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Science and innovation: working towards a ten-year investment framework

March 2004

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PREFACE

In January 2004, the Chancellor of the Exchequer announced that the Government would develop, as part of the Spending Review 2004 outcome later this summer, a ten-year investment framework for public and private investment in UK science and innovation to provide a secure medium-term platform for innovation and productivity growth.

This document sets out the Government's emerging thoughts on the economic and financial context for the proposed investment framework, and a number of policy issues on which it would welcome further views. Views are invited from the range of organisations with a stake in the future health of the UK science base and its relation to UK innovation performance.

This consultation builds on and will be informed by the extensive reviews which have been conducted in recent years on policy and funding reforms affecting UK science and innovation including:

- 2002 Cross-Cutting Review of Science and Research;
- 2002 Roberts report on the supply of people with science, technology, engineering and mathematics skills, *SET for success*;
- 2003 Higher Education White Paper, *The Future of Higher Education*;
- 2003 Review by the UK Funding Bodies of Research Assessment;
- 2003 Consultation by Office of Science & Technology on behalf of interested departments on *The Sustainability of University Research*;
- 2003 *Government Skills Strategy*;
- 2003 *DTI Innovation Report*;
- 2003 *Lambert Review of Business-University Collaboration*; and
- 2003 public consultation on the Office of Science & Technology's response to the British Association for the Advancement of Science report *Science in Society*.

Respondents should not feel the need to reiterate their previous substantive observations to earlier reviews. Instead they are invited to look beyond the period covered by the 2004 Spending Review (financial years 2005-06 through to 2007-08), to consider development in the areas highlighted over the period through to 2015, and to set out key observations on the Government's overall approach to the development of a ten-year investment framework for science and innovation.

This consultation welcomes responses from every part of the UK. Most of the analyses and reviews on which this consultation is based have had a UK-wide remit, and it is important that the framework for science works at a UK level. In many places, however, the analyses and recommendations in these reviews have focused on English policies and programmes. This is a consequence of the fact that the Devolved Administrations have lead responsibility for funding in a number of areas in taking forward the science agenda, such as funding for infrastructure at universities, and this consultation does not cover this funding. There are several references in the text of this consultation to the English Regional Development Agencies, and to English schemes such as the Higher Education Innovation Fund (HEIF). However, the Devolved Administrations have lead responsibility for, and

fund, similar economic development bodies and have their own parallel support schemes for research commercialisation. For the sake of avoiding over-complication in the text of this consultation, references are generally made only to the English version of such schemes or bodies. The intention, however, is for the framework to be developed at a UK level.

In order to inform Government policy running up to the Spending Review conclusions this summer, responses are invited by 30 April 2004 to

Ten-year investment framework for science and innovation
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or by email to scienceframework@hm-treasury.gov.uk

All responses received may be made public unless specifically requested otherwise. In the case of electronic responses, general confidentiality disclaimers that often appear at the end of e-mails will be disregarded for the purposes of publishing responses unless an explicit request is made in the body of the response.

FOREWORD

Since the industrial revolution Britain has prided itself as a nation of inventors and scientific genius. Three Nobel prizes for science last year remind us that even now Britain has more Nobel prize-winners in science than any country except America - and we lead the G8 nations in our research productivity.

But in today's world, international competition for scientific excellence is rising rapidly. And in an increasingly global economy, science and engineering skills and a supply of new ideas are crucial to Britain's ability to compete in high-technology, high-value sectors.

The Britain that succeeds in this new world will be the Britain that is a leader in science, in skills and in innovation. And we have much to do: overall, our businesses have lower levels of innovation than our competitors, and we face the challenge of attracting and retaining highly skilled researchers. So we recognise that the Government must be prepared to make the tough long-term decisions upon which our future economic prosperity and quality of life depend. But Government cannot do this alone – we must work in partnership with the businesses and charities which also invest in British science and innovation.

In the 2002 Spending Review we made a start; we delivered the largest sustained growth in science expenditure for over a decade and entered into a £1¼ billion pound partnership with the Wellcome Trust to renovate Britain's university science base. We have also extended the successful R&D tax credits. These measures have been complemented by a drive to recruit more science teachers to schools, to inspire more students to take up careers in science and engineering, and to improve the use of science by Government departments.

Building on these record levels of investment, accompanied by reforms necessary to renew our science base, and building on the Lambert Review of Business-University Collaboration and the DTI Innovation Report, which set out a strategy to support UK businesses in driving up their innovation performance, we are now in a position to consider where we want UK science to be in the future. The forthcoming Spending Review provides an excellent opportunity not only to take stock of current science policy and investment, but more importantly to look forwards.

While it would be easier to take the short term approach - and fail to make the necessary investments for the future - we instead propose to take the longer term view by setting out a framework for science, technology and engineering research and innovation over the next decade, in particular its contribution to economic development and public services.

Our aim is to show the science community our commitment to the future of British science, and to provide a clear lead to all those who invest in British science and innovation alongside government.

This consultation document sets out the areas that we will examine, alongside the ambitions that we want to achieve:

- world class excellence from our very best centres of science and technology, driven by competition for funding and talent;
- a dynamic research base that meets the needs of both public and private funders and is managed effectively to achieve financial sustainability;
- greater collaboration between universities and business to provide a sharper focus for research and an impetus to innovation and productivity growth;

- better commercial translation of leading edge technologies into applications in business and the public sector;
- the science and technology skills that our businesses and public services will need over the next decade, underpinned by excellent teaching in schools to engage the next generation of workers in the knowledge economy;
- and a society that is confident about the regulation and use of science and technology.

All this with one purpose: to make Britain one of the most competitive locations for science, research and development and for innovation.

We welcome your views over the coming weeks.

Rt Hon Gordon Brown MP **Rt Hon Charles Clarke MP** **Rt Hon Patricia Hewitt MP**

EXECUTIVE SUMMARY

OVERVIEW

1.1 The Government's ten-year investment framework for science and innovation will set out the attributes of a successful and competitive science and innovation system in the UK to which Government and other stakeholders are committed. This will enable the Government and other funders and investors in UK-based science and technology education, research and application to gauge their own future investment plans. This document sets out the key policy issues which the Government will develop further in the coming months, in consultation with public and private sector bodies engaged in research and development (R&D) in the UK.

1.2 The Government is ambitious to develop the UK science base and its contribution to our innovation performance. It sees the following as the qualitative attributes of a successful system to which the Government and other partners should work, which will be the central aims of the ten-year framework to be published in the summer:

World class research at the UK's strongest centres of excellence

The UK's leading research remains among the world's best, and can act both as a magnet for globally mobile corporate and private R&D investments and personnel, and as an inspiration to the next generation of researchers and educators. We must ensure that the institutions which foster the most excellent research can continue to compete at the highest level, and that the benefits of this global leadership can be leveraged across the UK economy.

Sustainable and financially robust universities and public labs across the UK

The high quality research and personnel in the UK science base must be maintained. High levels of productivity are to be welcomed, but not where this means that research is subsidised at the expense of under-investment in other areas. Increased funding for Research Councils' project costs, and a significant level of dedicated capital funding, as allocated in the 2002 Spending Review, provides a sound underpinning for sustainability. But action is also needed from other funders, in order to recognise properly the worth of the research they are commissioning from the science base. And universities themselves need to ensure that their corporate governance and financial management continue to develop to enable effective and sustainable management and delivery of their teaching, research and knowledge transfer outputs. Public Sector Research Establishments and their parent departments similarly need to clarify their long-term approaches to sustaining their research activities and supporting infrastructure.

A continuing step-change in the responsiveness of the research base to the needs of the economy and public services

Better translation of the wealth of knowledge in the science base into innovation by business and the improvement of public services will bring benefits to the science base, Government, business and the economy as a whole. Universities and public laboratories must continue to develop a stronger programme of engagement with users on knowledge exchange, to create conduits for productive flows of ideas and people between research and its practical application. Government funding for the science base must fully recognise excellence in applied and business-relevant research as it does basic research. Businesses need to improve their links to and engagement with the science base to access the raw materials needed to improve their innovative potential. The Government's own R&D needs to be of high quality, and focused on improvements in public services. Synergies between different funders and the science base should be recognised and the complementarities maximised to improve the impact of research and funding.

Increased business investment in R&D, and increased business engagement in drawing on the UK science base for ideas and talent

Leveraging up the levels of business investment in R&D in the UK is crucial to increasing the innovation performance of the UK economy. More businesses need to engage with the science base, either directly or through intermediary bodies. More businesses need to adopt the practices of the best UK-based companies in creating and sustaining partnerships with a network of research teams, providing a productive means for companies to access the creativity and expertise of the science base. More businesses should become engaged in shaping school and university curricula to inspire and attract the next generation of trained personnel.

A more responsive supply of science, technology, engineering and mathematics skills to the economy, and greater flexibility within schools and universities to attract the skills they need

The UK education and training system needs to become far more attuned to the evolving needs of UK-based businesses and public services in shaping the quality and quantity of students produced by schools and universities. To do so effectively, schools, colleges and universities themselves will need to be able to compete effectively with other employers to secure the right quality and quantity of teachers and researchers.

Confidence across UK society in scientific research and innovative applications

The UK must continue to be open to new ways of extending human knowledge and reaping the benefits of this through new products and processes. Science and innovation must continue to be set within a robust legal framework which supports and protects research operating within boundaries set by society through Government. Researchers and policy makers must earn public confidence and trust in science through addressing public priorities and concerns. In this way the scientific community, working with Government and other partners, can ensure that society's understanding and acceptance of scientific advances move forward, and does not become a brake on social and economic development in the UK.

Q1 Are these the right areas for the Government and its partners to target over the next ten years? What are the underlying components of success in these areas and what roles do Government and other funders of the science base need to play in achieving these aims?

INTRODUCTION

1.3 Innovation is at the heart of productivity growth and social gain. Creativity and inventiveness are some of the UK's greatest assets and have always underpinned the UK's economic success. In an increasingly global economy, future prosperity here will depend upon our ability to turn research, design and invention into innovation in products and services, and productivity gains. The UK has the potential and the desire to become a key knowledge hub in the world economy with a reputation not only for outstanding research, but also a world leader in translating science, engineering and technology into wealth.

1.4 Delivering growth through innovation across both the public and private sectors over the coming decade will require the UK to generate a stronger flow of ideas and talented people into the economy. The science[1] base in its broadest sense – including education, training and research – is a crucial underpinning of this goal. Concerted effort by Government, business and others is needed if the country as a whole is to achieve a shared goal of making the UK a more competitive location for research and development and for innovation.

1.5 The Government therefore intends, as part of Spending Review 2004, to set out its aspirations for science and innovation over the next ten years; the investment framework which will support its delivery; and the attributes of a globally successful innovation system to which our reforms are addressed, linking science and technology, education and research to tangible economic benefits. This consultation paper sets out the direction of the Government's thinking on the key components that will together contribute to a coherent investment framework. It builds on substantial policy review, reform, and public investment in recent years, and provides an opportunity for all stakeholders to contribute further to shaping the forward agenda for investment and reforms over the Spending Review period and beyond. A key part of this work will be to review the outputs and outcomes of existing public expenditure in this area, to ensure that best use is being made of existing resources.

1.6 The Government believes this strategy will only be successful if it is a broad partnership – if it sees parallel commitment from business, charity and public sector funders of UK R&D to their own engagement in the future of British science over the next ten years. The strength of this response from others will be a crucial consideration for the Government in the coming months as the framework develops.

1.7 The strategy will provide a framework for a successful and competitive science and innovation system in the UK, based on:

- a financially robust network of universities and public research laboratories across the UK;
- world class research;
- a continuing step-change in the responsiveness of the research base to the needs of the economy;
- raising business investment in R&D and innovation and encouraging stronger business engagement with the ideas and talent of the UK research base;

[1] 'Science' is used throughout this document in its broadest sense, to encompass all aspects of engineering, technology, mathematics, design, social sciences and the arts and humanities

- making the supply of science and technology skills more responsive to demand;
- greater flexibility within schools and universities to attract the skills they need; and
- greater public understanding of, engagement with and confidence in UK scientific research and its innovative applications.

