims of alerting users of science base as to where science may be going and trying to steer science into areas where the best opportunities exist. The DTI has been involved in a number of what we call 'business pull to match science push' schemes — the

science base pushes its expertise, people and knowledge out, and industry pulls the expertise, the people and knowledge from the science base in. On the 'science push' side, the current Spending Review has increased resources in this area under the newly constituted Higher Education Innovation Fund (HEIF).

There is major effort going on through the Foreign Office Science and Technology Advisers Network and British Trade International. Various linkages are moving forward, trying to get the message across to the world that the UK science base is excellent and is looking for excellent business partners.

Within the science budget we have set up Research Councils UK (RCUK). It is a grouping of the seven research councils as a body to foster forward strategic thinking and coordinated action. It is important that RCUK thinking links up with thinking in Scotland and Wales and the English regions so that we develop a coordinated view between the research councils and those helping to promote the exploitation of science as to where science is going and where we want it to go. The Research Councils' 'family' will shortly be expanded to include the first new council to be established in a decade, the Arts and Humanities Research Council.

On the key issue of sustainability, *Investing in Innovation* indicates the way forward. It is not in itself the final answer. Rather it provides a set of principles and major new investment from Government. The challenge now is for the various bits of Government and all other stakeholders to get together and work out to use this money to ensure that we can now use this opportunity to get science sustainable. That is a major work programme and it is being led by a Ministerial Group, chaired by Lord Sainsbury, with an officials group beneath it supported by various project teams.

We are working on a broad front to improve coordination between scientists, administrators and industrialists across the UK. Combining this effectively with the progress being made by the Scottish Executive and its advisory bodies is the key to ensuring the future. □

Bottlenecks. It was suggested that the biggest bottleneck to progress was the difficulty in recruiting post-doctorate staff, partly because of the poor remuneration available. The recommendations of the Roberts Committee (see page 13) were relevant in this context. The educational value of science centres, such as Edinburgh's Dynamic Earth, needed to be recognised and there was a problem about how such centres could be funded. The general conclusion of the discussion was that the Scottish Strategy Document should best be seen as a starting point and important challenges remained.

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Avoiding crucial skills shortages

Sir Gareth Roberts FRS

Sir Gareth Roberts' Review SET for success

In March 2001, Sir Gareth Roberts was asked by the Chancellor of the Exchequer and the Secretaries of State at the DTI and at the Department for Education and Skills to undertake a review into the supply of science and engineering skills in the UK. The Final Report of Sir Gareth Roberts' Review was published in April 2002. The recommendations of the review were debated at an FST dinner/discussion meeting at the Royal Society on 22 October 2002. The speakers were Sir Gareth Roberts, Harry Bush CB, Head of the Enterprise and Growth Unit, HM Treasury and Mr Bill Parsons, Executive Vice-President of Human Resources at ARM. The discussion was summarised by Sir Geoffrey Chipperfield KCB.



Sir Gareth Roberts FRS is President of Wolfson College, Oxford. He trained as a physicist and is an expert in semiconductors and molecular electronics and is a past-President of the Institute of Physics. He is Chairman of Medical Solutions plc and the Research Careers Initiative and also President of the Science Council. Recently he has been invited to chair a review of the Research Assessment process for the UK Funding Councils.

This is the first opportunity I have had to thank all those who helped me with the review, not just for the work that went into producing the report in April (2002), but for the lobbying required between April and July, before the Government produced its important paper *Investing in Innovation*. I am delighted that so many of my helpers are here tonight.

The review focused on the higher level skills we need. The other area of shortage, namely that of people with lower level skills, was excluded from our terms of reference.

Our main finding was that there are emerging shortages in mathematics, engineering, chemistry and physics. The cause is twofold: increased demand for people with those skills and fewer students opting to study in those fields.

These conclusions are supported by the figures you will find in the report. There has been a large percentage increase in the numbers of graduates in computer science and biology over the past five years and a downward drift in the other areas. (The growth in computer science does not continue into the doctorate area — there is already a shortage of people with doctorates in the field.) One of the root problems lies in what is called Stage 4 — the crucial 14–16 age group. We found that 67 per cent of people teaching physics do not have a degree in the subject and that 30 per cent do not even have an A level.

I was invited to carry out an assessment of the situation but not to make plans for spending money. I was, however, encouraged when the Prime Minister, on 23 May [2002], said in an excellent speech in this very room: "I want to make sure that the UK is one of the best places in the world to do science. For that we need our people, equipment and our infrastructure to be properly funded."

In reality, my optimism was justified. *Investing in Innovation* showed that the Government had been listening. With respect to school science and the structure of the research profession, the Government has responded warmly, even generously.

Unknown to me, while my review was underway a similar study was being carried out in California. That document (also published in April 2002) states: 'California's education system is not producing the science and engineering graduates to meet industry's growing requirements for skilled workers. The numbers

graduating in science and engineering annually need to be increased by nearly 70 per cent to make up this shortfall. The current educational problems are the result of many factors that have been decades in the making and will likely take decades to address.' Unsurprisingly, perhaps, their recommendations are not dissimilar to ours.

So our problem is not unique to Britain: certainly it cannot be blamed on the lack of sunshine in this country.

I shall now focus on two issues arising from the report where I believe a culture change is necessary. The first has to do with PhD training.

Many of those I met on visits to industry complained they were unhappy with PhD graduates. Often, PhDs were deemed to lack creativity but, more often, the complaint was that they lacked breadth and flexibility.

I believe that with the very large teams of people in which research students are treated rather as technicians, they are only rarely able to stitch the whole project together to give it breadth. Our review recommends that universities should introduce new procedures, or tighten existing ones, for the transfer of students to the grade of PhD. Many universities have hurdles, but they are not high enough.

Higher education institutions, and especially principal investigators, must encourage PhD projects that test or develop the creativity prized by employers; too often, students are used as data collectors. In many PhD vivas I have attended, the examiners' generosity has been in conflict with their consciences. Too little attention is paid to the standard phrase in higher degree ordinances that 'the candidate should show knowledge of the broad field in which the subject falls'.

Some universities, especially the Russell Group (or research-minded) universities and their supervisors also have a lamentable record in sending students sponsored by research councils on graduate training courses. Students attending these courses, lasting one week or so, regard them as the highlight of their PhD training. Yet few students go.

