Harnessing our Genius

British Science in the 21st Century

STUART LYONS

CENTRE FOR POLICY STUDIES
57 Tufton Street London SW1P 3QL
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THE AUTHOR

STUART LYONS HAS many years' experience of working in industry and with government. He led the Royal Doulton group for 12 years during the most successful period of the company's post-war history, and was chairman of both the West Midlands Development Agency and the British Ceramic Confederation. He has served as a member of the Monopolies & Mergers Commission, a director of British Ceramic Research Limited, a governor of Staffordshire University, and a member of Council of the University of Keele. A major scholar of King's College, Cambridge, and a graduate of the Advanced Management Program at Wharton, he is the author of *Can Consignia Deliver? The Post Office in the 21st Century* (Centre for Policy Studies, March 2001) and *A Department for Business: The DTI in the 21st Century* (CPS, October 2001). He was awarded a CBE in 1993.

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SUMMARY

- The UK has been at the forefront of world scientific research, but is now lagging. Britain's Nobel Prize ranking is about half the level of 25 years ago. UK research expenditure is low relative to its international competitors.
- The DTI's Science Budget has risen from £1.6 billion in 1997 to £2 billion this year. It is now the largest operational budget of that department and is set to rise to almost £3 billion in 2005-06.
- While this increase in expenditure may be justifiable, the way it is managed is not. There is no detailed analysis by any accountable body of how the money is applied; whether it is applied successfully; and whether the planned increases are appropriate and properly directed.
- The future of the UK science and research communities is in the hands of two weak organisations – a disenfranchised Office of Science and Technology (OST) and a powerless Research Councils UK (RCUK).
- The DTI and the OST are weak managers. As a result, the Treasury has commandeered the OST responsibility for science strategy. It now plays an excessive part in determining DTI and OST science strategies and priorities.
- There is an evident lack of control by the OST over the six Research Councils it sponsors.

- Three out of the six Research Councils have struggled, to maintain a satisfactory level of research grants. Highly rated projects have been cancelled, postponed or abandoned because of poor management.
- In 2001, a government review of the Research Councils found, by implication, that the Research Councils were not operating within a strategic framework; were not providing adequate input to national strategy or policy; and were not speaking or working collectively or to time.
- As a result, the Government established “Research Councils UK” (RCUK), an umbrella body to govern and co-ordinate the Research Councils. This was an opportunity to introduce effective management of Britain’s science.
- But RCUK has no powers. Its constitution, governance and terms of reference are flawed. It lacks the authority to deliver change in the management of science. Its agenda is driven by governmental programmes and a civil service culture.
- The Research Councils suffer from antiquated working practices. Standards of financial reporting in the Research Councils are generally inadequate, if not abysmal.
- A feature of the Research Council strategies is that they follow the Treasury’s signals. Language and themes are adapted to appeal to the latest government fashion. Research Council plans are adjusted to gain access to the funds available.
- The US National Science Foundation is a far more effective model than the British RCUK and operates within the framework of a vibrant research and development economy.
- The UK’s new investment in science has been widely welcomed. But, without effective governance and management, much of the new money will be wasted. There is a better way to harness our inventive British genius.

RECOMMENDATIONS

- Management of the UK's science base should be modelled on that of the more successful US National Science Foundation.

Managing a Nation's Science:

The US and UK compared

	USA-NSF	UK-RCUK
Independent agency	Yes	No
External chairman	Yes	No
Independent board	Yes	No
Strong top management	Yes	No
Integrated organisation	Yes	No
Delegation with accountability	Yes	No
Fully electronic processes	Yes	No
Simple funding criteria	Yes	No
Schools education remit	Yes	Ineffective
Public education remit	Yes	Ineffective
Flexible Intellectual Property Rights	Yes	No
Business culture	Yes	No

- To this end, a UK Science Foundation (UKSF) should be established as a stand-alone Non-Departmental Public Body with an independent chairman, independent directors, and a high-ranking chief executive. Management of the new UKSF should be upgraded.

- UKSF should take over the roles of OST and RCUK; should help determine national strategy and priorities for science and scientific research; should integrate the work of the Research Councils, and improve their operating procedures and accountability; and should stimulate knowledge transfer.
- In addition to the sponsorship of research through the Research Councils, UKSF should play an important role in pump-priming and developing new initiatives for science education in schools and among the wider community.
- UKSF should have a remit to address broader issues, including the release of intellectual property rights, the stimulation of commercial collaboration, and the development of more productive relationships between research professionals and the venture capital market.
- UKSF's mission should be to restore leadership, dynamism, focus, prestige and substantive achievement to Britain's lagging scientific establishment.