1.8 Achieving these attributes will enable the UK to derive to greater economic and social benefit from the nation's investment in the UK science and innovation system.

UK SCIENCE: PERFORMANCE AND IMPACT ON INNOVATION

1.9 Maximising the benefits of innovation is an increasingly urgent priority for both companies and countries. Trade liberalisation and falling communication costs mean that business faces opportunities to exploit UK innovation on a global scale, competing across a much wider range of manufacturing and service sectors than previously. A successful UK economy needs to develop new ways to create value added and employment. Technology and scientific advances open up opportunities for new waves of innovation and enterprise. Shifts in demand, enabled by technology and communications, in turn create pressures on companies and Governments to respond more quickly.

1.10 Innovation is also vital to improving the flexibility and performance of the EU economy, tackling the challenges which Europe set itself at the start of this decade through the Lisbon agenda. The UK, French and German Governments recently set out their joint approaches to improving innovation performance across Europe[2], highlighting the contribution of successful national programmes operating within a more flexible European regulatory framework.

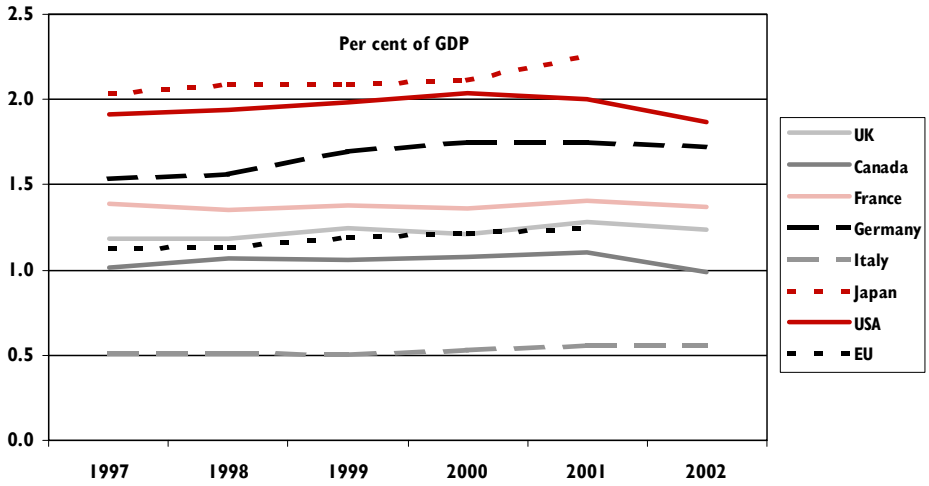
1.11 The importance of business investment in R&D is also reflected at a European level. At the Barcelona Spring Council in 2002, EU Member States set an aspirational target to raise public and private expenditure on R&D to approaching 3 per cent of GDP by 2010, with two-thirds of this new investment coming from the private sector. European business R&D trails that of the US, but the UK falls behind even the EU average.

1.12 The Government cannot know or direct the transformation of the UK economy over the coming decade. This will continue to be driven by competition, enabled by enterprise and innovation, and built on investments in skills and capital in the UK. But the Government can act now and in coming years to create the capacity to develop, absorb and apply knowledge to deliver innovation, growth and improvements in public services wherever the opportunities present themselves. It can also help foster a climate in which talented individuals and enterprising companies see the UK as one of the most attractive locations of choice for research and development. The Government has already set out its aim to be the leading major country in Europe within the next ten years in business R&D and patenting[3].

[2] Towards an innovative Europe: A paper by the French, German and UK Governments, February 2004.

[3] DTI Innovation Report, December 2003, www.dti.gov.uk/innovationreport/index.htm

Chart 1.1: Business expenditure on R&D



Source: OECD, Main Science and Technology Indicators, 2003

1.13 To do this, the UK must improve its relative national performance in the output, quality, and impact of research and trained people. This will require further progress on a range of related issues, including the approach to university research funding, improving university and business collaboration, the supply of and demand for and productive application of science and technology skills, and the interaction between the public and private funders and users of the UK science base. This progress is essential to improving quality and efficiency in health, education, environmental issues and other public services, hence improving UK national prospects and quality of life.

1.14 As part of the ten-year investment framework for science and innovation the Government will set out its plans for ensuring that the UK science base has the necessary attributes to compete globally. The Government wants the outputs of the UK's science base to be better scaled and shaped to match the growth in the economy and its goal for the UK to become a global knowledge hub. The Government has the prime responsibility to ensure that public investment in the science base is utilised most effectively, and that the UK education and research system is appropriately structured and adequately funded to deliver the quality and quantity of trained people and research outputs which will enable this goal to be achieved. But this will not be possible without parallel commitment from other funders and major R&D businesses.

1.15 Successful policy design and evaluation requires robust and practical measures of success. Measurement frameworks have been developed to support the Government's Public Service Agreements covering productivity growth, science and innovation. These need to be developed further during the 2004 Spending Review and as part of the ten-year investment framework. The objective is a basket of key indicators, and a trajectory for their development, which will reflect the health of the UK science skills, research and innovation system. These will identify the outcomes to

which the UK knowledge economy should be moving if we are to achieve our ambitions in the medium term.[4]

1.16 To ensure that the UK Government maintains the momentum of recent reforms, funding and improved outcomes from the science base, it will ensure that the level of public investment here will grow faster than the trend rate of GDP growth over the Spending Review period 2005-06 through to 2007-08.

1.17 To ensure that this growth in spending is well matched to the needs of the economy as a whole, the Government hopes to see parallel commitment from major business, charity and public sector funders of UK R&D to their own engagement in the future of British science over the next ten years. The strength of this response from others will be a crucial factor in the scale of the Government's commitment and the success of this strategy for the UK.

1.18 Consistent with the overall goal to move the UK to a leading position in Europe on the capacity to innovate, as measured by share of R&D in the economy, the Government will set out in the Spending Review its ambitions for British science over the next decade.

MANAGEMENT OF THE SCIENCE BASE

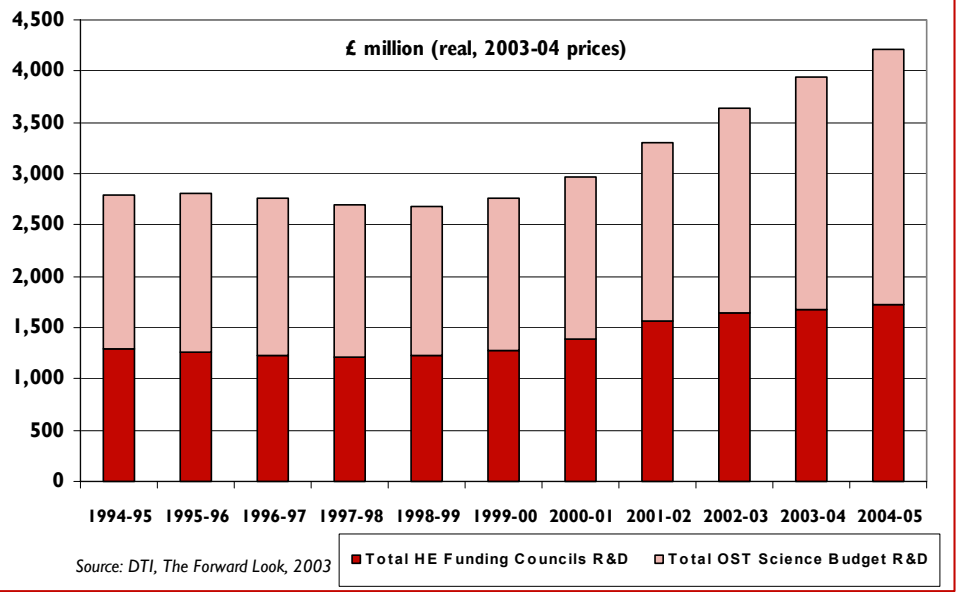
1.19 The UK's science and engineering base is one of its strongest assets for future economic growth, and one on which it needs to capitalise. The UK is well served by its network of universities and public research centres, which have continued to deliver highly productive university education and training for graduates and research which, at its best, is world-leading. In recent years the Government has invested substantially in their creativity and sustainability. The investment framework for the coming decade will set out how the Government intends to build on this, enabling other funders and users of the research base, and the science and engineering community, to set their own forward plans.

1.20 The Government's overall aim for the UK research base over the coming decade is two-fold: to capitalise on our world-class centres of excellence, and to reinforce the connections between both science teaching and research and the evolving needs of business and the public services.

1.21 These goals are complementary – the peaks of quality and achievement in the UK serve to attract and inspire talent and investment from business and individuals, and raise the performance of the research base as a whole, while the network of universities and research institutes provides a competitive market for emerging ideas and talented people across the country.

[4] See also parallel consultation on productivity indicators *Productivity in the UK 5: Benchmarking UK productivity performance,* HM Treasury and DTI (2004)

Chart 1.2: Core UK Government funding of the science and engineering base



Source: DTI, The Forward Look, 2003

1.22 They are also necessary: the most innovative world class companies will increasingly seek out partners in research which are globally rather than nationally excellent. At the same time, others – including many smaller and medium sized enterprises - will need better and more responsive regional access to skills and applicable research for their business needs. With public and private sectors working together, the Government's aim for the UK should be achievable. Continued commitment by Government to the core science base and effective use of resources will create a platform for parallel commitment by business, public services and charities which each have a major stake in the continued health and growth of research and innovation in the UK.

1.23 The UK's achievements to date in delivering excellent research have been underpinned by the framework of Dual Support funding of universities. This provides a platform of core funding for universities on which they can build their own research portfolio supported by project funding. Funding allocations for both strands are based on quality, and deliver a platform for the best in their field to innovate and advance the frontiers of knowledge.

1.24 The Government is committed to working with all those with a stake in the system - universities, Dual Support funders, charities, Government departments, regional and devolved bodies and business - to ensure that the economy-wide benefits of the Dual Support regime continue to be delivered. In particular, incentives from both sides of the Dual Support system for researchers to work more collaboratively across traditional disciplines and with a stronger focus on potential future applications must be strengthened. At the same time, the UK needs to ensure that its globally excellent centres are able to fulfil their potential as attractors and generators of future innovative talent and wealth creation. The ten-year investment framework will affirm the Government's commitment to Dual Support and set out the direction of reforms, building on recent consultations, to enhance the overall performance of university research.

1.25 The cost of competing in R&D at the highest levels is rising, as the UK becomes increasingly exposed to global labour markets and the complexity of and capital commitment required for major endeavours increases. Against this background, the Government will need to ensure that universities, public research laboratories and research funders across the public sector have the right incentives to maintain and develop the capital infrastructure required to perform at internationally competitive levels. It will also need to ensure that there are appropriate mechanisms in place to encourage the most efficient use of specialist capital facilities through collaboration and wide access. The UK will need to work for similar incentives for collaboration and access at the international level, to complement our domestic effort and ensure that UK public resources are focused on UK priorities.

1.26 To secure the sustainability of the science base, the Government is already increasing funding for Research Council grants to meet a higher proportion of the full economic costs to the higher education sector of the projects they fund. In return, the Government looks to other funders of the research base to recognise the necessity of paying a fair price for the research they support, having regard to the various ways in which they contribute to the system, in order to safeguard the future availability of high quality infrastructure, researchers and research. The higher education sector must also play its part, implementing robust and transparent financial management systems to ensure that institutions take responsibility for their own financial health over the long term.