I was therefore delighted that the Government, in the paper *Investing in Innovation*, made stern statements about the training and supervision of doctoral students. The Government expects all universities to meet these high-quality minimum training standards and some

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Perceptions. The issue of 'demand' as articulated by Mr Parsons (page 16) was a major theme in the discussion. Improving teaching, amending university curricula, improving liaison between industry and academia — all-important objectives to be pursued — would be wasted unless a desire on the part of students to become scientists and engineers was stimulated simultaneously. Much more effort must be put into persuading parents that engineering was a desirable career for their children. This was a task above all for the schools. Who had met a school careers adviser who knew about engineering careers, and was enthusiastic about them? If students had not been persuaded from the age of 14 that science or engineering was a good choice, the battle was lost.

The Canadian exception was due to the high status of teachers, 'destination syllabuses', good professional development courses and minimal monitoring or assessment. The UK could learn much from this, particularly on the need for a light hand on assessment (beginning, at last, to be recognised at university level).

funding is to be conditional on meeting these minimum standards. You will note that there is additional funding for the research councils to make possible enhanced training for their students. So there really is no excuse for students not being given the opportunity to have breadth added to their work.

There is also a new challenge in all this for employers. There are three main players in what we are talking about — the education sector (including the schools), Government and, to make up the trinity, the employers. My review

argues that sustained action by employers is required to improve the conditions of employment for highly skilled people. They must not be treated as appendages but should be able to see a career development path in front of them and so on.

Interestingly, the Government has said that it really will help to ensure that a group of R&D employers is established to monitor the responses over the next year or so. But one of the problems in this country is that there has been a decline in the growth of R&D spending in the past 18 or so years. Many corporate research

laboratories, which were excellent finishing schools for research students and contract researchers, have disappeared. There has also been a decline in Government funding. I hope that the promised tax incentives will be sufficient to change this culture because, without the corporate laboratories, universities are very often the last bastions of fundamental research in vital areas.

Our goal should be to strengthen links between universities and companies. The recent statistics on spin-off companies suggest that the incentives are working. The large companies like Rolls Royce are doing their bit. It is the medium-sized companies that we need to bring into the fold. One of the recommendations in my report refers to innovation partnerships, firmly based in their regions and working within the economic strategies of the Regional Development Agencies.

The Californian report I mentioned ends with the sentence, 'California's educational institutions, industry and government will need to cooperate on an unprecedented scale if the state is to sustain its position as a global leader in high technology.' The same is true here. Our report constitutes a significant challenge to all those in this country with interests in science, engineering and innovation. It is vital that momentum and progress are maintained in these areas. □

www.hm-treasury.gov.uk/documents

The fabric of British research

Harry Bush CB



Harry Bush CB was a Treasury Director and Head of the Enterprise and Growth Unit, HM Treasury. Mr

Bush was a Research Fellow at Nuffield College from 1977 to 79. He joined the Treasury in 1979 and worked in a number of areas before chairing the cross-cutting review of science in the Spending Review 2002.

He has recently moved to the Civil Aviation Authority as Group Director, Economic Regulation.

While the Roberts' Review was underway this spring (2002), the Treasury embarked on a study of the mechanisms for funding science in British institutions. The immediate purpose was to inform the then-current Spending Review, due to be completed in the summer of 2002, but it gave all concerned a better understanding of the financial structure of the British research enterprise.

The Treasury's study was called a 'cross-cutting review' because all relevant departments were engaged — a deliberate break with the tradition in which the Office of Science and Technology or some other agency would make a bid for funds that would be batted to and fro unconstructively.

The outcome was an extremely good settlement for science. We have also laid the foundations for making spending

decisions in the future. In reaching our conclusions, we consulted not only the universities (16 of which we visited), but also the Regional Development Agencies (RDAs), the devolved administrations, the medical charities, the CBI and others.

The starting point of our study was the economic contribution that science-led innovation can make. We were, for example, conscious that the new R&D tax credit will not serve its purpose of stimulating industrial R&D unless the science base generates the appropriate skills, which requires an appropriate scale and balance of funds from public sources.

The Treasury's interest in the degree of detail you will find in our report¹ stems mostly from its productivity agenda. The aim is to improve the performance of existing businesses and to encourage structural changes in the economy. Innovation and thus the science base are

clearly crucial. But we are also interested in competition, in creating an investment-friendly climate and enhancing the skills of the workforce more generally.

The success of our plan will hang on continued and enhanced knowledge transfer. Government incentive schemes have helped to vamp up these activities, but we now recognise that they are insufficient in scale and too complex. That is why it has been decided that current spending in this field will be, by 2005/6, subsumed into a permanent single funding stream for universities to promote knowledge transfer. We hope that the RDAs will be key additional players; they now have substantial pots of money and can be flexible in their use of it.

On the science base itself, we agreed that it was underfunded. The precise degree of the underfunding is an academic question, but its reality is evident to anyone who visits universities. It has persisted for many years: for example, buildings erected in the 1960s and 1970s are no longer adequate. The funding streams have also gotten out of kilter. Research funds from the higher education funding councils must now support far more research council and third-party research than 20 years ago. Industry and charity funding increased significantly in the second half of the 1990s, but there was no attendant increase in funding council resources. Clearly, that had to change.

Overall, our response has been a 10 per cent per annum real growth in the science budget — one of the highest growth rates of any government spending programme. This will include a dedicated capital fund rising to £500 million a year for university infrastructure. At the same time, the funding council stream is to increase by over £200 million a year by 2005, while the research council overhead element will increase by £120 million a year. These steps will help to restore the balance.

We found a lack of clarity about the pricing of research among the universities. The 46 per cent research council overhead is a low benchmark (and is now to be increased). What about research for industry or government departments? We do not believe that Government should subsidise research aimed at companies' bottom lines or at the operational objectives of departments. Over the next few years, the price of university research will have to increase — the more, the nearer it is to the bottom line. Prices will have to be negotiated with universities, which will have to be tougher. Government departments and the CBI have been warned of what to expect.

One reaction of industry is that increased costs will have to be matched by

Adjusting. Different speakers took different views on the question of whether we needed many more PhDs in science and engineering. On the one hand, the link between universities and industry was often dependent on the knowledge of PhDs, and we needed more of them to develop the essential interchange between them. But others held the view that industry certainly needed a lot of trained scientists and engineers, but not PhDs, who so often failed to adjust to industrial needs. It was important not to confuse the need to have a public, part of whose education was an understanding of science: a large, technically competent cadre of scientists and engineers working in industry; and a much smaller cadre of high-quality PhDs working in academia and industry.