CHAPTER ONE

BRITAIN'S LAGGING PERFORMANCE

If only we harness our inventive British genius…

Margaret Thatcher
8 December 1982[1]

THE UK HAS BEEN AT THE FOREFRONT of world scientific research. British scientists are internationally respected. But there are growing grounds for concern about Britain's performance. Although the UK science establishment thinks of itself as second only to the US, its claims become thinner by the year.

English is the *lingua franca* of the sciences. The Department of Trade and Industry (DTI) boasts that the UK received over 9% of citations in published papers recorded in the Science Citation Index (SCI) from 1981-2000.[2] But, per head of population, Sweden leads the SCI, followed by Switzerland and Israel.

Similarly, the UK Research Councils, in a glossy publication entitled *Science Delivers*,[3] have noted that since 1901 the UK has won 72 Nobel Prizes in the physical sciences, describing the awards as "the gold standard for intellectual excellence."

But the bad news for the UK is that Britain's Nobel Prize ranking in the sciences is only half the level of 25 years ago.[4] From 1901 to 1950, Britain's awards were level with the USA at 28 prizes each. Between 1951 and 1976, the UK ranked a worthy

1 Speech at the Conference on Information Technology, Barbican Centre, London.

2 Cm 5002 and 5416. The latest figures show a decline to a current level of 8%.

3 Research Councils UK, December 2002.

4 There are three categories of Nobel Prizes for the physical sciences: Physics, Chemistry, and Physiology or Medicine. Economics is not included in the sciences for the purposes of this paper.

second. But since then Britain's share of prizes has declined, while the US performance has raced ahead.

Table 1

UK and US Nobel Prizes, 1951-2000

	1951-1975	**1976-2000**	**% change**
US			
Physics	24	35	+ 46%
Chemistry	13	28	+ 115%
Physiology or Medicine	32	37	+16%
US Total	**69**	**100**	**+45%**
UK			
Physics	6	1	– 83%
Chemistry	13	6	– 54%
Physiology or Medicine	10	7	– 33%
UK Total	**29**	**14**	**– 52%**

Note: From 1901 to 1950, the UK won 28 Nobel Prizes for the physical sciences. ADDS UP TO 71 The USA also won 28 prizes in that period.
Source: Nobel Foundation.

While the UK is restoring its position in physiology and medicine, with four awards in 2001 and 2002, there has been a severe and continuing decline in physics and chemistry.[5]

Research and development

Table 2 shows that the UK has fewer scientific researchers per thousand economically active persons than many of our economic competitors. Japan has nearly twice as many with nine, Sweden and Finland more than eight each.

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5 During the same period, the USA won four prizes for physics, three for chemistry and two for physiology or medicine.

Table 2

Researchers per 1,000 economically active persons (1997)

Japan	9.0
Sweden	8.5
Finland	8.25
US (1993)	7.25
France	6.0
Germany	6.0
Switzerland (1996)	5.5
UK (1996)	5.0

Source: OECD *Basic Science and Technology Statistics,* 2001.

National expenditure on research and development (R&D) tells a similar story. As Table 3 shows, Sweden is comfortably at the top of the OECD league table. The UK is well down the list.

Table 3

R&D expenditure as % of GDP (1998)

Sweden (1997)	3.7
Japan	3.0
Finland	2.9
US	2.7
Switzerland (1996)	2.7
South Korea	2.5
Germany	2.3
France	2.2
UK	1.8
Canada	1.6
Italy	1.0

Source: OECD *Basic Science and Technology Statistics,* 2001.

National expenditure on R&D is an imprecise measure, as definitions can vary and the quality of data collection is inconsistent. However, the 1998 UK figures quoted by OECD show a similar pattern to those for 1999 recorded in the government paper *Investing in Innovation*.[6] UK R&D spending fell in the 1990s as overseas defence commitments were reduced, and restrictions in government spending meant that science programmes were not taken up by other government departments. Private-sector research spending failed to make up the shortfall.

Science education

The UK's shortage of trained scientists, mathematicians, technologists and engineers has been well documented, for example by Sir Gareth Roberts, president of the Science Council and of Wolfson College, Oxford, whose investigation was commissioned by the Chancellor of the Exchequer.

The Roberts Report, *Set for Success*, published in April 2002, highlighted Britain's inadequate teaching standards and dull curricula. Fewer students were taking physics and chemistry A-levels and degree courses. Girls continued to disregard the sciences as an academic option. Research Council PhD stipends were too low to attract high-quality graduates.