KNOWLEDGE TRANSFER AND THE LAMBERT REVIEW

1.27 The Government also wants to ensure that the economic benefits of the research it funds are realised. The UK has an excellent science base, producing high quality research outputs and skilled workers, yet our businesses overall do not perform well on measures of innovation in comparison to our competitors. Knowledge transfer between the science base and industry has increased in recent years, and there are many examples of good practice and successful outcomes. As the Lambert Review of business-university collaboration found, universities are showing increasing levels of interaction with business, with licensing agreements and joint publications rising. Many businesses are making more use of the research capacity of the science base and realising the benefits of joint working. In previous spending reviews, the Government has allocated funding for knowledge transfer activities, recognising the importance of building such a capacity in the science base. The DTI Innovation Report and the Lambert Review both emphasised the importance of strengthening links between our research base and the UK business sector, creating economic benefits for universities, business, and for the economy as a whole. Working on both the supply and demand side, our ten-year investment framework will set out our intentions for improving these linkages, in a full Government response to the Lambert Review.

EDUCATION, SKILLS AND PUBLIC ENGAGEMENT WITH SCIENCE

1.28 A strong science base depends critically on the supply of skilled researchers, to maintain the quality of research output, and to progress into research careers, whether in the public or private sectors. Government has a role in ensuring that the flow of trained research personnel through the education system is strengthened to meet future demand. At the same time, business needs to ensure that its demands, current

and future, are clearly articulated. Career structures and rewards need to ensure we can recruit and retain the best researchers in the world.

1.29 The 2002 Roberts Review of the supply of people with science, engineering and technology skills made recommendations for change, including increasing postgraduate stipends and post-doctorate salaries, and creating a network of Science Learning Centres to provide continuing professional development for science teachers and science technicians, measures which are currently being implemented. Roberts advised that action was needed from Government, universities and employers to tackle shortages in supply; the Government will take stock of the situation two years on to assess progress so far and what more needs to be done. In particular, in science and related subjects, where there may be a shortage of qualified teachers, it will consider whether to promote further flexibility in pay to respond to market conditions.

1.30 Science plays an increasingly prominent role in society and everyday life – from technological and medical advances improving quality of life to high-profile media coverage of often-controversial issues. Public support for science and technology is crucial, and this in turn will rely on public confidence in the way science is regulated, developed and used. To earn public confidence and support, the scientific community and policy makers must engage in a dialogue with the public to better understand and respond to public priorities and concerns – and to increase public awareness of scientific policy, issues and processes. Research shows that there is general recognition of the benefits that science and technology can bring to individuals and the economy; this must be built upon if the UK's ambitions in this area are to be realised.

PARTNERSHIP FUNDING

1.31 In all of these areas, Government action alone is not enough. The Government need to work with its partner funders of the science base – business and charities – to cement a coherent and complementary framework within which the UK science base can thrive. Business R&D in the UK is low in comparison with our competitors, and markedly concentrated in a few sectors, but businesses are also investing increasing amounts in our science base. Charities are also key funders of research in universities and elsewhere. This investment is often delivered in partnership with other funders, ensuring complementarity of approach. Many priority areas for charity research are closely linked to public service priorities, for example in medical research. In these areas, coordinated working between different funders – including in the case of medical research the NHS, Department of Health and other public sector funders, academics and industry – is essential and fosters wider economic benefits from enabling business to work more efficiently with the NHS, for example through clinical trials.

SCIENCE AND RESEARCH ACROSS GOVERNMENT

1.32 Government Departments also invest considerably in research in developing evidence-based policy and delivering public services – around £2 billion in 2002-03 by civil departments. The Cross-Cutting Review of Science & Research in 2002 made recommendations, now being implemented, for improving the quality and cohesiveness of Government Departments' research spend. It will therefore also be important to consider research priorities and needs across Government as
part of the investment framework, and how to get the most of the research carried out on behalf of Government programmes. For example, science and technology are key to achieving the Government's environmental aims, including climate change objectives.

1.33 Meanwhile, the regional and sectoral aspects of science and innovation policy have become increasingly important in recent years. The DTI Innovation Report identified key elements in a partnership between national government and the regions. Regional Development Agencies and their equivalents in the Devolved Administrations are directing resources towards science and innovation activities. All regions now have, or are establishing, Science and Industry Councils or equivalent bodies, bringing together regional stakeholders in the science base.

1.34 Sector Skills Councils (SSCs) are also working with employers to identify key strategic issues for their sectors, and to define the skills that employers need to raise productivity in all major sectors of the economy. Two Sector Skills Councils covering science, engineering and technology skills, which are now fully operational, are SEMTA (Science, Engineering, Manufacturing Technologies Alliance) and e-skills UK. Both are developing Sector Skills Agreements to address these critical issues. Whilst science funding is allocated nationally on the basis of excellence, wherever that excellence is found, there are clear benefits in engaging regional and sectoral partners in knowledge-transfer activities, for example in facilitating links between business and the science base. The Lambert Review recommended that the regional and sectoral dimension of knowledge transfer, and business-relevant research, needed to be developed further.

2 UK SCIENCE: PERFORMANCE AND IMPACT ON INNOVATION

UK PERFORMANCE AND PROSPECTS

2.1 The UK has an excellent research base. It ranks second only to the US in measures such as world citations and research impact (citations per paper)[5]. On other metrics, however, such as the availability of highly skilled people with research training, and business expenditure on R&D, the UK falls behind its competitors. Competition from other countries is strong, and increasing, with countries like India, South Korea and China investing heavily in their science bases. This highlights the need for the UK science base to continue to evolve and improve. The evidence now available about the performance of the UK science base, as benchmarked against other countries, is helpful in illuminating our relative strengths and weaknesses, and the Government is keen to address both. For example, there is differentiation in performance in terms of subject areas, looking at the share of the world's citations: the UK is currently second only to the US in most fields, but 3rd in mathematics and 4th in engineering and physical sciences.

Measured against a group of twenty-five countries including the G8, larger OECD countries and small nations with rapidly growing R&D bases, the UK:

- lies 13th in *R&D expenditure as proportion of GDP*;
- is behind the US and Germany; similar to Japan in *share of PhD awards*;
- has long been behind the US and has recently been overtaken by Japan in its share of *world journal articles*;
- is second highest to USA (Germany now a close third) in overall *share of world citations*: in mathematics we are third; in physical sciences and engineering we are fourth;
- is second behind Germany in the G8 for *PhDs awarded per researcher*;
- leads the G8 in *papers published per researcher* and *citations acquired per researcher*;
- is second only to Switzerland in *citations per unit of Gross Expenditure on R&D*; and
- is one of the lowest ranked among G8 nations in *highly skilled people with research training.*

Q2 Which strengths of the UK science base could be further developed; what are the weaker areas that need to be addressed; and what are the risks to the UK's continued production of internationally competitive levels of research? What criteria should the Government use to help determine its overall commitment to science?

2.2 For the UK to compete in the global economy on a high-value added basis requires the development and application of new technology and the supply of skilled personnel, in order to capitalise on rapid scientific advances. As set out in the DTI Innovation Report, published last year[6], government has a role to play in working with

[5] Metrics published by the Office for Science and Technology at www.ost.gov.uk/policy/psa_target_metrics.htm)

[6] http://www.dti.gov.uk/innovationreport/index.htm

the private sector to help businesses develop and implement new products and services. This is becoming a higher priority in the Government's wider productivity strategy, and as a result the Government needs to harness its resources more effectively in promoting technological innovation.

2.3 The Government aims to improve both the supply side and the demand side of our research performance. Fundamental to its approach will be setting priorities, taking account of the growing international mobility of business R&D. In conjunction with business, the science base, Government Departments, the Devolved Administrations, Regional Development Agencies (RDAs) and other stakeholders, the DTI is developing a National Technology Strategy. It will be formulated by a business-led board and will have a medium to long-term perspective, which will provide a framework for setting policy priorities and improving the effectiveness of business support, to focus support on key technologies in order to harness their potential benefits in the future. The Strategy will also feed into priorities for Government-wide R&D, European research programmes and RDAs' support for science and technology. It will inform the future development of technical regulations, measurement and product standards, and identify opportunities for innovative public procurement. The DTI Innovation Report identified potential barriers to innovation by business, and the ten-year framework will link closely with action being taken to address these.

DTI Innovation Report: competing in a Global Economy (December 2003)

The DTI's Innovation Report sets out a detailed strategy for improving innovation performance to help British businesses succeed in the global market. Following a review of innovation policy, led by Science & Innovation Minister Lord Sainsbury, the report argues that the UK has an excellent science base and track record in invention, but needs to do more to exploit this for commercial benefit. The report argues that the UK cannot compete in the global market on the basis of low labour costs, but can instead compete through the exploitation of new ideas.

Key proposals include:

- A £150 million National Technology Strategy to provide a framework for policy priorities and improve support for innovation. Funds released from the review of DTI business schemes will be used to support the strategy.
- New government procurement guidelines to help British firms and make government a more intelligent customer for the £109 billion it spends each year on products and services.
- Best practice guidance on capturing innovation from suppliers to be produced by the Office of Government Commerce and the Department of Health to take forward pilots on innovative hospital design and greater uptake of telecare and telemedicine technologies.
- New targets for increasing the rate of knowledge transfer and level of interaction between science and business - to be taken forward by the Director General of the Research Councils with each Council.

DTI Innovation Report: key proposals (continued)

- An increased role for the Small Business Service, and the equivalent in the Devolved Administrations, to promote innovation and knowledge transfer. Advisory services will include: Intellectual Property Rights advice, assistance with R&D Grants and Knowledge Transfer Partnerships, brokering collaboration between companies and Higher Education Institutes and alerting SMEs to public procurement opportunities.
- New measures to help women entrepreneurs and improve their access to mainstream finance.
- A regional drive on innovation with refocused DTI support for investment in the Assisted Areas to help create sustainable high-value investment and jobs. Regional Science and Industry Councils, or equivalent bodies, will be set up and high-tech clusters supported.
- A major awareness-raising programme on intellectual property (IP) from the Patent Office, targeted towards SMEs, along with a national strategy for dealing with IP crime. The National Measurement System will increase its research on emerging technology areas such as the biosciences and nanotechnology. And the Design Council will launch a series of demonstrations to show how design can raise innovation and profitability in manufacturing, emerging technology and service industries.
- A new Ministerial team to deliver on innovation across Whitehall and with wider stakeholders, reporting to the Economic Affairs Policy Committee every six months.

2.4 The UK's business sector includes some global leaders in innovation, particularly in sectors such as pharmaceuticals, aerospace and health technologies. Concerted investment in R&D over many years has enabled the leading companies in these and other sectors to deliver continued growth in value added through innovation. There are also newer emerging sectors such as biotechnology which through early commitment to R&D are laying the foundations for future commercial innovations and revenue growth. As the DTI Innovation Report highlights, though, the UK a relatively low number of innovating companies in other technology-based sectors and, overall, UK business R&D in these sectors lags that of other leading economies.

Q3 In which key technology-based sectors does the UK have the potential to maintain and grow internationally competitive value added over the coming decade? What are the barriers to capitalising on our strengths and addressing areas of relative weakness in business innovation and R&D? How can investment in the UK science base and Government support for business R&D best contribute to that growth?

2.5 Decisions on the specific programmes within research fields should be, and are, made by those in the science base itself working together with industry and other partners. For example, the Research Councils consult widely in the scientific community and beyond in developing their strategies and plans. In recent Spending Reviews there has been a move to develop cross-Council and priority programmes, reflecting the increasing importance of inter-disciplinary working. The following Research Council priority programmes have been highlighted in the last two Spending Reviews:[7]

[7] See *Science Budget 2003-4 to 2005-6*, www.ost.gov.uk/research/funding/budget03-06/index.htm

Research Council priority programmes, from Spending Reviews in 2000 and 2002

Stem cells (£40 million from 2003-04 to 2005-06) – aims to take advantage of recent conceptual and technical advances and generate new insights into fundamental stem cell biology and developmental processes, applying them towards the development of new treatments for major diseases and disabilities. Achievements so far include the establishment of a National Stem Cell Bank.

Towards a sustainable energy economy (£28 million over 2003-04 to 2005-06) – will underpin research to support the development of economically viable and publicly acceptable renewable energy sources and technologies to enable the UK to meet its target for 10 per cent of electricity generation from renewable energy sources by 2010 and beyond.