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a more responsive and commercially minded service; that is for universities to ponder. There may be university collaborations with third parties from which both partners expect to benefit, which may complicate the university's pricing of its contribution. We believe there is a role here for the RDAs: it will be for universities to try to draw them into their work, seeking sponsorship for some of what they do. Some universities in the north-west are already doing this and the RDAs are responding well.

The research charities present special issues. They now contribute substantial funds to the support of research, but are out of step with other funders in their policy on overheads; traditionally, they have resisted contributing overheads to support the research they sponsor (on the grounds of "not helping with the upkeep of the vice-chancellor's car"). They hanker after the concept of 'the well found laboratory', central to the doctrine of the British dual-support system for research.

We hope to have finessed this argument. Our enquiries revealed that charities are prepared to invest in infrastructure when that accords with their priorities. (The Wellcome Trust has strikingly exemplified such policies in the past few years.) Universities will have to establish partnerships with individual charities and look for cost recovery through investment in infrastructure — the refurbishment of a laboratory, for example.

Clearly there cannot be hard and fast rules. Our position is that we have provided a sense of direction. But there will be a funders' forum, comprising the charities, universities and the research councils, to thrash out some of these issues. We want to see a better alignment of objectives and a common understanding of costs. Government cannot write an open cheque to the funding councils, backing up whatever research the charities want to support. There needs to be more dialogue, about

forward plans over a 5-year horizon for example, not so that everyone does the same thing but so that we are all aware of each other's ambitions.

Perhaps the biggest challenge is the one the universities will face. They need a more commercial approach. Defining full economic cost is not a trivial problem, but industry will ask for the higher costs to be justified. There are also procedural matters to be dealt with. Many research sponsors told us that universities fail to submit their final bills for collaborative projects which sat oddly with universities' emphasis on underfunding. More generally, universities must work towards the financial sustainability of their research.

There remains the issue of market-based pay for researchers. There is a world competition for talent. Many universities are already engaged at the professorial level, if only to a degree. The difficulty is to extend the practice to the middle ranges of the lecturer scale and to attract promising newcomers with salaries and prospects they might reasonably expect. These issues are a challenge for the universities because they raise the question whether people should be paid more because they could get more elsewhere.

In broad terms, our conclusions were that present concerns are not just about funding. We recognise that there is a shortage of money, but there needs to be reform as well — in the pricing and costing of research, for example.

The universities themselves must deal with the non-government streams of research money. They have to coax people into giving more. There will also have to be partnership at all levels. Government, charities and industry must get together to talk about priorities and about the problems in the system. Regionally, the RDAs must play a key role. And each university must think out what part it can play in the whole system. □

1. *Cross-Cutting Review of Science and Research* HM Treasury (March 2002). www.hm-treasury.gov.uk/Spending_Review

How industry sees the problem

Bill Parsons



Mr Bill Parsons is Executive Vice-President of Human Resources at ARM, the Cambridge company whose licensed software is found in many of the world's mobile phones and other devices. Mr Parsons studied materials science and worked first in the nuclear industry and in the design of storage systems.

I shall give an industry view of the Roberts' Review proposals, but one that is also based on my own experience. Although I work as a human resources director — in plain English, a personnel manager — I am actually an engineer. My early work experience persuaded me that my passion for engineering was not matched by a similar passion for a career in engineering. So I ended up as a Human Resources (HR) person. I have worked for a handful of different companies, but now I am at ARM, the chip designer.

Apart from my own experience, I have two other direct sources of information about matters related to the Roberts Review. My wife is an engineer who chose to become a physics teacher. I also set up a focus group of HR directors of technology companies in the Cambridge area.

ARM, founded in 1990, is the successor of a company called Acorn, which itself had partly derived from companies such as Sinclair. ARM manufactures nothing, but sells know-how; it licenses the designs for the microprocessors in 85 per cent of the world's mobile telephones, for example. One of the advantages, although not the main one, for not manufacturing is the fear that manufacturing would give the company a poor image, especially among potential recruits.

We employ more than 700 people, of whom more than half have either a PhD or a Master's degree. Many of them took first-class degrees at leading universities.

My overall reaction to *SET for Success* is that its recommendations are individually excellent and, as a set, coherent. The report addresses all the main parts of the supply chain, from inspiring people in junior schools to retaining people in PhDships. That was its remit, but we should not forget that there is much to say about the demand side of the equation.

In many universities, electronics departments and electrical engineering

departments are now essentially going bankrupt. We have built factories for making graduates, but people seem not to want to work in them or attend them as students. We agonise about making them more attractive to students: we do not have comparable discussions about the over-crowded classrooms for business studies. It seems that people want to become accountants more than they want to become engineers. This is a major deep-seated image problem. It will take a long time to solve.

Indeed, some of the recommendations will not have much impact for a very long time. The overall problem has worsened over the past 20 years. Remedying the situation is likely also to be a 20-year job. It will take a lot of money and will require sustained political support by several successive governments, possibly of different complexions. We have not been good at sustaining investment in universities, research and education. Great courage will be required.

The main issue facing us is the quality of teachers. Bernard Shaw's quip that, "those who can do and those who can't, teach" points to only part of the trouble. It is more relevant that people cannot now afford to be teachers. The report estimates that the lifetime income of a physics graduate will be £200/300,000 greater than that of a schoolteacher. Although teachers' salaries are rising and the flexibility within the system is being used to some effect, pay differences are so great that it must be doubtful whether impending changes will cure the shortage of good teachers.

Set for Success mentions that there is also a shortage of language teachers. Many members of my focus group consider that it would be unwise to pay schoolteachers differentially — more for science and mathematics, for example. The argument is that there are so many subjects in which teachers are in short

Narrowness. A number of speakers commented on the narrow nature of university degree courses, which seemed designed to sideline or ignore matters and problems which young people would be interested in. UK practice was contrasted with MIT, where 25 per cent of a student's time is given to Humanities. Combining science with social study subjects, such as psychology, could have great value — after all, even scientists have to deal with other people.

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supply, ranging from games teachers to language teachers, that it would further divide an already divided profession. My view is strongly the opposite.

There is also concern about the 'dumbing down' of the curriculum. We are caught between a rock and a hard place. On one hand, we want people to be interested in science, which is perceived as difficult. We are trying to make these subjects more attractive by making them easier. Yet universities say that people often arrive to study engineering without a physics A level or without sufficient mathematics. So degree courses become ever longer to compensate for problems at school level.

