THE ROYAL SOCIETY

Developing a National Strategy for Science

A submission to the inquiry by House of Commons Science and Technology Committee into the impact of the 1993 White Paper *Realising Our Potential: A strategy for science, engineering and technology*

Summary

- The statement of aims in the Government's 'Science and Innovation Strategy' consultation document is too narrowly focused on certain aspects of the role of science in wealth creation, and lacks the breadth of intentions required for a national science strategy.
- In order to ensure and maintain the excellence of the UK's Science Base, a strong commitment to improving academic pay and conditions and investing in infrastructure is required, ideally through a plurality of funding sources.
- It will be difficult to arrest and reverse the damaging drop in expenditure on research and development by Government Departments unless each Department regards support for a world class Science Base to be part of its mission, and invests accordingly.
- The most important asset and output of the Science Base is skilful and knowledgeable people, and this must be made clear in a national strategy for science.
- The Government must recognise in a national strategy for science that the aims of wealth creation and improving quality of life are both vitally important.
- A national strategy for science should include as an aim the promotion of a dynamic interaction between scientists and the rest of society.

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Introduction

The Royal Society welcomes the opportunity to contribute to this inquiry. This submission has been prepared by a working group chaired by Professor David Wallace CBE FRS (Vice-Chancellor, Loughborough University) and consisting of Dr Jonathan Blackburn (Dept of Biochemistry, University of Cambridge), Professor Michael Brady FRS (Dept of Engineering Science, University of Oxford), Professor Julia Higgins CBE FRS (Dept of Chemical Engineering, Imperial College of Science, Technology and Medicine), Dr Steve Howdle (School of Chemistry, University of Nottingham), The Lord Hunt of Chesterton (Dept of Space and Climate Physics, University College London), Sir John Kingman FRS (Vice-Chancellor, University of Bristol), Professor Anthony Ledwith CBE FRS (Chairman, Engineering and Physical Sciences Research Council), Sir John Skehel FRS (National Institute for Medical Research, Mill Hill, London), and Dr Michael Stowell FRS (Dept of Materials Science and Metallurgy, University of Cambridge), with support from Dr Mark Scott (Royal Society), Mr Bob Ward (Royal Society) and Ms Kirsty Brown (Royal Society). The submission has been endorsed by the Council of the Royal Society.

Although the Committee has identified a number of questions to which it is seeking answers (see Appendix), this submission focuses on two questions:

- *Do you agree that the aims listed in the Government's recent consultation document on 'Science and Innovation Strategy' are appropriate for a national strategy for science?*

- *What do you believe should be the main features of a modern strategy for science, engineering and technology, and why?*

Aims of a national science strategy

We note the following statement from the 'Science and Innovation Strategy' document:

Innovation is the successful exploitation of new ideas, products, materials, techniques and processes. It covers new ways of performing old tasks, new ways of using old materials and new working methods in long established businesses, in manufacturing and services. Poor performance in innovation has long been a problem in many parts of UK industry. The Government now plans to tackle that problem through action to:

- *sustain the excellence of the science and technology base;*

- *encourage private investment in innovation;*

- *streamline knowledge transfer schemes and focusing them on clear goals;*

- *foster regional networks;*

- *improve the flow of skilled scientists and engineers to industry;*

- *improve the ability of the science base to play a role in the knowledge economy;*

- *take advantage of the globalisation of research; and*

- *improve public confidence by creating greater transparency in the regulation of science.*

This statement lacks the breadth of intentions that was encapsulated in the strategy outlined in paragraph 8.2 of *Realising Our Potential*. The new aims are too narrowly focused on certain aspects of the role of science in wealth creation, and neglects other important goals. We identify here some of the most important omissions.

The Science Base

We welcome the stated commitment to ensuring and maintaining the excellence of the UK's science base. But if the Government is to translate its good intentions into real outcomes, there are two issues that it must face.