Rural economy and land use (£20 million over 2003-04 to 2005-06) - addresses issues of agricultural policy reform, food supply chains, and rural regeneration. Will contribute to the long-term outcome of achieving a rural economy that meets social and economic objectives, with protection of the rural environment and a modern, sustainable and competitive agricultural industry.

E-Science (£213 million over 2001-02 to 2005-06) - aims to address major challenges in the processing, communication, storage and visualisation of data, to give UK researchers a leading position in the development and exploitation of Grid technologies, and in the definition of next generation standards for information utilities. Achievements to date include the establishment of a National e-Science Centre.

Post-genomics and proteomics (£246 million over 2001-02 to 2005-06) - aims to enhance the UK's capability in genomics and proteomics that will underpin the translation of post-genome research into improved health and economic outcomes. Many of the investments are long term, but achievements to date include initiation of UK Biobank – the prospective study in a cohort of half a million people of the interplay of environmental and genetic factors causing ill health.

Basic technology (£104 million over 2001-02 to 2005-06) - aims to establish a UK technology research capability to underpin the industrial base of the future. Crosses traditional research boundaries and disciplines. The programme supports a wide range of basic technologies relevant to healthcare, biology, nanotechnology and nano-scale engineering.

Brain sciences (£15 million over 2002-03 to 2005-06) - builds on existing investments and will focus on mental health and neurodegenerative disease. Working with the Health Departments and industry to build research capacity in basic and translational research, and develop shared resources for the research community. Encouraging younger researchers and high-risk high-pay-off research will be priorities.

Q4 In order to inform decisions on the future investment framework, and building on the Research Councils' extensive consultations with stakeholders, in what areas are there opportunities for the UK research base to excel and contribute to the economy and society, which might form the basis of future strategic research programmes over the next ten years?

3 MANAGEMENT OF THE SCIENCE BASE

RESEARCH ASSESSMENT

3.1 Sir Gareth Roberts, on behalf of the UK higher education funding bodies, carried out a review of the Research Assessment Exercise[8] (RAE) in 2003, involving extensive consultation. He found overwhelming support for the continuation of a peer review system for assessing research, and made proposals for improving the RAE, which is the basis for allocating funding intended to provide a foundation for research capacity and "blue skies" research. In response to this report, the UK funding bodies have now set out their proposals for the next RAE[9], for which submissions will be made in 2007 with the process concluding in 2008. The reforms aim to reduce bureaucracy and "game playing", and will introduce a continuously graded funding profile, which will address the issue of "cliff edge" funding, while maintaining the capacity to reward excellent research.

3.2 One of the areas the review was tasked to look at was the need to properly recognise collaborations and partnerships both across institutions and with organisations outside Higher Education, and to recognise fully all aspects of excellence in research (such as pure intellectual quality, value added to professional practice, applicability, and impact within and beyond the research community). The Lambert Review of Business-University Collaboration, published in December 2003[10] also recommended that the RAE needed better to recognise excellent research of any type, including applied/practice-based research. The re-styled RAE proposals seek to address this. The funding bodies will be taking this issue forward in developing the guidelines and panel framework, through consultation on the structure and appointment of panel members. Full details of the assessment process, including panel criteria and working methods, will be in the public domain at the end of 2005.

Q5 In the light of the changes to be made to the next RAE, how can funding mechanisms build on existing resources and research assessment reforms to reward excellence and underpin sustainability?

FULL ECONOMIC COSTS

3.3 In July 2002, the Government identified[11] that the UK science base was very productive in terms of outputs per unit funding, and of high quality, but that this performance was not likely to be sustainable. Universities were not recovering the full costs of the research they carried out, they were subsidising current research activities at the expense of medium term investment in research infrastructure, and imposing costs on other parts of their business.

3.4 Sources of income for the science base, and the balance of funding between them, have changed considerably in recent years. In particular there has been a marked

[8] www.ra-review.ac.uk/

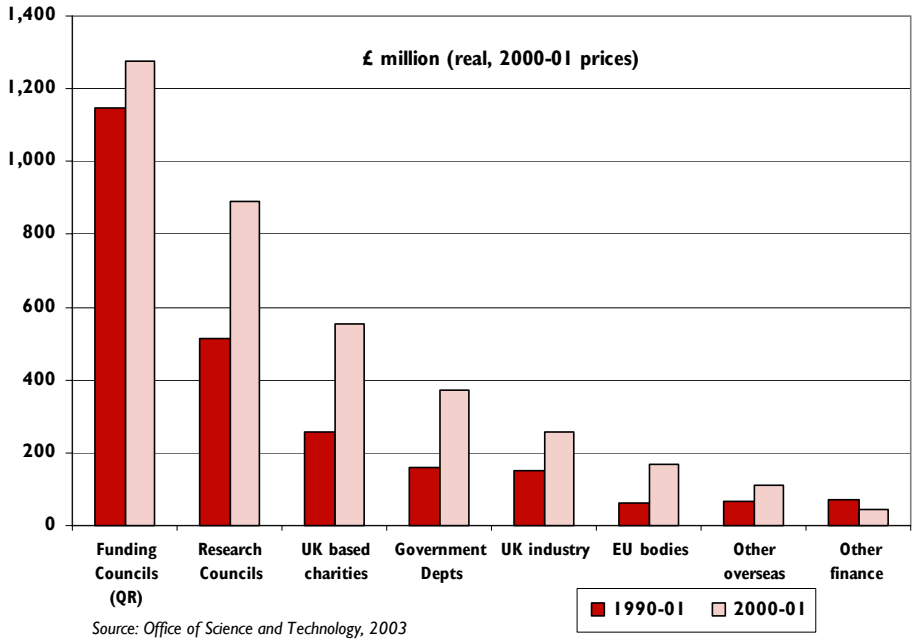
[9] www.hefce.ac.uk/news/hefce/2004/rae.asp

[10] www.lambertreview.org.uk

[11] www.ost.gov.uk/policy/invest-innov.htm

increase in the proportion of university research income from third parties (income from bodies other than the Research Councils and the Funding Councils). In 1990-91 approximately 30 per cent of total university research income came from third parties; a decade later, in 2000-01, this had increased to 40 per cent. Where the full economic costs of the research carried out for these third parties is not being recovered by universities in the amount they charge, public funding is being spread increasingly thinly, with adverse impacts on investment in infrastructure.

Chart 3.1: Comparison of sources of university research funding in the UK in 1990-91 and 2000-01



Source: Office of Science and Technology, 2003

3.5 The 2002 Spending Review took a first step in addressing this issue, setting out the Government's commitment to move the UK science base onto a sustainable financial footing, working in partnership with other research funders and the universities. An extra £120 million was allocated in the last Spending Review to enable the Research Councils to pay a higher percentage of the costs of projects they fund, to be accompanied by reform of universities' costing and pricing procedures.

3.6 Following the Dual Support sustainability consultation[12] and parallel work on financial sustainability in Public Sector Research Establishments, universities and public laboratories are moving towards the overall recovery of the full economic costs of the research each undertakes. Implementation of robust accounting systems through the Transparent Approach to Costing methodology (TRAC) at project level to assist in this process is well under way, meaning that universities will be better placed to cost and price their research transparently. Government, through both the Research Councils and its directly commissioned research, will be paying a higher price for the research it funds, and expects other funders of research to do the same, taking account of the various ways in which they contribute to the system.

[12] www.ost.gov.uk/policy/invest-innov.htm - innovationsupport

Q6 What are the main barriers or challenges to the achievement of a sustainable public research base in the medium term? What further action could the Government take, in partnership with universities and other funders of research, to create robust incentives on all parties to work together to deliver greater financial sustainability of the UK's research base?

CAPITAL SUSTAINABILITY

3.7 *Investing in Innovation* recognised that a symptom of the problem of overtrading and under-recovery of costs was that universities had been under-investing in their infrastructure, as they prioritised their funding elsewhere. This, combined with the nature of the HE estate and changing requirements for research infrastructure, has resulted in historical under-investment in the research base, and hence an urgent need to address the backlog of investment in capital stock. The 2002 Spending Review therefore added to the dedicated capital stream – the Science Research Investment Fund (SRIF) – with funding rising to £500 million a year in 2004-05. Conditional allocations are made to institutions, which subsequently submit an investment strategy for this funding. A report from an interim evaluation of the outcomes of the first round of SRIF (2002-4), based on a representative sample of institutions, will be available in May this year.

3.8 A project carried out by OST during 2003 found a similar problem – albeit on a lesser scale – with Public Sector Research Establishments, in terms of under-investment in asset bases[13], and made recommendations for addressing problems identified with this, and the trading relationships of PSREs.

3.9 Given the importance of a strong and sustainable research infrastructure to support researchers in our universities and public sector research establishments, and the need to prioritise limited resources, it is essential that Higher Educations Institutions develop holistic investment and asset management strategies for putting this investment – and income from other sources to fund capital spend – to optimum use.

Q7 How could funding for universities provided by Government and other funders create stronger incentives for the effective creation management and usage of the research base infrastructure over the next decade?

LARGE FACILITIES

3.10 The Office of Science and Technology funds, or contributes to, a number of strategically important large-scale scientific facilities. Many of these involve long planning timescales and significant investments. Some are also based overseas, which the UK secures access to through funding or reciprocal agreements. Research Councils UK has set out its priorities for large facilities for the UK in the Large Facilities

[13] *Research Council Institute and PSRE Sustainability Study (RIPSS)*, November 2003. The full report will be published on the OST website.

Roadmap[14], in order to assess strategically the most expensive and complex scientific facilities with which UK researchers are or may wish to be involved.

3.11 In many disciplines, as the frontiers of science expand, the technology required to make major advances in human knowledge is becoming increasingly complex and expensive. Major facilities are therefore a crucial component in advancing science globally. At the same time, advances in computing power and communications enable greater collaboration by scientists internationally in managing and using the experimental results from shared facilities. Given limited resources, there is always a need to prioritise the need for such facilities against other claims on Government funding, and to consider how these needs can best be met.

Q8 What is the optimal means of developing access to large research facilities at national and international level? How should funding of large facilities be prioritised?

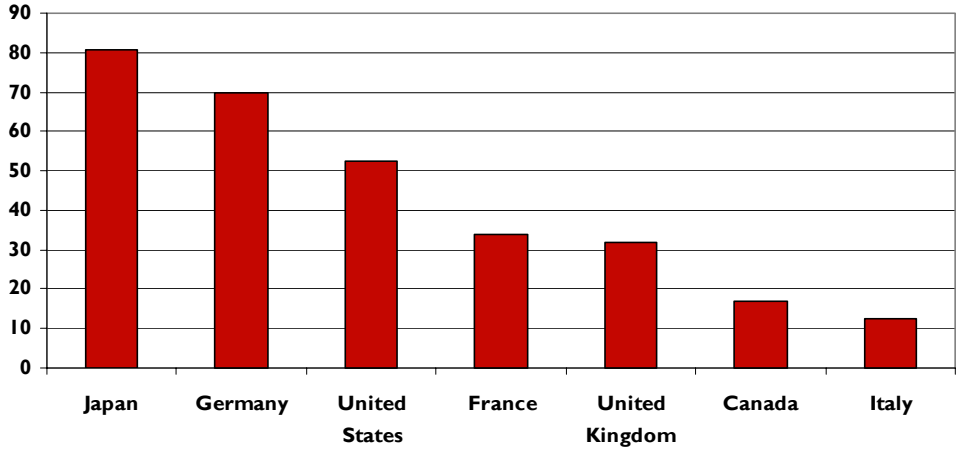
[14] http://www.ost.gov.uk/research/funding/lfroadmap/index.htm

4 KNOWLEDGE TRANSFER AND THE LAMBERT REVIEW

4.1 Investment in research provides much of the foundation for innovation, and the new products and services that result. In *Investing in Innovation*[15] the Government recognised that such exploitation depends on the ideas, knowledge and skills transferring between universities, other research organisations and business – a process often referred to as knowledge transfer – and recognised the need for effective two-way links between research and the market.