Many people are unsure of the difference between the proposed teaching assistants and teachers. The idea of teaching assistants is a brilliant one, as all in the focus groups thought. Their concern was that the quality of people going into teaching is often so low that there would be no difference between the teaching assistant and the teacher. My view is that the first objective must be to make teaching an attractive profession and then support that profession (as they do in France) with assistants who are rather like technicians to scientists.

Many people are also concerned about the current innovative courses in undergraduate education. Of course, university education has to be inspiring, challenging and all those things, but one university I have visited is offering 'electronics with psychology' on the basis that five times as many people do psychology as physics. The course is a confidence trick. The hope is that students will soon realise that it is a silly degree subject and will convert to something more useful. I do not know whether the expectation is justified, although I understand why people are doing it.

We also need much more exchange of staff between industry and academia, as the report recommends. But it is not that easy. We have people trying to become professors at UK universities who have been told that their academic credentials are not good enough even though they are, literally, world leaders in embedded microprocessor design. That is a challenge to be met. The structure of universities also needs attention. While science and engineering are converging in the real world, universities remain faculty-based.

There are also conflicts between making courses attractive and the requirements of professional bodies. Universities complain that the engineering institutions are pushing them towards longer degrees and higher entrance requirements. The drawback is that good and high standards make the hurdle ever

Salaries. Speakers also noted with appreciation that the Treasury had now started

to work with academia to redress some of the problems that had developed. The Cross-Cutting Review and the acceptance of the Roberts Review were major steps forward. But doubts still remained about whether the real needs of industry had been understood and whether the objectives of encouraging high-quality scientists to stay in academia and developing greater university/industry collaboration was as achievable as ministers desired. Two problems would still be with us — academic salaries could never match industry rewards, and when a scientist goes into industry, academia often thinks that the reason is that he/she is not good enough to make it with them.

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higher, repelling entrants. We must decide whether we want higher professional standards or an overall increase of numbers.

“People do not
want their children
to go into
engineering.”

Image and people's experience seem to be key issues. If you go to your local pub and talk to your friends, are they recommending that their children do engineering? You will find that many of them are not, often because they have worked for leading engineering employers (some of whom I have worked for); they prefer the other things that people do, other professions, other sectors, for their own family let alone for themselves.

Student funding is, I think, another key issue. At ARM, we offer bursaries to about 70 or 80 people at any time (roughly 10 per cent of our workforce). We sponsor our own degree programmes at universities throughout the world. But generally, longer courses mean that students incur more debt, while employers generally have cut back on bursaries. Undergraduate courses are at the same time more crowded, so that there is less time for students to do part-time work to supplement their grants. So, an idea, possibly not popular with Government, would be to bring back student grants rather than just hardship allowances for those subjects, such as the sciences, to

which it is more difficult to attract students.

I have a particular point to make about PhD degrees in engineering. ARM, as I have said, employs a lot of them, but there is a general feeling that they are eternal students, studying life but not anything particularly useful. It is a problem for Britain and it is specifically an engineering problem. Many of the PhDs to whom I have talked say that, in the real world, the major benefit of their degrees is behavioural — tenacity, the ability to pursue things, to design experiments and so on. But if the PhD represents behavioural education, I believe we could provide that in the workplace in different ways. What we want are fewer PhDs, but of much higher quality. In other words, numbers of PhDs is not an issue, paying them better is.

How can industry help? We have a lot to do on pay and status. Generally, engineering is underpaid, given the talents of the people concerned relative to, say, those in financial services. If you are a mathematician, you are better off as an actuary than an embedded systems engineer. Stock options have allowed some companies (like our own) to make millionaires of engineers, but that is rare. But creating 'fat cat' engineers provides glamour. In the United States, Silicon Valley, Bill Gates and so on have changed the perception of engineering. But too often, bad employers forget that engineers are bright people and they want involvement, not to be forced at some stage in their careers to make a choice between professional engineering or management.

The emphasis of the Roberts' Review is on the supply side. It is for us in industry to fix the demand side, to understand why people do not want their children to go into engineering. Obviously we need to improve our image, both in the quality of the workplace and the financial opportunities available. □

Engaging employers in training

Mr Michael Stark

How should technical skills education be supported?

The Learning and Skills Council was established in April 2001 to address education and training in the UK. Its Workforce Development Strategy, published in November last year, set out a radical approach. At an FST dinner discussion on 19 November 2002 held at the Royal Society, three speakers—Michael Stark, Ivan Lewis MP and Dr Geraldine Kenney-Wallace—outlined the strategies and needs for learning and skills in the near future. The discussion was summarised by Sir Geoffrey Chipperfield.



Mr Michael Stark is Head of Skills and Workforce Development at the Learning and Skills Council. In 2001 he produced the Learning and Skills Council's first Corporate Plan. In his current role he works with Government on the development of new mechanisms for financing adult learning.

The Learning and Skills Council (LSC) has inherited the functions of the Training and Enterprise Councils, the Further Education Funding Council and a great deal besides. We also fund every sixth form in state schools and are responsible for post-16 learning outside universities. Our mission is to transform the quality of education and training with a specific focus on economic success, the employability of individuals and the effectiveness of our business processes. We have set a goal that, by the end of this decade, people in the UK will have knowledge and productive skills matching the best in the world.

However, in terms of knowledge and productive skills at adult level, we are near the bottom of the OECD rankings of countries. (This is emphatically not the case at university level.) Britain is worse than its leading OECD competitors in Level 2 and Level 3, which are, respectively, the equivalent of GCSE 16-year old qualifications and A Level and GNVQ qualifications. Moreover, our relative position is declining.

Figures for participation in learning of some kind during a 3-year period show vividly that we are falling far short of our goal. Up to age 19, some 81 per cent of the age cohort participates actively in learning, at age 20-24, the proportion falls to 70 per cent, but thereafter we do not manage 50 per cent in any age cohort. On the average, people in our workforce have not participated in structured learning—formal or informal—over the past three years. Probably the statement would be true for the past 13, or the past 30 years.

There is a dichotomy about whether individual learning is more important than employer-led training. In a sense, it is the debate between the open-toed sandal brigade, as they are caricatured, those who support extension of participation and the hard-nosed grab-grinds for whom only employer-led training is of any value. Employers have demonstrated that they will pay for parts of this agenda. But as a state we have a responsibility to deliver the basics: improved schooling, improved college access and the opportunity to acquire core skills at a young age. We also have to provide people with the opportunity of a second chance.