It is our conviction that problems with pay are arising in almost all grades within UK academia and that uncompetitive salaries are making it more difficult for higher education institutions (HEIs) to recruit and retain the best scientists. The HE sector has achieved the substantial growth in student numbers during the last decade through increased productivity: between 1989-90 and 1997-98 the unit funding per student declined in real terms by 35%. Despite these efficiency gains, staff salaries have continued to decline against those of similar professional groups. Under the current funding

[1]References in this document to 'science' mean 'science, engineering and technology', unless otherwise indicated

arrangements for the sector, HEIs are now expected to make further efficiency gains of one per cent each year, against inflation, with a larger gap against national salary increases. These constraints make it difficult for universities and colleges to tackle the problem of pay. Additional funding will be required from public and other sources to ensure that HEIs can recruit and retain the right calibre of staff required to preserve the UK's world class Science Base.

But competitive pay and conditions are not the only factors required to attract the best scientists to the UK Science Base. World class scientists require world class equipment and facilities. Sadly, the infrastructure of the Science Base, relative to the number of people it supports, has suffered a perilous decline because of acute under-investment. The creation of the Joint Infrastructure Fund (JIF) following the Comprehensive Spending Review provided much needed funding to tackle the years of neglect of laboratories and equipment. The injection of such sums of money is very welcome, but their appearance after so many years of under-investment has not been without cost. The percentage of applications to the JIF which have been supported has been low, so that HEIs have diverted significant resources towards the preparation of substantial numbers of unsuccessful bids. In a number of cases, when a bid has been successful, the award of funding has been made as partial contribution towards a particular facility and without due regard for the bidder's strategic priorities. Consequently some HEIs have had to divert their hard-pressed financial resources towards lower priority facilities in order to cover the shortfall from the JIF awards.

The decline in the Science Base's infrastructure has occurred over a long period, and can not be remedied overnight. World class infrastructure requires substantial funds on a continuous basis. A national strategy for science must include a long-term plan for ensuring appropriate investment in infrastructure, and we expect JIF to signal the beginning, not the end, of this process. The strategy must consider where this investment is best directed. For instance, in future JIF should be administered in a way that recognises more explicitly the strategic objectives of individual HEIs and an overall national strategy. And as the recent experience of the process of site selection for the DIAMOND synchrotron source has illustrated, the Government should also develop a clear strategy for building and maintaining major facilities.

Given the difficulty of consistently selecting good research and good researchers for funding, and the explicit and implicit constraints imposed by the selection criteria for any funding line, the Science Base is in principle strengthened by having a plurality of funding sources, mechanisms and criteria. Each funding source has its own set criteria. What is essential for the overall health of the Science Base is that the various funding sources reinforce each other. What has actually been happening is that one source (the Funding Councils) provides the infrastructure (meaning here salaries of core staff, buildings, routine consumables etc rather the major items funded by JIF) and the others (Research Councils, other streams of Government funding, sources from the European Union, charities and industry) provide project funding; but, over the years, project funding has greatly outgrown infrastructure funding and the whole system is now under massive pressure as a result. The balance between the various funding sources, and the health of the system as a whole, need careful monitoring. It may be that the traditional separation of infrastructure and project funding needs to be reconsidered.

Support for the Science Base by Government Departments

Other Government Departments do not regard support for the Science Base as part of their missions. The sharp decline in expenditure on research and development (R&D) by the civil Departments, excluding the Science Budget and funding through the Higher Education Funding Councils, over the last 15 years suggests that not all, if indeed any, Departments now believe that they should contribute to sustaining a world class Science Base. R&D expenditure by the civil Departments (excluding the NHS) is projected to be 52% lower, in real terms, in 2001-02 than it was in 1986-87. Coupled with the drop in defence R&D expenditure, this means that the proportion of UK R&D funded by Government has fallen from 35.4% in 1988 to 30.8% in 1997. This figure is lower than for any other G7 country except Japan (and there the figure has risen from 16% in 1991 to 21% in 1995). It is not evident that such a policy is in the interest of the UK.