4.2 The UK has a strong science base on many academic measures. However it performs less well on measures of business innovation such as the total amount of business investment in R&D, the number of patents per capita or the proportion of companies who have introduced new products or processes in the last 12 months.

Chart 4.1: Number of triadic patents per million population, 1998



Source: OECD

Note: Triadic patents registered in the EU, US and Japan

4.3 Looking forward over the next ten years, the Government would like to see substantially more companies undertaking R&D and innovation in the UK than is currently the case, and across a much broader industrial base. Currently the UK's industrial R&D base is fragile and heavily dependent on the investment decisions of a dozen large companies, concentrated particularly in two sectors: pharmaceuticals and defence.

4.4 The Government is also determined to ensure that more publicly-funded research is undertaken that is relevant to the needs of business, the economy and public services, and that those academics who chose to work in collaboration with business and others have access to the resources that they need, and enjoy the career progression and recognition that they merit.

[15] *Investing in Innovation: A Strategy for Science, Engineering and Technology*, DTI, HM Treasury and Department for Education and Skills, July 2002

4.5 A strong, vibrant university sector is also essential, where institutions play to their diverse strengths and can compete with the best in the world in their field, and where the links between the science base and the business community are strong, to maximise the likelihood that wealth is created from the public investment in research.

4.6 The Government has already recognised the importance of knowledge transfer between the science base, the business community and others through:

- continued investment in the Higher Education Innovation Fund[16] to enable universities to build up their capacity for knowledge transfer activity. The Government has stated its intention to make HEIF a continuous, permanent third stream of funding alongside teaching and research. The latest round of HEIF has funding of £187 million over 2004-06;
- creating a parallel fund for Public Sector Research Establishments, worth £15 million over 2004-06;
- initiatives run through the DTI – such as Knowledge Transfer Partnerships, Grants for R&D (SMART awards) and collaborative R&D programmes (Knowledge Transfer Networks, Collaborative R&D) to encourage greater demand from business for the ideas and knowledge in the science base; and
- undertaking the Innovation Review to look at ways that the UK can strengthen its innovation performance; and commissioning the Lambert Review of Business-University Collaboration to recommend ways that the UK can strengthen the links between the science base in the UK and businesses.

4.7 The evaluation of science budget funded knowledge transfer programmes currently underway will inform the future shape of such programmes. The DTI published its Innovation Report in December 2003, setting out the Government's intention to bring greater coherence and rationalisation to the DTI's innovation activities through the development of a Technology Strategy.

4.8 Richard Lambert published his Review of Business-University Collaboration on 4 December 2003 and the Government is now developing its response to the recommendations of that review.[17]

4.9 Richard Lambert identified a number of issues that needed to be addressed including the weakness of business investment in R&D, complex negotiations over intellectual property and the need to ensure that research that is relevant to the needs of business is supported and sustained. The main recommendations of the review were:

- a greater role for the Regional Development Agencies in facilitating knowledge transfer in their regions;
- a new funding stream for business-relevant research, along with increased and improved "third stream" funding for knowledge transfer;
- universities to develop a code of governance and to demonstrate good management and strong performance in return for a lighter regulatory touch from Government and the Funding Councils;

[16] HEIF is England only. The Devolved Administrations have similar programmes of support through their own Funding Councils.

[17] *Lambert Review of Business-University Collaboration: Final Report*, December 2003, available at www.lambertreview.org.uk.

- development of model contracts and a protocol for intellectual property (IP) to speed-up IP negotiations; and
- encouraging new forms of formal and informal networks between business people and academics, including the establishment of a business-led R&D employers' forum; and
- universities to provide more information on student employability, and businesses to take a greater role in influencing university courses and curricula.

4.10 The Government's ten-year strategy requires linkage at national, regional and international levels. Within this framework of national-regional partnership, the Government intends to develop the main strands of policy reform put forward by the Lambert Review:

- to build the Higher Education Innovation Fund as a permanent third stream of funding for universities in England to further build the capacity in the university sector for knowledge transfer;
- to work with universities and business to develop a set of model research collaboration contracts and to undertake further work to develop an intellectual property protocol; and
- to enhance the role of the English RDAs in strengthening business-university links.[18]

4.11 The Lambert Review stressed the importance of local universities for knowledge transfer to small and medium sized businesses. It recommended a greater role for the RDAs in supporting university departments that can demonstrate strong support from business to increase business-university collaboration. The RDAs also have a role to play in facilitating cross-regional collaborative activity. All the RDAs are now setting up Science and Industry Councils that will provide new opportunities for collaboration at a regional level and act as a link to national strategies and programmes.

4.12 The Government believes that the RDAs are well placed to promote business-university collaboration but recognises that they need the capacity and links to national programmes to do this most effectively. The Government will continue to explore with the RDAs and other stakeholders the best mechanisms for fostering business-university collaboration which meet the following key criteria:

- investment should be driven by demonstrated support from business;
- regional investment should complement national innovation priorities; and
- public support should not directly subsidise industry's near-market research.

4.13 Finally, the Committee of University Chairmen is currently developing a code of governance for the university sector. The Government welcomes this progress and is working with the Funding Councils and other agencies to explore further whether a workable lighter-touch approach to risk-based regulation of the university sector can be developed.

[18] The Devolved Administrations have primary responsibility for working with their own development agencies and HE institutions to improve business innovation and economic performance in their respective countries, including through strengthening business-university collaboration.

Q9 The Lambert Review was based on extensive consultation during 2003. Reactions to the analysis and proposals set out by the Lambert review, and in particular to the Government's proposed response, are very welcome.

4.14 The Government will make its final response to the Lambert Review in the ten-year investment framework for science and innovation, to be published this summer.

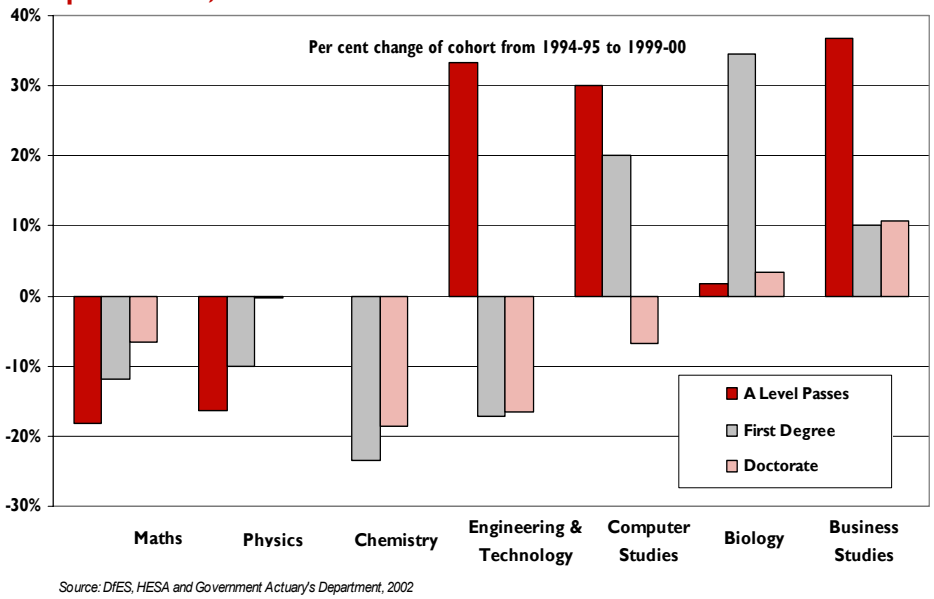
5 EDUCATION, SKILLS AND PUBLIC ENGAGEMENT WITH SCIENCE

SCIENCE, TECHNOLOGY, ENGINEERING AND MATHS SKILLS

For the UK's science base to provide a firm foundation for R&D, it is vitally important that businesses, universities and the public sector are able to attract and retain high-quality scientists and engineers from the UK and around the world. At the time of Budget 2001 the Government asked Sir Gareth Roberts to lead a review to determine whether the UK has an adequate supply of people with science, technology, engineering and mathematics skills. The Review's final report was published in 2002[19].

5.1 The Review found that fewer students in the UK are now choosing to study many science and engineering disciplines. As a result of these trends, and increasingly attractive opportunities for skilled scientists and engineers to work outside R&D, the Review found evidence of emerging shortages to R&D employers. The Review concluded that these emerging shortages will act to constrain R&D and innovation in the UK, not just in these disciplines but also more widely, since much cutting-edge research is multi-disciplinary.

Chart 5.1: Change in students gaining scientific or technical qualifications, 1994-95 and 1999-00



Source: DfES, HESA and Government Actuary's Department, 2002

5.2 The Review also concluded that securing a strong future supply of scientists and engineers would require co-ordinated action from the Government, employers and universities to ensure firstly that those individuals gaining graduate and postgraduate qualifications and training in science and engineering were given attractive options to work in university and private sector research and development; and secondly that there is a strong supply of students at every stage of the education system both able, and wanting to study and work in science and engineering.

[19] The report of Sir Gareth Roberts' Review, *SET for success: The supply of people with science, technology, engineering and mathematics skills*, April 2002, www.hm-treasury.gov.uk/roberts.

5.3 To ensure this, the Review identified responsibilities and challenges for the Government, R&D employers and others with an interest in science, engineering and innovation in the UK. Together with schools, colleges and universities, the Government has a role in ensuring that the benefits of science careers are promoted, that sufficiently attractive opportunities exist for individuals to study science and engineering subjects and that universities and the public sector are able to offer attractive employment opportunities in scientific research. Furthermore, the Government has a role in creating a favourable environment for scientific research and development, through improving the public's understanding and perception of science, engineering and technology.

5.4 However, the Review was clear that responsibility for an appropriate flow of scientists and engineers into private sector R&D also rests with employers, and with their ability and willingness to offer opportunities that are competitive with the other sources of employment open to highly skilled scientists and engineers.

5.5 The Government's detailed response to each of the Review's recommendations was published along side the Spending Review in July 2002[20]. The Government provided substantial measures and resources in the 2002 Spending Review to take forward its response, including:

- pay increases targeted on the recruitment and retention of permanent staff in all disciplines to improve the attractiveness of careers in higher education;
- additional funding for Research Councils to increase the average PhD stipend to over £13,000 by 2005-06 and postdoctoral salaries by £4,000, improved training opportunities for postdoctoral researchers and 1000 new academic fellowships;
- a major new programme that will pay science, maths, IT and engineering undergraduates to return to school during their studies and support teachers in the classroom;
- a joint initiative between the Government and the Wellcome Trust to establish a network of Science Learning Centres; and
- an increase in investment in school buildings, in England, from £683 million in 1996-7 to £3 billion for 2002-3 and then to £5.1 billion by 2005-6 with science laboratories highlighted as a priority in guidance on capital funding.