Money does matter. My Council has over £8 billion a year to spend. Of that sum, roughly £2.5 billion goes to adult learning, some £2 billion of which is spent through subsidies to colleges, linked to individual learners passing through the

system. The remaining £0.5 billion is split between work-based learning, typically modern apprenticeships, for young adults in the 19-24 year age group and adult and community learning, much of which is delivered through local authorities. This £2.5 billion roughly buys 200 million training days.

Employers spend a great deal more money. The figures are disputed — one estimate is about £23 billion, another is £15 billion — but what is not disputed is that it buys you massively less, roughly 50 million training days.

So, if £2.5 billion buys 200 million training days while £15+ billion buys 50 million days, something very odd is going on. We have two systems that hardly touch one another and they don't engage in terms of the direction of employers. The system is neither fee-driven nor demand-led. If these two systems continue to run on parallel tracks, we are going to be in even worse trouble.

The LSC has a statutory remit to engage employers more actively and we have to develop a much-needed measure of the baseline. The 'Investors in People' standard has had considerable success over the past decade but we need to go further because Investors in People is not a measure of training and development, it is a measure of quality standards as they affect employees and others working within a business.

We also have a target for levels of attainment. One in five of our adult population is not fully literate or numerate. Of these 7 million people, a target of 750,000 by 2004 doesn't look ambitious — it is a little over 10 per cent and there is a target to double that over the following three years.

In the last Spending Review, there was also a focus on Level 2 skills — five good GCSE passes or the vocational equivalent thereof. Half our young people currently achieve this level by the age of 16. But there are roughly 12 million adults who have not achieved this standard. The new target, a million more adults by 2007, is much more ambitious but the further target of over 3 million by 2010 is even more so. It is not achievable within existing policies, funding and cultural arrangements. Unless we implement some of the strategies that I am going to describe next, we are not going to get there.

In our *Workforce Development Strategy*, published last week, we have set out a radical strongly demand focused approach. We believe that adults need to be guided into acquiring skills that will help them to

get a job, progress within a job, improve productivity, engage them more actively within a community, change their lives. To achieve this we need to start with the demand, especially employer demand which will refocus the motivation of individuals as employees and drive it up dramatically higher. Alongside that we have to improve the quality of the supply and building capacity.

Of the 5,000 employees of the LSC, perhaps 90 per cent are engaged mainly in supply issues, so it is vital that there are a few who are starting from a demand approach. Within this, we have a lot of work to do on qualifications, information, advice and guidance to steer people in the right direction, to improve the funding methodologies and to find some good measures of progress.

We are doing significant work in a number of areas where employability and individual employer interests meet. To take one example, about 15 years ago, the Government privatised the gas industry, then fragmented it and then prevented it from cross-subsidising. The result is that, in an industry of 100,000 people, there are 46,000 employers with an average of two staff. Is it surprising that those employers are not very inclined to train apprentices or to update their 'workforce'?

We need to address those sorts of

structural issues when we make big changes to our economy. Construction is an interesting case where the impact is not so much regulatory but skill levels remain better than average. The industry is committed to having a fully qualified workforce by 2010 and that means, effectively, Level 2 vocational skills of high quality, funded by employers. If we can achieve this, our buildings will be better built and all sorts of benefits will flow to customers. But the LSC has to be ready with the structures that will enable this to happen.

The Council is a sub-regionally organised body with 47 local councils. That is close enough to be able to get a sniff of what a real labour market is like, what the job centre is telling you about unemployment activities, what employers in your area are saying are their latest skill needs. We cover a very wide range of activities to meet those needs.

We are also engaged in some experimentation. For the first time, Government is funding the full release costs for employers for adult workers who lack either basic skills or Level 2 qualifications. We are trying to motivate employers by taking away the cost issues, by funding the training, the advice and the wages even up to 150 per cent of those wage costs for smaller employers to cover the frictional issues. It is highly targeted, specifically

towards small employers who have the lowest propensity to train.

We also have to think about the roll-out. So we are also promoting the notion of a tax credit, payable to employers on qualification and with a cash incentive to the learner as well.

How do we finance learning? We could encourage a longer term view by making it easier either to borrow or save to learn. We need to tap into the nation's natural propensity to save when given the right tax incentives and we need to engage employers in that activity. To this end we have put forward a proposal for what is in effect a cash ISA that could take in employer contributions and with a dual key to deliver the funding at the moment of greatest need.

I am going to leave you with five issues. First, who pays? Second, can we do more to integrate learning into the natural lives of people? Third, how are we going to engage employers, specifically the small and medium enterprises? Fourth, how can we get qualifications that are for the purpose yet sufficiently flexible that people will want to take them up and be able to do so in smaller chunks? Finally, how do we get a national agenda that will also take into account regional and local differences and give flexibility and devolved accountability down to the levels it should be? □

Industry training needs

Dr Geraldine Kenney-Wallace



Dr Geraldine Kenney-Wallace is Director of e-Strategy and Learning, City & Guilds, the UK's largest awarding body for work-based qualifications. Formerly she was Managing Director and Vice-Chancellor of the Virtual University of BAE Systems plc. She has had considerable international, academic and business experience.

Tonight, with my 'employers hat', I am going to pose three questions in the context of the training offered through Levels 1 Basic, apprentice, all the way through to Levels 5, advanced diploma, masters level and give you an idea of some of the barriers that have been experienced in the past.

The UK economy is about 25 per cent manufacturing and construction and about 75 per cent services. These services are dominated by 27 per cent financial and business services and 17 per cent Government services. I want to focus on the private sector, although some points carry through into the public sector.

The mix of large corporations to firms is such that, while 80 per cent of the economy is actually represented by the small and medium size enterprises (SMEs), the vast majority of the demand for training comes from larger corporations. SMEs are focused on survival, retaining markets, but that doesn't mean because 80 per cent of them have no internal training capability

that they do not have a will to be involved in training; it is a cost-effectiveness, time-effectiveness issue.

When I was a member of the CBI committee in the late 90s, I was struck by how much confusion there was over the plethora of qualifications, schemes, programmes and so on in the UK. So, how do we get clarity, transparency and coherence? The varying degrees to which the employer has felt, in the past, that his voice has been heard depended very much on the degree of clarity and transparency. It was perceived that decisions were driven by Government funding and, as we heard earlier, it was supply-led not demand-led. I am, therefore, very pleased to see demand-led up there in front.

My first question is, should the employer have a voice in determining industry training needs? The answer should be yes, we need a dialogue. But, there are many different voices and that makes the sector approach so appealing.

While employers are seeking a

demand-led skills development, the individual trade and professional associations in any given sector have a voice too. There have sometimes been conflicts between those voices. The economy doesn't really come in neat divisions, so how strong the employers' voice should be and on what issues depends on what the problems are.