In 2001-02, R&D expenditure by the Ministry of Agriculture, Food and Fisheries is planned to be 34% less in real terms than in 1986-87, and the Department of Trade and Industry plans to spend 66% less than the combined expenditure of the Department of Trade and Industry and Department of Energy in 1986-87. Without examining in detail the R&D policies of each Department, it is impossible to judge how far these expenditure trends reflect Foresight priorities or Ministerial objectives, let alone whether they are in the best interests of the UK. But the net outcome of these individual decisions, coupled with the investment decisions made in the industrial sector, is that the UK spent only 1.80% of its gross domestic product on R&D in 1997, compared with 2.09% in 1993, the year in which *Realising Our Potential* was published. We believe that the UK's R&D expenditure is currently too low for a country trying to compete globally in a knowledge-driven economy.

There are well known arguments for associating R&D budgets for specific purposes (eg health, agriculture, environment, etc) with the Departments charged with overall responsibility for those purposes. Equally familiar are the reasons why such a policy, coupled with traditional Whitehall territoriality, makes it difficult to deliver a single coherent approach to Government expenditure on R&D as a whole. This has been exacerbated in recent years by the practice of relying on 'internal markets' within each Department to drive the use of departmental R&D budgets: it has become all the harder to influence these budgets from the outside. Within each Department, there needs to be a strong group defending the R&D budget and using it effectively. This must be linked to a strong voice for R&D at cabinet level.

It will be difficult to arrest and reverse this damaging drop in R&D expenditure unless each Government Department accepts that its policy objectives depend upon a world class Science Base. Each Government Department should then include support for a world class Science Base in its Mission, and should invest accordingly. This far-sighted approach, if acknowledged in a national strategy for science, would help the Departments to achieve other parts of their Missions. Many Departments turn to the Science Base for policy guidance. This will be available only if the UK Science Base is diverse and healthy enough to nurture new ideas and to stay at the forefront of global developments in science.

The role of the Office of Science and Technology and advisory bodies

The Office of Science and Technology has a pivotal role in advising on departmental R&D spend and in co-ordinating such expenditure across Government. We believe that OST has achieved significant progress, notwithstanding the low overall level of investment in R&D, with these roles in recent years, for example in setting in place co-ordinating machinery at Ministerial and at official levels. We note with interest the establishment of the Chief Scientific Adviser's Committee, which, among other things, provides collective advice to Ministers through the Ministerial Science Group. It is clear that the new Committee faces major challenges in improving the handling of issues that affect several Departments.

We also wish to draw attention to the importance of the Director General of Research Councils (DGRC) having access to independent advice. *Realising Our Potential* stated that "the Director-General will be advised by a small standing group of independent experts selected to allow him or her to draw upon the requisite scientific, economic, industrial and management expertise in considering the baseline programmes, corporate plans, longer-term prospectuses, and performance of the Research Councils". The establishment of such a group would assist the DGRC in his efforts towards the achievement of the aims of a national strategy for science.

It is difficult to assess the impact of the Council for Science and Technology, which replaced the Advisory Council on Science and Technology after publication of *Realising Our Potential*. It may be beneficial to make more widely known the role of the CST and how it relates to the other bodies advising Government.

This seems like several advisory bodies doing quite closely related tasks. It may be timely to review whether a degree of collaboration, or even merger, would improve the overall effectiveness of the system.

The Science Base's most important asset and output: knowledgeable and skilful people

The most important asset of the Science Base is inventive, knowledgeable and skilful people, and this must be made clear in a national strategy for science. To ensure that a steady flow of people enters the Science Base, science must pervade all levels of the formal and informal education system. The critical first step is to enthuse the young about science.

Science education provides pupils with knowledge of the natural world, the skills of investigation and experimentation, and an appreciation of the importance of science to individuals and society. Science can also develop such personal skills as curiosity, motivation, teamwork and the ability to communicate. These skills and values help prepare pupils for further study and a broad range of careers, as well as providing a basis for informed citizenship.

Scientists and engineers from both academia and industry have an important role to play in supporting the professional development of science teachers and giving pupils an accurate image of life in science, providing ideas, resources and real contexts for science activities. Partnerships between active scientists and schools can yield significant benefits for teachers, pupils and the scientists themselves.