5.6 Specific groups that have shown particularly low participation rates in science have also been identified. For example, Baroness Greenfield's report on women in science, engineering and technology[21] found a range of barriers that prevented women from pursing higher education in these subjects and from entering, staying in and returning to, science careers. For example, the numbers of female science, engineering and technology (SET) graduates within SET occupations was just over 80,000 in 2002, compared with around 400,000 male graduates in SET occupations. The Government's response to Baroness Greenfield's report[22] set out a strategy to encourage participation of women in science, engineering and technology. As well as introducing some new initiatives such as a resource centre to support and advise SET employers and

[20] *Investing in Innovation: A strategy for science, engineering and technology*, July 2002

[21] *SET Fair - A Report on Women in Science, Engineering and Technology*, Baroness Greenfield CBE, November 2002

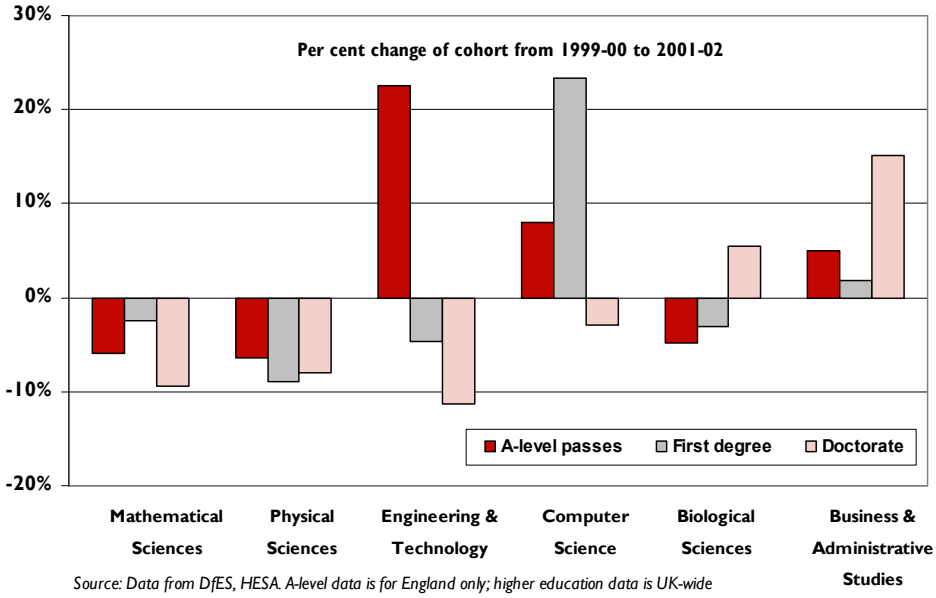
[22] *A strategy for women in science engineering and technology*, DTI & OST, 2003

professional bodies, the Government is ensuring that mainstream policies directed at women reach the SET sector and that these issues are taken into account in implementing Roberts' recommendations.

5.7 In addition to measures aimed at improving the supply from within the UK, the Government has also made progress on reducing the barriers to migration to the UK of those with higher level skills in demand here, including in science and technology areas. From summer 2004, international students in shortage science, maths and engineering subjects will be able to work for a year after graduating from UK institutions without the need for a work permit. Changes have also been made to the criteria for entry through the Highly Skilled Migrant Programme, to ensure that the scheme recognises the potential of younger applicants. The framework will also look at the flow of graduates between the UK's regions.

5.8 The Government believes that its actions will go some way to addressing the range of issues that the Roberts Review and Baroness Greenfield's report identified. Whilst implementation of Roberts' recommendations has not yet had time to make a full impact, the Government acknowledges that the scale of the challenge remains enormous. For example, since the Roberts Review reported, data have shown the proportion of students gaining any higher-level mathematical science and physical science qualification has fallen further, with accompanying falls in engineering and technology at degree and doctorate level and computer science at doctorate level[23].

Chart 5.2: Change in students gaining scientific or technical qualifications, 1999-00 and 2001-02



Source: Data from DfES, HESA. A-level data is for England only; higher education data is UK-wide

5.9 In addition to contributing to the science and engineering base, graduates in science, technology, engineering and mathematics are increasingly important to long-term UK growth as significant proportions move into other productive sectors, for example financial services, where employers demand highly numerical and analytical

[23] Engineering and technology A-level figures are for Design and Technology; Physical Sciences figures at A-level are the average of Chemistry and Physics subjects

employees. Recent evidence[24] suggests that it is the managerial, professional and technical occupational groups (including careers in science and financial services) that will see greatest industry expansion and hence the greatest future demand for increases in skilled employees.

5.10 Further to the Roberts Review, the Government launched the Smith Inquiry into post-14 mathematics education[25]. That inquiry has now reported and has identified three issues of major concern:

- a shortage of specialist mathematics teachers, particularly in England and Wales;
- the weaknesses in the current assessment and qualifications framework in England, Wales and Northern Ireland mean that the needs of many learners and the requirements of many employers and Higher Educations Institutions are not being met; and
- a lack of resources, infrastructure and a sustained continuing professional development culture to support and nurture teachers of mathematics.

5.11 The Smith Inquiry made a number of recommendations to tackle these concerns. The ten-year investment framework for science and innovation will take into account evidence and analyses in the Smith Inquiry that are relevant to its work. The Government will respond to the Smith Inquiry in due course.

5.12 The Government also asked Richard Lambert to consider the supply of skills from Higher Education Institutions to industry. The Lambert Review made recommendations on increasing the availability of graduate employment and other relevant data, enhancing the role of Sector Skills Councils in influencing university courses and curricula, and examining whether financial incentives should be provided to universities to stimulate the supply of certain courses. The Government would welcome further responses to Lambert's recommendations in the context of skills, science and innovation.

5.13 Poor skills levels have also hindered innovation performance. The UK is particularly weak in basic and intermediate skills. This delays innovations and investment programmes or hampers the transfer to full product development. UK managers are, on the whole, less well qualified than their counterparts in other countries. On average the culture within UK firms places less emphasis on creativity and this is influenced by management. The causes of this are not entirely clear. To address some of the issues, the DTI Innovation Report proposes to develop curriculum material with Business Schools to aid the teaching of skills for the management of high-tech, fast-growth businesses, and will support the DfES work to develop capacity in Centres of Vocational Excellence. In addition, and to tackle leadership and management issues more broadly, the Report of the Council of Excellence in Leadership and Management (May 2002)[26] identified the need to raise the skills of business leaders at all levels, and an extensive programme of work is now being taken forward jointly by the DfES, DTI and other partners. It would be helpful to hear views

[24] *Working Futures: National Report 2003-04*, Institute of Employment Research, University of Warwick, http://ssda.org.uk//pdfs/wf-national.pdf

[25] *Making Mathematics Count:: The Report of Professor Adrian Smith's Inquiry into Post-14 Mathematics Education*, February 2004 www.dfes.gov.uk/mathsinquiry/

[26] *Managers and Leaders: Raising our Game*; Report by the Council for Excellence in Leadership and Management, May 2002.

on leadership and management issues specific to new technology, research and innovation.

Q10 Following the 2002 review by Sir Gareth Roberts of the supply of scientists and engineers and the Government's response, what is the emerging evidence on the prospects for the supply and demand of science, technology, engineering and mathematics skills? What further steps could the Government take to ensure that the supply of these skills is responsive to the demands of the economy over the coming decade? How can women and other low participatory groups be more encouraged to pursue higher education in science, technology, engineering and mathematics and to pursue careers in these areas?

Q11 Do UK business leaders and managers have the necessary skills and knowledge to exploit new technology and research to maximum effect? Where are the areas of greatest weakness and opportunity in terms of sector size of enterprise and level of management? What can and should be done to bridge the gap?

SCIENCE AND SOCIETY

5.14 Science has an increasing impact on our everyday lives, from improving quality of life through technological advances, to high-profile media coverage of sometimes controversial subjects. It is important that the scientific community and Government engage in a dialogue with the public to increase public awareness and understanding of, and engagement with, the role of science in society. It is equally important for scientists – including the social sciences, which have a key role to play here - and policy makers to better understand public attitudes towards science and technology and to respect and address society's legitimate concerns and priorities. As the Prime Minister has said, we need "better, stronger, clearer ways of science and people communicating. The dangers are in ignorance of each other's point of view: the solution is in understanding them"[27].

5.15 The Office of Science and Technology's Science and Society Programme is working to bring science and society closer together through a range of activity, for example, promoting improved collaboration across Government and between the Research Councils; promoting public engagement in science (particularly by providing funding for the British Association for the Advancement of Science), promoting the participation in and role of women and ethnic minorities in science; and enthusing children and young people to appreciate both the benefits of pursuing science subjects in education and the potential offered by science careers. Research Councils also invest in their own science and society activities.

5.16 Research commissioned by the Office of Science and Technology[28] has shown that the public is not anti-science and recognises the benefits that science and technology bring to our lives and to the economy. However, there is a concern that one

[27] 'Science matters' speech, April 2002, www.number-10.gov.uk/output/Page1715.asp

[28] *Science and the public: A review of science communication and public attitudes to science in Britain,* Office of Science and Technology/Wellcome Trust., 2000.

of the principal risks to reaping the full benefits from the UK's investment lies within society's complex and ever changing relationship with science.

5.17 This in turn has the potential to inhibit the future development of science and innovation in the UK, to the detriment of public services and the economy. The Government wishes to ensure that science and its application can progress safely, with risks and benefits properly recognised, with effective regulation where necessary and with the public confident that this is the case.

5.18 It is vital that the relationship between science and society develops within the legal framework. The Government views the intimidation and harassment of scientists and businesses involved in legitimate research – many carrying out research into life-saving medicines - by a small number of animal rights extremists as a very serious matter. It has taken action against those involved and will continue to do so. The Government is determined that legitimate research can be conducted without intimidation or harassment.

5.19 A topical controversial area is that of Genetically Modified (GM) crops and food. It is important that decisions are underpinned by the best science available, properly evaluated. There may be reasons why we might not want to develop certain GM crops, for example because of problems of biodiversity. On the other hand, GM technology has a huge range of application and potential, not just in relation to food, but also in medicine. The Government will continue to make decisions on the basis of the best available scientific evidence, while recognising that people need to have confidence in the way Government does this, and confident that the Government is willing to discuss their interests and concerns with the technology as it develops.

5.20 The Government wants to create an environment where scientists have a clear licence to practise from the public, where there is a healthy supply of the brightest and best people for postgraduate and postdoctoral research in academia and industry in all key areas, where decision makers follow best practice in public engagement and in the commissioning, use and regulation of research and the resulting outputs, and where the public is confident about participating in decision making involving the use of science - and confident about the resulting decisions.

Q12 What should the role of Government be in improving the interaction between science and society? Are there areas where Government could improve the promotion of science in society? How can we improve public confidence in the Government's use of science? What should we be aiming to achieve in this area in the next ten years?

6 PARTNERSHIP FUNDING

6.1 The Government is one of many stakeholders in funding and using the UK research base. Other funders – business, charities, regional bodies and Government Departments – also need to play their part in investing in the science base. There are many examples of partnership working between funders of the science base – for example the joint commitments to infrastructure funding between Government and the Wellcome Trust, and the involvement of the English RDAs in the assessment of proposals for funding through the second round of the Higher Education Innovation Fund. The Government wants to see this partnership working increasing, to maximise the benefits of complementary investment. A Funders Forum was established last year, with representatives from business, charities and the Higher Education sector, to discuss issues of interest to stakeholders in the UK science base.

BUSINESS R&D

6.2 As set out in the executive summary, the Government's ambitions for UK science and innovation are focused on achieving some key attributes, which are ultimately addressed at improving business innovation and economic performance:

- **A continuing step-change in the responsiveness of the research base to the needs of the economy**. Better translation of the wealth of knowledge in the science base into innovation by business and the improvement of public services will bring benefits to the science base, Government, business and the economy as a whole. Universities and public laboratories must continue to develop a stronger programme of engagement with users on knowledge exchange, to create conduits for productive flows of ideas and people between research and its practical application. Government funding for the science base must fully recognise applied and business-relevant research as it does basic research. Businesses need to improve their links to and engagement with the science base; to access the raw materials needed to improve their innovative potential. Government's own research and development needs to be of high quality, and focused on improvements in public services. Synergies between different funders and the science base should be recognised and the complementarities maximised to improve the impact of research and funding.

- **Increased business investment in R&D, and engagement in drawing on UK research for ideas and talent**. Leveraging up the levels of business investment in R&D in the UK is crucial to increasing the innovation performance of the UK economy. More businesses need to engage with the science base, either directly or through intermediary bodies. More businesses need to adopt the practices of the best UK-based companies in creating and sustaining partnerships with a network of research teams, providing a productive means for companies to access the creativity and expertise in the UK science base. More businesses should become engaged in shaping the curricula at universities and schools to inspire and attract the next generation of trained personnel.