The second question focuses on how the sectors interact with each other. For example, let's take security, electrical engineering and hospitality interfaces. Think about a hospital or a night club. Who is responsible for the security guard in night clubs? Is it hospitality? Is it the security sector? Who has the responsibility for installing the security cameras in this nightclub? Is it security or is it the electrical engineer? Exactly the same questions arise for the hospital security, catering, engineering and various interfaces in the leath and social care sectors. You can keep looking at these problems as a complexity and sometimes complexity has prevented certain initiatives going forward in a simple, coherent and responsive way. I am looking for the answer to that interface question from the new sector skills strategy and boards.

By the mid-90s, because of the disconnect, because of some of these boundary issues and certainly because the technical training sector was not being responsive to employer needs, we began to see a new and radical departure from the larger employers. Clearly responding to the international competitiveness pressure, organisations and private companies decided to take radical approaches and

re-work what they were doing from the inside. They began by putting education and training for the workforce into the core of the growth strategy of the company and thus began the appearance of the so-called 'virtual universities', the industry-based institutes.

To come back to an employer organisation, isn't it interesting that the NHS and MoD have decided to pull together, in a strategic way, all their own internal training needs and education needs. This has only recently begun and we look forward with great interest to seeing how it progresses in forming the Virtual Defence Academy and NHSU.

That leads me to the next question: How can one now absolutely ensure that the provision of education and training matches today's and tomorrow's standards rather than yesterday's arguments over what they ought to have been? We have to make sure that education and training is soundly designed in a pedagogical sense, flexibly delivered, confidently assessed to meet vocational and international standards and that the qualifications and professional licences are portable – we are living in a world economy.

If the business direction of a company changes, then we have to look at how fast the technical training infrastructure can respond to the new needs. It is not just a demand-led strategy that is required, there has also to be a responsiveness-led response. For this reason, it would be a good idea if the Sector Skills Councils could approach these industry-based academies, capture the lessons learned

and see how these could inform the way forward.

Finally, I would like to talk about another issue that we must address when moving forward. As the new Sector Skills Councils focus on skills and standards of training to the development of national occupational standards, remember that these standards should be re-assessed, sometimes every three to five years. But if the standards are to be re-designed, and they are not yet approved by the regulator, time runs out, qualifications run out and the funding runs out, leading to confusion where you have an old standard that is still valid and a new standard that is not yet available. That could create confusion from the employers' perspective. Let's understand, by working together, what time it takes to do things properly and make sure that we don't accidentally lose something by time running out.

In summary, with the highlighted national focus on skills shortages, such as plumbing, and developing skills to meet labour demands, the employers and the Sector Skills Councils have a vital role together, particularly to realise there is no single voice, no 'one size fits all' solutions. If those large organisations could be challenged to reach out to their small business supply chain, that might be a very promising start to persuade and encourage through example. Employers large and small need a strategic, coherent approach encompassing clarity, transparency and responsiveness. They are much looking forward to a skilled, futuristic and flexible workforce. □

A national skills strategy

Ivan Lewis MP



Ivan Lewis is Parliamentary Under Secretary at the Department for Education and Skills. Mr Lewis was a member of Bury Metropolitan Borough Council from 1990 to 1998 and has been MP for Bury South since 1997. From 1999 to 2001 he was Parliamentary Private Secretary to Stephen Byers, then Secretary of State for Trade and Industry.

I have recently concluded a tour of the English regions to consult on the development of a new national skills strategy and delivery plan that the Government will produce in June 2003. It is vital that we shape our policies based on the everyday real-life experiences of the people who have to make the skills system work.

I am referring to the public sector agencies, such as the Regional Development Agencies and the Learning and Skills Council and local authorities but also the customer—the employer and the individual learner. We have to ensure that our policies accurately reflect their definition of what works within the current system.

In each of the English regions we now

have an agreed regional strategy for employment and skills action with all the partners — public sector, private sector, voluntary sector— signed up. What I now have to develop is a national strategy that can add value to those regional and sub-regional initiatives. My initial view is that there are several areas in which a national strategy can clearly add value.

First, we have to reduce the bureaucracy and the red tape. It is confusing, almost terrifying, to see the diagram of the number of organisations and agencies that are involved in trying to deliver education and training skills. That, inevitably, confuses the customer — the learner or the employer — and does not support our objective to engage people

and organisations in the skills agenda.

Also, at a national level, we can address sector deficiencies as distinct from regional and sub-regional priorities. We know that there are significant skills shortages in many sectors that have to be resolved in the interests of the future success of our economy.

Finally, I think one of the fundamental issues that this strategy should seek to address is the qualifications framework. As they are currently established, qualifications often fail to meet the needs of employers – too long, too complex, inflexible, not focused enough. Our challenge is to create employability for life and we need a more flexible, employer-focused, employer-friendly qualification framework. We also have to address the balance of the contribution from the Government, employers and the individual learners.

Unquestionably, employers should do a lot more; they experience the skills shortages that undermine their productivity and competitiveness. Our challenge, as a Government, is to simplify the system and make it far more customer-focused.

It is critical that we recognise the fundamental importance of science and technology to our economic success. In particular, we would like to see more women coming in to science and technology.

UK productivity levels continue to lag significantly behind France, Germany and the USA. There is no doubt that the biggest single factor contributing to that productivity deficit is skill shortages and skill challenges. Too many people in our country drop out of education and training at age 16. Only six out of ten 15-24 year olds attain Level 3 qualifications compared with nine out of ten in Germany.

What are we doing about this level of under-achievement? First, we have developed foundation degrees, the new intermediate vocational higher education qualifications, which aim to address the skills deficit at associate professional and higher technician level identified by the National Skills Taskforce. There is £25 million of capital funding for new technology institutes in each of our regions to meet the high demand for technical skills and they will offer innovative provision from Level 3 to foundation degree and beyond.

We are developing a network of Centres of Vocational Excellence (CoVEs) to develop new and enhanced existing vocational provisions, focused on meeting the skills needs of employers locally, regionally and nationally. Successful CoVEs will have effective links with partners in higher education and schools and

Academic obsession. A principal concern was failings of secondary, and to some extent, primary education. From an early age, there was a failure to engage girls in becoming interested in technical and vocational matters except those deemed to be suitable for them, such as hairdressing. But the most severe problems arose in secondary schools where the system seemed to be obsessed by the academic/vocational split and to regard vocational qualifications as being inferior to others.