But the teaching of science should not be regarded only as a means of meeting the needs of the Science Base and industry. A high level of scientific literacy among a wide

range of people will allow society to understand and appreciate the benefits and limitations of science, an increasingly important feature of a modern democracy. A flow of talented people into universities and colleges ensures the high quality of the output from the Science Base, in the form of skilled scientists and knowledge, on which successful industry is so dependent. Four further points need to be considered.

First, the flow between the Science Base and industry has been helped by initiatives such as collaborative research grants, engineering doctorate centres, industrial CASE awards, Faraday centres and special funding for PhD students to spend an additional year in industry. The Government's emphasis on lifelong learning is also particularly relevant for scientists and engineers, given the pace of technological change. We welcome initiatives such as the Higher Education Reach-out to Business and the Community Fund, jointly established by the Higher Education Funding Council for England, the Department of Trade and Industry, the Department for Education and Employment and the Department of Education Northern Ireland, and the concept of flexible postgraduate training accounts pioneered by the Engineering and Physical Sciences Research Council. Such schemes should be expanded.

Second, the Science Base has a proud record of serving the needs of industries based on physical and biological sciences, and of contributing to the UK's quality of life, not least through developments in the medical and plant sciences. Increasingly, scientists and engineers will be of value in the financial services, leisure and creative industries.

Third, it is valuable to have flows of people in many directions. The Science Base needs a flow of knowledgeable people from industry, so that there is free exchange of ideas between industry and HEIs. There are numerous cases, particularly in information technology, where people educated in the humanities or social sciences have become skilled in science. We welcome this and believe that a national strategy for science should encourage schemes to support the retraining of people to provide them with scientific knowledge.

Finally, *Realising Our Potential* identified another significant problem with the flow of knowledgeable people to and from the Science Base. It stated:

Women are the country's biggest single most under-valued and therefore under-used human resource. The Government believes that there is massive scope to attract more women into science and engineering.

This problem was examined in more detail in *The Rising Tide* in 1994. Although there have been some attempts to address the factors preventing women from realising their potential in science at all levels, much more needs to be done. A national strategy for science must address this issue, and it would be timely for the Government and the scientific community to consider together what progress has been made since publication of *The Rising Tide*, and what further action needs to be taken.

Wealth creation, innovation and the Science Base

Basic research can and does contribute to innovation in ways that are often unforeseen and science is a basis for more innovation in industry and commerce than is generally recognised. The Research Councils have taken forward the need to support wealth creation in industries drawing upon classical disciplines such as the physical and biological sciences. However, the very essence of much innovation today is that it does not fall into classical categories, yet it still needs to be underpinned by the science base. A national strategy for science must address the need to invest in basic research in new disciplines and across disciplines and the application of ideas from the science base to non-traditional areas such as financial services, even though these are not naturally represented by one of the Research Councils. To this end, we welcome the recent emphasis on initiatives across Research Councils, and would encourage their expansion.

Technology Foresight, re-launched as Foresight on 1 April 1999, is intended to promote links between business, science and government to identify future needs, opportunities and threats. It is not clear that all of the sectors of academia, industry and commerce that can benefit from this initiative have embraced it with enough enthusiasm.

Support for innovation is best focused on giving incentives to entrepreneurs to innovate, and removing barriers. We welcome, for example, the concessions on Capital Gains Tax for start-up businesses. It is less efficient for Government to try to build directly the capability of firms to undertake innovation that is, by its very nature, extremely varied.

SMART and the Teaching Company Scheme are important sources of pre-product funds for start-up and small companies. They are of proven worth and should continue to be extended both in scale and in scope. A relatively small investment in increased seed funding here could increase innovation markedly.

The vast majority of start-up companies need to identify and protect their intellectual property. The Government's University Challenge has made an excellent start at encouraging the identification and initial protection of intellectual property rights (IPR) emanating from the science base. However, we note the huge and often unaffordable costs of patenting IPR in Europe, because of the need to conform to each individual national framework. A national strategy for science should include plans for the Government to take the lead in pressing for harmonisation of IPR legislation in Europe, so that a patent may be lodged in only one European Union country, yet will be recognised and enforceable in all Member States.