6.3 Business investment in R&D is a useful indicator of technology-based innovation, though of course innovation can take other forms (eg process improvement) and need not involve R&D. UK business investment as a share of GDP is

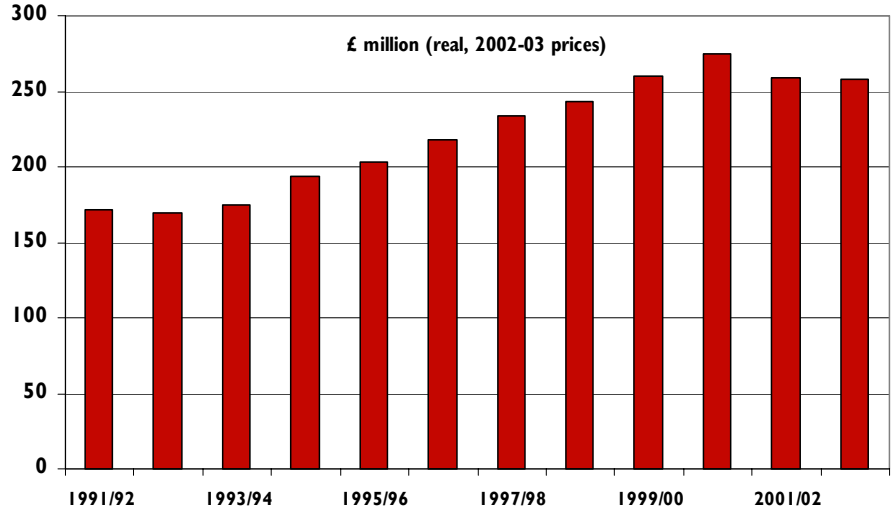
lower than in many of our competitor countries, and is largely concentrated in a few sectors. Given that business R&D tends to constitute the majority of gross expenditure on R&D in advanced industrial economies, this is cause for concern. It is estimated that differences in R&D spending (as a proxy for innovation performance) make up a quarter of the UK's productivity gap with the US.

6.4 Government encourages businesses to invest in R&D by:

- creating stable economic conditions and a supportive investment climate;
- ensuring a strong supply side, with skilled personnel and a sustained output from the science base; and
- stimulating demand conditions, so that more firms face stronger incentives to apply R&D to their businesses, to innovate, compete and grow.

6.5 Business also invests in the science base, an investment which has been increasing over the last decade, with research grants and contracts in HEIs rising steadily from £169 million in 1992-93 to over £270 million in 2001-02, a year on year increase of 6 per cent. The nature of business investment ranges from contract research to establishing research centres at an institution, and sponsoring students. Strategic investment by business in conjunction with the science base is an important component of an overall investment framework.

Chart 6.1: Research grants and contracts income from industry, commerce and public corporations received by UK Higher Education Institutions



Source: Higher Education Statistics Agency (1994-2003), Universities Funding Council Statistical Record (1991-1994), Polytechnics and Colleges Funding Councils Finance Record (1991-1994)

6.6 As the Lambert Review showed, there are also potentially big gains to be realised by business, universities and the economy as a whole from greater collaboration between academia and business to translate ideas into new products and processes.

Q13 What is the outlook for business investment in R&D over the next decade? How can business investment contribute to the success of a ten-year framework for science and innovation?

6.7 Charities are now major funders of the science and research base. In 2001-02 they invested over £600 million in research grants and contracts in Higher Education Institutions, almost double the level of funding in 1994-95. Much of this funding is delivered in partnership with other funders, and represents a key contribution to both strategic and targeted research programmes and facilities.

MEDICAL RESEARCH

6.8 Research in the NHS is crucial to supporting the Government's health modernisation agenda, and to delivering better, more personalised services to patients. Over many years, the NHS has provided an authoritative and expert resource for the conduct of both national and international clinical studies. However the recent reports of both the Biosciences Innovation and Growth Team (BIGT)[29], and the Academy of Medical Sciences[30], stress that the NHS could do even better for patients in relation to the evaluation and adoption of new science-based approaches to the prevention, diagnosis and treatment of disease. They call for a boost to the broad area of clinical research in order to strengthen the effective and efficient translation of scientific advances into patient care. Such a boost could also promote the recruitment and retention of healthcare professionals into the NHS, and greatly encourage the bioscience and pharmaceutical industries to maintain and increase their R&D activities in the UK. Both industry sectors recognise the strength of the NHS and the key role it plays. Such a strengthening of clinical research would achieve the twin benefits of improving national health and increasing national wealth.

6.9 The problems are not peculiar to the UK, or the NHS, since all health care systems and research institutes in Europe, North America and Australasia have similar problems. The NHS, however, provides an opportunity for equality of access to high quality care for the entire population as well as unparalleled opportunities for clinical research that are greater than those of any other country.

6.10 Although the Medical Research Council (MRC) and Department of Health are the largest contributors in the public sector, there are many other funding sources for medical research in the UK[31]. Charity investment is a crucial component of UK investment in medical research: the combined investment of the medical charities is around £540 million per annum, which is more than the MRC budget and the same as the amount the Department of Health spent in England through its policy research programme and NHS R&D programme in 2002-03. Industry is the largest research funder: according to the Association of the British Pharmaceutical Industry, some 40 per cent of industry spending on pharmaceutical R&D is in the clinical phases – i.e. on patients rather than in laboratories. This key contribution from both industry and the medical charities make it even more important that synergies are developed with the delivery of health benefits through research carried out by the NHS, Department of Health, and their Devolved counterparts, the MRC and other public sector funders. The

[29] www.dti.gov.uk/sector_biotechnology.html

[30] "*Strengthening Clinical Research*", October 2003, http://www.acmedsci.ac.uk/p_scr.pdf

[31] NHS funding for research and the Higher Education Funding Councils is devolved; the Research Councils, including the MRC, have a UK-wide remit

Department of Health is currently conducting a review, involving research partners, to develop practical proposals for improving patient benefits from research; final recommendations from this review are due in April 2004.

6.11 The Government would be particularly interested in views from universities, the NHS, charities and industry on how well their partnership in medical research works in practice, and what, if any, changes would be desirable to improve the effectiveness of partnership working. Views are also welcome on the scope for more partnership funding in generic areas like skills development, including how this might work, and what additional benefits and resources it would bring. On an institutional level, it would be helpful to understand whether there are ways in which Government support for medical research could be better structured in order to maximise the benefits of investment from our partners in industry and the charity sector, and, as a result, to optimise health outcomes and the economic rewards of leadership in this crucial area of research.

6.12 The second Wanless Report, Securing Good Health for the Whole Population, published in February 2004[32], recommended that, as a part of the development of a ten-year framework, public health research capacity should be examined, as well as the links between academics and deliverers of public health. It asked that this work also consider the role of the various research bodies in relation to public health and how they can best work together to identify and address gaps in public health research, to ensure the public health research requirements of England are met in a structured and coherent way.

6.13 Progress is also being made with regard to commercialising innovations arising from work in the NHS. Nine Regional Innovation Hubs for the NHS in England have been funded, primarily by the DTI and Office of Science and Technology, and via the Public Sector Research Establishments (PSRE) Fund and the Department of Health, to manage the commercialisation of innovations arising from within the NHS. Three further Hubs are seeking funding to complete a network of 12 NHS Innovation Hubs located throughout England.

Q14 What are the research aspirations and funding plans of the medical charities over the coming next decade? How best can Government and charity funders work together to enhance the impact of their complementary research efforts on national and global health outcomes and contribute to the development and maintenance of a sustainable UK science base?

Q15 Are there ways in which Government support for medical research – in terms of both institutions and the distribution of funding - could be better structured in order to maximise the benefits of investment from partners in industry and the medical charities? What should Government and the NHS be doing over the ten years of the science and innovation framework to ensure successful partnership working in medical science?

[32] http://www.hm-treasury.gov.uk/consultations_and_legislation/wanless/consult_wanless04_final.cfm

Q16 In light of the second Wanless Report, where are the weaknesses in public health research capacity? How can we improve the links between academics and deliverers of public health, to ensure a strong evidence base both on causality and on effective, well targeted interventions? How should the roles of the various research bodies be better coordinated in relation to public health, to ensure that public health research requirements are met in a structured and coherent way?

7 Science and research across Government

7.1 Science and technology can offer innovative solutions to many of the national challenges we face. In particular, Government through its many policy and delivery functions must use high quality science and research, and expert and independent advice, to deliver evidence-based policies and excellent public services. That is why departments spend significant sums of money on research and development: an estimated £4.2 billion in 2002-03, with some £1.8 billion of this spent by civil departments.

7.2 Energy and environmental issues, for example, will present major challenges in the 21st Century, and science and engineering are an essential part of the solution. The Government invests in environmental research and innovation, including through the Research Councils and the Carbon Trust, and is at the forefront of international efforts to tackle climate change, making clear the UK's commitment to a path to reduce carbon dioxide omissions by some 60 per cent below 1990 levels by around 2050. To achieve this, a radical shift will be needed from our current reliance on fossil fuels to a low carbon economy. We will need to see a doubling of the rate of improvement in energy efficiency compared to that of recent decades and far greater use of renewable technologies such as wind, wave, biomass and hydrogen. Investment in research, development and the demonstration of new technologies will be key to achieving our energy goals.

7.3 The 2002 Cross-Cutting Review of Science and Research set out the Government's approach to science across Government[33]. As part of the ten-year investment framework for science and innovation, we will also be considering the underpinning knowledge resource that Government departments will need in future as an input into their areas of policy responsibility, among public service providers and in the wider economy, as well as strategies for stimulating the maximum economic benefits from this research.

7.4 The Government has taken a series of measures in recent years to strengthen the ability of departments to plan and conduct research, to exploit where appropriate the outputs of such research, and to make proper use of expert knowledge. These include:

- a reversal of the decline in the 1980s and 1990s in civil R&D expenditure;
- Chief Scientific Advisors appointed by all Government departments with significant research spend, and Science and Innovation Strategies developed, costed and subject to external scrutiny; and
- the implementation of the Baker Report[34], which recommended steps to be taken in encouraging the commercialisation of research from Public Sector Research Establishments.

7.5 As a result of these reforms, most departments can now demonstrate that they have in place the mechanisms necessary for the sophisticated use and management of science and research. Looking forward, the Government must ensure that departments remain well placed to exploit the opportunities that science and technology have to

[33] Cross-Cutting Review of Science and Research: Final Report, DFES, OST, DTI, HM Treasury, March 2002

[34] www.hm-treasury.gov.uk/documents/enterprise_and_productivity/research_and_enterprise/ent_sme_baker.cfm

offer, and that they have a clear idea of what their science and innovation priorities should be, both now and in the future.

Q17 What are the public service objectives and priorities for science and research over the next decade, to contribute to policy development, service delivery and the wider economy? How can the wealth creation potential of investments R&D across different Government programmes be increased?

Q18 How can Government best secure greater synergies between research funding and strategies across different public programmes, and link the Government's overall objectives for research outputs with the capabilities in the UK science base?

R&D ACROSS THE UK'S REGIONS AND NATIONS

7.6 Meeting the Government's objectives of increased prosperity and reducing the gaps between regions requires partnership working between national government and the regional development agencies. Regional bodies, particularly the RDAs in England and similar bodies in the Devolved Administrations, have played an increasingly active role in the area of science and innovation in the past few years. In 2002-3, the English RDAs invested an estimated £240 million in science and innovation-related activities. The Government welcomes the value that RDAs can add in supporting private investment in scientific research, and facilitating linkages between local businesses and universities, and would like to see this develop further, for example in the implementation of the recommendations of the Lambert Review. Most RDAs have identified science and innovation as high priorities in their economic strategies, recognising the benefits it can bring and the potential for attracting investment. All English regions now have, or are establishing, similar bodies to the northern RDAs' Science and Industry Councils, which will also play a useful role in bringing together local and regional stakeholders.