Teachers and career advisers did not take sufficient account of employability, pushing pupils towards academic courses that would not yield such satisfactory and well-paid employment as vocational work. There was concern that the 14 to 19 year review had lost impetus, and speakers emphasised the importance they attached to this review and the need for it to develop a strategy which would integrate academic and vocational learning. It was important to focus on the 50 per cent who don't take GCSEs.

discussion

will actively promote participation by employers. We need to move towards locating CoVEs in areas that are relevant to the particular skills shortages.

Modern apprenticeships represent a genuine high-quality alternative to the academic pathway. We have a challenging target – we want 28 per cent of young people to begin a modern apprenticeship by the age of 22, by the year 2004. But we have to change the outdated attitudes towards apprenticeship if we are going to achieve our objectives on skills: it needs to be accepted as high status and high quality.

Specialist schools are going to become important in providing enriched learning opportunities in technological subjects while continuing to meet national curriculum requirements and we have an increased flexibility programme for 14-16 year olds.

We are also enhancing work-related qualifications. We have the new GCSEs in vocational subjects—applied science is one of them. It is a demanding qualification, enabling students to gain an understanding of the professional world of scientific activity and research. When I inherited this job, I was told that we were introducing vocational GCSEs and my immediate question was 'why are we calling them vocational GCSEs?' We don't describe the others as academic GCSEs.' So they are now simply described as new GCSEs, a small but significant step towards shifting once and for all outdated perceptions of vocational education and training.

Pilot schemes in four of the English regions will pool Regional Development Agency and Learning and Skills Council skills budgets. We have Regional Development Agencies at a regional level

and local level Learning and Skills Councils at the sub-regional level. They are both, in their own way, responsible for driving forward the skills agenda. They are increasingly working well together, but not yet well enough. We have to ensure that we are making maximum use of existing resources within the system.

The National Training Organisations, on the whole, failed so we have created strong, employer-led strategic networks around viable and strong sectors. These new Sector Skills Councils will give employers a voice in developing skills policy and drive the skills agenda forward, making Government shape policy in a far more effective way around the needs of sectors. The Science, Engineering and Manufacturing Technologies Alliance (SEMTA) is currently in the development phase of becoming a Sector Skills Council and it has a crucial part to play in positioning the science and technology community at a far more strategic level than in the past. (SEMTA was licensed as a Sector Skills Council in April 2003.)

People have outdated views of the traditional industries and we have to shift perception amongst young people and adults whom we want to retrain and encourage to come into new industries. We have also got to shift attitudes amongst parents; surveys show they are still the single most influential force that determines the choices their children make about education and career futures.

We are determined to change the way that the education and training system is currently set up. Tony Blair said that education is the best economic policy that we have—I think you would agree with that sentiment. □

Encouraging women in science, technology and engineering



A workshop held at the Royal Society on 29 January 2003 was organised by the FST to distil a report of a committee organised by Baroness Greenfield and to explore how to make better use of the resource of women in science, engineering and technology. The workshop was addressed by the Secretary of State for Trade and Industry and Minister for Women, the Rt Hon Patricia Hewitt MP. The meeting was summarised by Sir Geoffrey Chipperfield.

As the participants of this workshop were chosen from amongst those responsible for setting the policies for and developing the management of professional staff, they were inevitably largely male.

Addressing the workshop, the Secretary for Trade and Industry, The Rt Hon Patricia Hewitt MP, said that making better use of women in science, engineering and technology (SET) was essential, not only because of questions of fairness, but also because failure to use half the talent pool affected the whole economy.

The problem began in schools and universities, where there were declining numbers going into science, particularly physics. It continued with the numbers of women using their degrees in relevant industries – half as many as men – and culminated with the failure to reach top academic posts – while there were equal numbers of men and women getting Ph.D.s, there were 10 times more men than women in the professoriat – to say nothing of board level in industry. There were 50,000 SET qualified women not in employment.

Government alone could not solve the problem: a tripartite effort was needed by Government, industry and academia. There were valuable initiatives working

— the Science Ambassadors Scheme, the mentoring schemes, the Rosalind Franklin awards, and the law on maternity rights was to be changed — but these were not enough to create the necessary culture change which recognised and fitted individual needs. This aim might be difficult, but it was not impossible, given the progress in other countries, for example Singapore.

The Government's challenge was to coordinate policy across Whitehall, prin-

cipally the Department for Education and Skills (DfES) and DTI. Business needed to recognise that inadequate policies worked against its interests. She hoped that the workshop would produce some practical suggestions about how change might be brought about.

Mr Alan Clark, Chief Executive of the Engineering and Technology Board summarised the conclusions of the Engineering and Technology Board (ETB), Royal Society and Royal Academy of Engineering session entitled *Complementing Setfair* held on 27 January 2003. These were: fast-tracking professional qualifications, so they were obtainable at age 28 (average age for chartered engineers was currently 37); improving maternity leave and career break conditions; developing an e-community linking all women in SET initiatives; and requiring professional institutions, higher and further education, business and industry to publish gender and diversity policy, statistics and initiatives. The last conclusion, he stressed, was by no means unanimous.

In the discussion that followed there was warm support for the first three of these conclusions, but strongly differing views on the fourth.

Major points made in the discussion were:

1. Science was a passion. Those who had it wanted to give a 24/7 commitment. They couldn't always give it, of course, but failure to recognise the passion, and feed it would kill it. It was crucial, therefore, to avoid interrupting careers and work: every effort must be made to keep women in the system once they had started. This meant not only generous maternity provision, but also childcare help over long periods, up to age 14. It meant providing part-time work, home working opportunities,

and the ability to keep in touch with professional developments even if not actually working. Such provision would keep the passion alive in women who had dropped out of full-time work, and they would then return.

2. Women preferred to work in areas where there were already significant numbers of other women. For example, in environmental science, where 70 per cent were women, there was no problem in attracting and retaining women.
3. Company culture was crucial. Training and induction courses were often off-putting to women, and there was still an inappropriate protective attitude in some areas to women. Culture change had to be led from the top: it would happen far too slowly if left to itself, where it would inevitably suffer from priority given to other business goals. It would come more easily when staff were recognised as assets, whose motivation and retention then became justifiable in business case terms. Money spent on culture change and facilities or programmes, such as nurseries, crèches, home or part-time working, or outreach, then became part of a core budget.
4. Schools were the problem. At primary-school level there were still far too many teachers who were afraid of maths and science, and failed to motivate or encourage their pupils, particularly girls. This was still true at secondary-school level, where girls frequently failed to find role models among women science teachers. This must be compensated for by getting SET graduates, employed in business or academia, to go into schools and demonstrate the excitement and interest of SET. But don't leave it too late; remember attitudes can get set by age 11.