Some IPR is best protected by non-disclosure and confidentiality agreements (NDCAs). However, if they try to prove breaches of a NDCA, small companies are always at the mercy of those with deeper pockets. There is no equivalent of the Legal Aid system for small and medium sized enterprises (SMEs). We believe a national strategy for science should include plans for the Government to investigate the idea of an 'IPR Legal Aid' scheme to support SMEs in cases arising from alleged breaches of NDCAs.

Quality of life and the science base

Wealth creation is only one of the outcomes from the application of science that were identified by *Realising Our Potential*. The other, an improvement in the quality of life, is equally, if not more, important. In an article in *The Independent on Sunday* on 27 February 2000, the Prime Minister, in commenting on recent advances in biotechnology, wrote:

The challenge for scientists is to demonstrate that they can use these advances not just for making profits for firms but to improve the lives of people. The challenge for governments is to provide the highest level of protection for human health and the environment.

We believe that, if there really is a perception that scientists are focusing too much on wealth creation and not on improving quality of life, then the Government itself must also bear much of the responsibility. The consultation document for the new White Paper examines the role of science in improving innovation in industry, but does not emphasise the importance of science in improving quality of life.

Some areas, such as drug development and combating crime, provide the potential for improving quality of life as well as being commercially attractive. The Government must recognise that a national strategy for science should address both wealth creation and quality of life. It is not clear if this will be possible if the national strategy for science is considered only to be a subsidiary part of the mission of the Department of Trade and Industry.

Science and society

Many within the scientific community have recognised the need to look beyond the public understanding of science. As highlighted in the report on 'Science and Society' by the House of Lords Science and Technology Select Committee, scientists and other parts of society must engage in a constructive dialogue to overcome what has been described as a 'crisis of confidence in science'.

Certainly greater transparency in the way science is regulated is required to preserve the scientific community's 'licence to practise', but such a measure only addresses one of the many challenges facing the scientific community in its quest to cultivate the public's trust. A national strategy for science should outline ways to promote a dynamic interaction between scientists and the rest of society.

The Committee on the Public Understanding of Science (COPUS) could play a key part in promoting a dialogue between science and society. Its future role is to act as a national focus for organisations and bodies involved in promotion of science in the UK. In order to undertake this new role, the sponsors of COPUS (the Royal Society, the Royal Institution of Great Britain, and the British Association for the Advancement of Science) will disband the existing Committee, replacing it with an expanded membership to include a broader representation from the engineering sector, social scientists, the museums and visitor centres, charities, trusts, learned societies and other key players. The new Council will monitor national developments, share and disseminate best practice, and seek new mechanisms for engaging the public in the development of science policy and the applications of science in an informed way. A national strategy for science should acknowledge this.

Appendix

Are We Realising Our Potential?

The Science and Technology Committee have agreed to conduct an inquiry with the following terms of reference:- *"To inquire into and examine the impact of the 1993 white Paper Realising Our Potential: A Strategy for Science, Engineering and Technology.*

The 1993 White Paper, on the organisation of science, engineering and technology policy across Government, introduced several changes and initiatives, including:

- *The annual publication of Forward Look to provide a clear and up-to-date statement of the Government's Strategy for science, engineering and technology (replacing the more limited annual review);*
- *The creation of Technology Foresight (now Foresight), designed to "achieve a key culture change: better communication, interaction and mutual understanding between the scientific community, industry and Government Departments";*
- *The abolition of the Advisory Council on Science and Technology and its replacement with the Council for Science and Technology "to help ensure that the Government benefits from outside independent and expert advice when deciding on its own research spending priorities",'*
- *A shifting of emphasis for technology transfer initiatives to place more importance on "the interchange of ideas, skills, know-how and knowledge between the science and engineering base and industry";*
- *Programmes to improve access for small and medium-sized enterprises to innovation support programmes;*
- *The reorganisation of the research councils with modified management structures and new mission statements which made more explicit their commitments to wealth creation and the quality of life;*
- *The creation of the post of the Director General of the Research Councils and the absorption of the functions of the Advisory Board for the Research Councils into the Office of Science and Technology; and*
- *The launch of a new campaign to spread understanding of science among school children and the public.*

A key theme throughout the White Paper was the need to improve the application of science, engineering and technology to wealth creation and quality of life.