7.7 In Scotland, the Scottish Executive is taking forward the science agenda energetically under a programme of commitments in its *"Science Strategy for Scotland"*, published in 2001[35]. The strategy strongly underlines the need to harness better the benefits of science for Scotland's future economic success and quality of life. Many initiatives, including most of the effort to boost commercialisation activity, are being taken forward under devolved powers by the Scottish Executive, Scottish Enterprise and the Scottish Higher Education Funding Council. This includes development of three Intermediary Technology Institutes in digital tech-media, biosciences and energy, and increased strategic collaboration between Scotland's Higher Education sector, the NHS, and Scottish and UK Research Institutes to develop critical mass in key strategic areas. The Scottish Executive fully recognises that the science agenda in Scotland needs to work with the grain of developments and funding at a UK level.

7.8 In Wales, the Welsh Assembly Government, in conjunction with the Welsh Development Agency and the High Education Funding Council for Wales, is strongly driving the knowledge exploitation agenda forward as part of its "*Wales: A Better*

[35] http://www.scotland.gov.uk/library3/education/ssfs-00.asp

Country"[36] and associated strategies. Recognising that economic success is boosted by university excellence married to dynamic companies, stronger bonds are being forged between the two through a range of programmes including the major and unique "technium centres" and knowledge exploitation fund initiatives.

7.9 In Northern Ireland, Invest NI[37] offers a portfolio of regional R&D programmes, covering everything from large scale R&D infrastructure projects, through pre-competitive R&D and near-market product and process development, to technology transfer support mechanisms and various advisory services. The Regional Innovation Strategy for Northern Ireland, published in 2003, identified the lack of "pre-seed funding" as restricting the creation of hi-tech spin-outs from the higher education sector. Invest NI addressed this gap by establishing a new "Proof of Concept" fund in December 2003. Invest NI and the Department for Education and Learning, which funds the higher education base, work closely in partnership. Joint initiatives include the EU funded "RTD Centres of Excellence" programme, set up to enhance Northern Ireland's reputation for technological excellence and its appeal to high-tech inward investors. A total of 18 company and university-based Research & Development centres have been allocated funding under the programme, representing a total public/private investment in the local economy of around £120 million over 3 years.

7.10 Funding science research on the basis of excellence, wherever it occurs, is a fundamental part of the Dual Support system; this does not lend itself to regionalisation. However, when considering knowledge transfer, business-university collaboration, network building and information sharing, capacity and funding at a regional level may most effective. Coordinating national and regional initiatives and funding so that the two are complementary and each is able to play its full role in the partnership is a challenge for both Government and the regions.

Q19 How can the Government and the Regional Development Agencies and their equivalents in the Devolved Administrations help integrate funding of science research on a predominantly national basis with development and delivery of regional economic strategies? In particular how can Government and RDAs strengthen partnership working to facilitate more effective knowledge transfer and research collaboration?

R&D ACROSS EUROPE

7.11 Innovation is vital to improving the flexibility and performance of the EU economy, tackling the challenges which Europe set itself at the start of this decade through the Lisbon agenda. In 2002, EU Member States at the Barcelona Spring Council set an aspirational target for R&D investment to rise towards 3 per cent of EU GDP by 2010, including both public and private investment. This was followed by the R&D Action Plan adopted by EU leaders in March 2003 to support progress towards this goal[38]. This target is likely to prove challenging even for those countries where R&D investment has significantly increased in recent years. The aim is for two-thirds of this investment to come from the private sector, highlighting the importance of business commitment to investment in R&D as well as Government action.

[36] http://www.cmo.wales.gov.uk/content/work/wbiw/wales-a-better-country-e.pdf

[37] A Non-Departmental Public Body sponsored by the Department of Enterprise, Trade and Investment

[38] *Investing in research: An action plan for Europe*, COM (2003) 226 final/2, April 2003.

7.12 As described below, the UK, French and German governments recently set out joint proposals for improving innovation performance across Europe, emphasising the contribution of national programmes operating within a more flexible European regulatory framework[39].

Towards an Innovative Europe: next steps in raising EU innovation performance

Improving innovation performance is central to the Lisbon goal for the EU to become the most competitive and dynamic knowledge-based economy in the world by the end of the decade. Despite current efforts, however, the innovation performance of the EU remains poor relative to that of a number of its major international competitors. Tthe US, for example, performs significantly more strongly on a number of indicators of innovative activity such as patenting and the provision of early stage venture capital. It is therefore important that efforts to increase investment in research and development are backed by wider action to tackle the structural barriers to innovation itself.

To address this challenge, the Finance and Industry Ministers of the UK, France and Germany recently submitted a joint paper to the European Commission and other Member States setting out a range of priority actions to strengthen intellectual property regimes, raise levels of scientific skills, reduce the regulatory burden faced by innovative companies, strengthen the links between science and industry, improve access to finance, and secure greater value from EU research funding.

The paper listed a number of priorities for action at Community level, including:

- a review of the state aid framework to ensure that the R&D and venture capital guidelines are properly designed to allow Member States to address the market failures that inhibit innovation;
- improvements in the regulatory process to reduce the administrative burden on innovative companies;
- steps to ensure strong and effective competition throughout the EU, combined with action to ensure that the application of competition policy does not inhibit the dissemination of innovative ideas through intellectual property-sharing agreements between companies;
- measures to improve Framework Programme design and administration in order to reduce complexity, and to enhance researcher mobility and business-university collaboration, including private sector inter-company mobility;
- rapid progress on legislative actions to support and clarify the IP framework, including the Community Patent, ensuring that the outcomes strike the right balance between the needs of businesses and consumers; and
- prioritisation of industrial R&D projects within the European Action for Growth initiative, especially in key cross-sectoral technology areas with the potential to have pervasive, long-term impacts, such as biotechnology, micro- and nano-technologies, and telecommunications.

7.13 Increasingly many research problems and priorities do not end at national boundaries. Collaborative programmes between countries (including between universities and businesses) and EU funded projects are useful ways to address this.

[39] *Towards an innovative Europe*: A paper by the French, German and UK Governments, January 2004.

European and international collaborations of this kind raise their own challenges, including negotiating often-complex processes. This makes it important to consider both the balance of and coordination between international and national strategies.

7.14 Framework Programmes are the European Union's main instrument for research funding in Europe, with participation open to all organisations engaged in research, including businesses, research institutes and academia. The Sixth Framework Programme (FP6), which became operational in January 2003 and will run until 2006, has been designed to support the establishment of an European Research Area, with the bulk of funding designated to the promotion of research networks, collaborations and integrated projects, giving research consortia greater flexibility and autonomy. The overall budget of €19.2 billion will contribute to the Barcelona aspiration to raise overall levels of investment in R&D.

7.15 EU support is allocated on a shared cost basis, whereby some of the costs of projects are covered by participating institutions. This principle is intended to align EU R&D projects with the organisation's wider aims. As the UK moves towards funding a greater proportion of research costs directly, it is necessary to consider whether the different approaches might create barriers to international collaboration.

7.16 To assess the priorities for the next Framework Programme (FP7), due to start in 2007, a formal public consultation of the research community and industry will begin in Spring 2004. The Government has also commissioned its own external evaluation of existing Framework Programmes to inform the UK position on FP7.

Q20 Are there barriers facing business and the science base in effective engagement with EU research programmes? How can the UK more effectively influence and benefit from EU research funding and policies? In what ways can action at Community level add value to UK science and innovation policies? How can national and community funding complement each other more effectively?

8 SUMMARY OF CONSULTATION QUESTIONS

EXECUTIVE SUMMARY

Q1 Are these the right areas for the Government and its partners to target over the next ten years? What are the underlying components of success in these areas and what roles do Government and other funders of the science base need to play in achieving these aims?

UK SCIENCE: PERFORMANCE AND IMPACT ON INNOVATION

Q2 Which strengths of the UK science base could be further developed; what are the weaker areas that need to be addressed; and what are the risks to the UK's continued production of internationally competitive levels of research? What criteria should the Government use to help determine its overall commitment to science?

Q3 In which key technology-based sectors does the UK have the potential to maintain and grow internationally competitive value added over the coming decade? What are the barriers to capitalising on our strengths and addressing areas of relative weakness in business innovation and R&D? How can investment in the UK science base and Government support for business R&D best contribute to that growth?

Q4 In order to inform decisions on the future investment framework, and building on the Research Councils' extensive consultations with stakeholders, in what areas are there opportunities for the UK research base to excel and contribute to the economy and society, which might form the basis of future strategic research programmes over the next ten years?

MANAGEMENT OF THE SCIENCE BASE

Q5 In the light of the changes to be made to the next RAE, how can funding mechanisms build on existing resources and research assessment reforms to reward excellence and underpin sustainability?

Q6 What are the main barriers or challenges to the achievement of a sustainable public research base in the medium term? What further action could the Government take, in partnership with universities and other funders of research, to create robust incentives on all parties to work together to deliver greater financial sustainability of the UK's research base?

Q7 How could funding for universities provided by Government and other funders create stronger incentives for the effective creation management and usage of the research base infrastructure over the next decade?

Q8 What is the optimal means of developing access to large research facilities at national and international level? How should funding of large facilities be prioritised?

KNOWLEDGE TRANSFER AND THE LAMBERT REVIEW

Q9 The Lambert Review was based on extensive consultation during 2003. Reactions to the analysis and proposals set out by the Lambert review, and in particular to the Government's proposed response, are very welcome.

EDUCATION, SKILLS AND PUBLIC ENGAGEMENT WITH SCIENCE

Q10 Following the 2002 review by Sir Gareth Roberts of the supply of scientists and engineers and the Government's response, what is the emerging evidence on the prospects for the supply and demand of science, technology, engineering and mathematics skills? What further steps could the Government take to ensure that the supply of these skills is responsive to the demands of the economy over the coming decade? How could women and other low participatory groups be more encouraged to pursue higher education in science, technology, engineering and mathematics and to pursue careers in these areas?

Q11 Do UK business leaders and managers have the necessary skills and knowledge to exploit new technology and research to maximum effect? Where are the areas of greatest weakness and opportunity in terms of sector size of enterprise and level of management? What can and should be done to bridge the gap?

Q12 What should the role of Government be in improving the interaction between science and society? Are there areas where Government could improve the promotion of science in society? How can we improve public confidence in the Government's use of science? What should we be aiming to achieve in this area in the next ten years?

PARTNERSHIP FUNDING

Q13 What is the outlook for business investment in R&D over the next decade? How can business investment contribute to the success of a ten year framework for science and innovation?

Q14 What are the research aspirations and funding plans of the medical charities over the coming next decade? How best can Government and charity funders work together to enhance the impact of their complementary research efforts on national and global health outcomes and contribute to the development and maintenance of a sustainable UK science base?

Q15 Are there ways in which Government support for medical research – in terms of both institutions and the distribution of funding - could be better structured in order to maximise the benefits of investment from partners in industry and the medical charities? What should Government and the NHS be doing over the ten years of the science and innovation framework to ensure successful partnership working in medical science in the long term?

Q16 In light of the second Wanless Report, where are the weaknesses in public health research capacity? How can we improve the links between academics and deliverers of public health, to ensure a strong evidence base both on causality and on effective, well targeted interventions? How should the roles of the various research bodies be better coordinated in relation to public health, to ensure the public health research requirements are met in a structured and coherent way?

SCIENCE AND RESEARCH ACROSS GOVERNMENT

Q17 What are the public service objectives and priorities for science and research over the next decade to contribute to policy development service delivery and the wider economy? How can the wealth creation potential of investments in R&D across different Government programmes be increased?

Q18 How can Government best secure greater synergies between research funding, investment and strategies across different public programmes, and link the Government's overall objectives for research outputs with the capabilities in the UK science base?

Q19 How can the Government and the Regional Development Agencies and their equivalents in the Devolved Administrations help integrate funding of science research on a predominantly national basis with development and delivery of regional economic strategies? In particular how can Government and RDAs strengthen partnership working to facilitate more effective knowledge transfer and research collaboration?

Q20 Are there barriers facing business and the science base in effective engagement with EU research programmes? How can the UK more effectively influence and benefit from EU research funding and policies? In what ways can action at Community level add value to UK science and innovation policies? How can national and community funding complement each other more effectively?