Such visits should be consistent and part of a programme — one offs are poor value compared with a systematic series of visits and talks.

5. Problems in employing and retaining women SET graduates were problems of kinks in the hosepipe. These were trivial compared with the blockage of the pipe lower down. What we should be concentrating on was getting the trickle of women SET entries into higher education into a flood. This would not happen until there were far more trained and enthusiastic SET teachers. This meant paying them a lot more, making their jobs more attractive, and assuring them of continuous professional development.
6. Companies must ensure that their policies work together. It is no use providing facilities, such as nurseries, if there is a cultural reluctance to accept that women using them were as important as men who didn't.
7. Best practice does not spread because of ignorance. People simply do not know what other businesses or institu-

tions are doing, and, if they do, if there are any benefits.

8. The Set Fair proposal for a Working Science Centre was greeted with a good deal of scepticism. It could create more confusion and weaken other bodies, without great benefit. What was important was to streamline funding sources, and this could be done without setting up a new organisation.

The workshop concluded by taking up the Secretary of State's request for practical suggestions for advancing the aim of making better use of women in SET. The following proposals were put forward:

1. Tax breaks to make it easier to employ home helps, nannies, or childcare for women in work. Also proportional relief from university debt on SET women taking maternity leave.
2. Develop case studies showing the benefit of running on-site nurseries and crèches on the retention of women staff.

3. Overcome ignorance by publication, not only of measures but also of statistics.
4. Government to recognise the value of facilities and outreach in setting budgets in the public sector, and to encourage public sector SET employees to work actively as role models.
5. See if there are ways in which childcare in the community could be made easier, in spite of the legal difficulties
6. Tackle the teacher problem by pay, other incentives and training. Do not accept anti science attitudes in primary schools. Ensure SET teachers get more remission of university debt than others do.
7. Continue with and improve existing schemes such as Science Ambassador and mentoring schemes, but be wary of introducing initiatives, which could increase burden of compliance and create confusion.
8. Back up incentives for SET teachers, outreach schemes, and development of role models by a sustained media campaign. □

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Dr Ken Boston AO, Chief Executive, Qualifications and Curriculum Authority
 Professor John Holman, University of York
 Ms Sue Flanagan, Deputy Headteacher, Forest Gate Community School, Newham and Chair, ASE
Pfizer and SEMTA

14 May, 2003

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The Lord Puttham of Queensgate CBE, Chairman, National Endowment for Science, Technology and the Arts
 Dr Robert Hawley CBE DSc FRSE FREng, Deputy Chairman, The Foundation for Science and Technology
 Mr David Hughes FREng, Director-General, Innovation, DTI
 Mr Julian Anderson, Composer in Residence, City of Birmingham Symphony Orchestra and Head of Composition, Royal College of Music
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30 April, 2003

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Professor John Bell FMedSci, Regius Chair of Medicine, University of Oxford
 Sir John Pattison FMedSci, Director of Research Analysis and Information, Department of Health
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08 April, 2003

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Sir William Stewart FRS FRSE, Chairman, Health Protection Agency
 Dr Pat Troop, Deputy Chief Medical Officer, Department of Health
 Mr David Veness QPM CBE, Assistant Commissioner, Specialist Operations, The Metropolitan Police
Centre for Applied Microbiology & Research and CodaSciSys

25 February, 2003

UK in the Arctic

Mr Graham Fry, Director-General, Public Services, FCO
 Dr Dougal Goodman, Director, The Foundation for Science and Technology
 Professor John Lawton CBE FRS, Chief Executive, NERC
 The Rt Hon Michael Meacher MP, Minister of State, DEFRA
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04 February, 2003

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Mr Nick Sanders, Director, Higher Education Group, DfES
 Sir Richard Sykes DSC FRS FMedSci, Rector, Imperial College
 The Lord Oxburgh KBE FRS, Chairman, House of Lords Select Committee on Science and Technology
 Mr Peter Johnson, Chief Executive, George Wimpey and member, CIHE Council
Pfizer, The Royal Commission for the Exhibition of 1851 and The Michael John Trust

29 January, 2003

Women in Science, Technology and Engineering

The Rt Hon Patricia Hewitt MP, Secretary of State for Trade and Industry and Minister for Women
Pfizer

2002 Events

10 December, 2002

Christmas Reception

Baroness Wilcox, The House of Lords Select Committee on Science and Technology
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Mr Richard Parry-Jones, Group Vice President Product Development, Ford
 Mr David Richards, Managing Director, Prodrive
 Mr Stuart Smith, Technology Vice President, Fuels & Lubricants, BP (Castrol)
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27 November, 2002

How is the Internet Changing Business and Government?

Ms Frances Cairncross, Chairman, ESRC and The Economist, The Economist
 Mr Andrew Pinder, e-Envoy to the government, Department of Trade and Industry
 Mr John Leggate, Group Vice President Digital Business, BP
Autonomy, BRIT, Microsoft Research and BTExact Technologies

19 November, 2002

How should technical education be supported – the Learning and Skills Council?

Mr Ivan Lewis MP, Parliamentary Under Secretary, Department for Education and Skills
 Mr Michael Stark, Learning and Skills Council
 Dr Geraldine Kenney-Wallace, Director e-Strategy, City & Guilds
EMTA and City & Guilds

05 November, 2002

The Lessons Learned from the FMD Outbreak

Sir Brian Follett FRS, Chairman, The Royal Society Inquiry on Infectious Diseases in Animals
 Mr Ben Gill CBE, President, The National Farmers' Union
 Mr Elliot Morley MP, Parliamentary Under Secretary, Department for the Environment, Food and Rural Affairs
BBSRC, DEFRA and The Royal Society

31 October, 2002

The 2002 Zuckerman Lecture

The Science of Climate Change: Mitigate, Adapt or Ignore
 Professor David King ScD FRS, Chief Scientific Adviser to the UK Government and Head, Office of Science and Technology
Schlumberger

24 October, 2002

A Science Strategy for Scotland (held at the Royal Society of Edinburgh)

Sir Muir Russell, Permanent Secretary, Scottish Executive
 Professor Wilson Sibbett FRS, Chairman, Scottish Science Advisory Committee
 Dr Chris Henshall, Group Director, Office of Science and Technology
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