Our inquiry will examine the extent to which the measures and objectives outlined in the White Paper have been successfully delivered, their impact on the management and performance of science and technology, and whether the structures it specified are still appropriate."

The Committee intends to publish its Report on this inquiry in time to feed into the development of the forthcoming White Paper on Science and Innovation.

The Committee would welcome a memorandum addressing these issues. In particular it is keen to establish -

1 The extent to which the objectives set out in the 1993 White Paper, *Realising Our Potential*, have been delivered;

2 Whether the objectives and themes of the 1993 White Paper remains appropriate to the development of a strategy for science, engineering and technology and, if not, what other themes and objectives would be more beneficial;

3 Whether attempts to deliver the proposals of the 1993 White Paper have resulted in a culture change across, or in parts of; the science, engineering and technology base, and, if so, what is the nature of this change and how has it been demonstrated;

4 The Government's recent consultation on Science and Innovation Strategy stated that "the aim is to use the UK's excellence in science to achieve improvements in our national innovation performance and so to improve the competitiveness of the economy and the quality of everyone's life" and indicated its plans to achieve this by: -

   - sustaining the excellence of the science and technology base; encouraging private investment in innovation; streamlining knowledge transfer schemes and focussing them on clear goals; fostering regional networks;
   - improving the flow of skilled scientists and engineers to industry;
   - improving the ability of the science base to play a role in the knowledge economy;
   - taking advantage of the globalisation of research; and
   - improving public confidence by creating greater transparency in the regulation of science.

   Do you agree that these are appropriate aims for a national strategy for science? (If you responded to the Government's consultation exercise, you may wish to address this by forwarding a copy of that response with your memorandum); and

5 What do you believe should be the main features of a modern strategy for science, engineering and technology and why?

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Therapeutic cloning: A submission to the Chief Medical Officer's Expert Group (document 02/00, February 2000; ISBN 0 85403 5346)*

Complementary and alternative medicine (Response to the House of Lords inquiry into complementary and alternative medicine, statement 18/99, December 1999; ISBN O 85403 5311)*

Academic pay and conditions (Response to the *Independent Review of Higher Education Pay and Conditions*, statement 17/99, November 1999; ISBN 0 85403 529 X)*

National Curriculum Orders for Science (Response to the statutory technical consultation on the National Curriculum review, statement 16/99, October 1999)

Royal Society Links with Japan, (statement 15/99, October 1999)

Royal Society Links with Russia, (statement 14/99, August 1999)

The science National Curriculum (Royal Society response to the consultation on proposals for a revised National Curriculum for 2000, statement 13/99, July 1999)*

Science and Society (Royal Society response to the inquiry by the House of Lords Science and Technology Select Committee, statement 12/99, June 1999)*

Nuclear Energy - The Future Climate - Summary (8 pages 11/99, June 1999)*

Nuclear Energy - The Future Climate (joint report by the Royal Academy of Engineering and the Royal Society, statement 10/99, June 1999; £20; ISBN 0 85403 526 5)

Review of data on possible toxicity of GM potatoes (Royal Society statement 9/99, June 1999)*

GMOs and the environment (Royal Society response to the inquiry by the House of Commons Environmental Audit Committee, statement 8/99, April 1999)*

Scientific advice on GM foods (Royal Society response to the inquiry by the House of Commons Science and Technology Committee, statement 7/99, April 1999)*

Non-food crops (Royal Society response to the House of Lords Select Committee Inquiry on non-food crops, statement 6/99, April 1999)*

Devolution and science (14 page report by a Joint Working Group of the Royal Society of London and the Royal Society of Edinburgh, statement 5/99, April 1999)*

The teaching profession (6 page statement 4/99, April 1999)*

Regulation of biotechnology in the UK (Royal Society response to the Government's consultation exercise, 4 page statement 3/99, February 1999)*

Science and the revision of the National Curriculum (3 page statement 1/99, January 1999)*

***** The full text, or summary, of these reports can be found on the Royal Society's web page **www.royalsoc.ac.uk**

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