Many of the brightest young science graduates are drawn to American universities, laboratories and high-tech companies, where prospects and salaries are better, and the interaction between academic research and commercial exploitation more exciting. Indeed, the European Commission has estimated that nearly two-thirds of European science graduates entering the US on student visas are still working in the US five years later. The EC's concern is such that it proposes to spend about €1.6 billion on a European Research Area.[7]

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6 Subtitled *A strategy for science, engineering and technology*, and published by HM Treasury in July 2002.

7 Reported in *The Times*, July 3, 2002. The UK Government intends to increase the minimum Research Council PhD stipend to £12,000 by 2005-06 (*Science Budget 2003-04 to 2005-06*, December 2002.)

SCIENCE EXPENDITURE AND RESEARCH FUNDING

THE UK GOVERNMENT'S annual science, engineering and technology expenditure is currently about £7.5 billion. According to government figures, this falls into five broad categories:[8]

1. About £2.5 billion is defence-related spending sponsored by the Ministry of Defence (MoD), the armed forces and the former Defence and Evaluation Research Agency (DERA).[9]

2. About £2 billion consists of the DTI's Science Budget, which the Department uses to support the Office of Science & Technology and, through it, the Research Councils. The DTI now spends as much on the Research Councils as on its entire programmes for industrial competitiveness, energy and regulation.

3. About £1.25 billion is spent on science by the Higher Education Funding Councils (HEFCs) for England, Scotland, Wales and Northern Ireland, which give science support to UK universities and colleges.

4. A further £1.25 billion is spent on science by other home departments.

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8 *UK Science Expenditure in Real Terms, 2001-02*.

9 On 1 July 2001, DERA was split into Qinetiq Group plc and the Defence Science and Technology Laboratory (Dstl). Qinetiq now has annual sales of about £800 million and Dstl about £320 million.

5. About £0.5 billion is identified as an indicative UK contribution to the European Union R&D budget.

The Treasury's *Investing in Innovation* paper provides a slightly different perspective:

> Total [R&D] spending by government departments, not including surveillance and testing, was nearly £4 billion in 1999-2000, with £1.35 billion being spent by civil (as opposed to military) departments. Science base funding by Research and Funding Councils, by comparison, was of the order of £2.5 billion in the same year.[10]

The Comprehensive Spending Review of July 2002 promised a substantial increase of £1.25 billion additional resources from 2002-03 to 2005-06.[11]

Research Funding

The Higher Education Funding Councils of England, Scotland, Wales and Northern Ireland support about 130 universities and colleges in the UK with roughly 630,000 students in science, engineering and technology. These universities employ about 114,000 academic staff on teaching and research.[12]

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10 In real terms, spending was higher in 1986-87. By 1994-95, however, it had fallen to just over £6 billion at today's values, mainly due to cut-backs in defence spending (where R&D fell from 0.5% of GDP in 1989 to 0.2% in 1999) and the science budgets of the non-DTI home departments. The Higher Education Funding Council science budget suffered a 6% real-term reduction between 1986 and 2000, but the Research Councils enjoyed an increase of almost 50%.

11 This figure consisted of £890 extra for the OST, the "major part" (about 80%) of £244 million for DfES research spending, £100 million for DfES Roberts Review implementation, and £50 million through DfES for research infrastructure.

12 Of these, about 60% have both teaching and research duties, 30% (mainly younger academics at the start of their careers) are employed for research only, and 10% (mainly in the new universities) are employed for teaching only. Source: A. J. Gill, *British Science and Research in the Universities*.

THE RESEARCH COUNCILS

Government funding for research in the universities comes principally through the "dual support" system:

1. The Funding Councils meet annual costs of just over £1 billion for research salaries, premises, central computing and libraries.[13] This expenditure has no explicit programme goal, other than to support high quality research capability.[14] Government expects the Funding Councils to provide research departments with:

    - the base from which permanent academic staff can make credible proposals for research project funding;
    - training costs for new researchers;
    - the resources to build research capabilities; and,
    - the freedom to pursue some "blue-skies" research.

2. Six grant-awarding Research Councils, sponsored by the Office of Science and Technology, meet the costs of specific university research projects and pay the researchers, whose proposals are approved through a system of peer group review co-ordinated by specialist committees and teams in each of the Councils. The Research Councils also support postgraduate trainees, UK research institutions and laboratories, and international collaborations.

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13 HEFCE, for example, allocated core funding of £868 million for research in 2000-01. In 2001-02, the Scottish HEFC had a £116 million budget for research funding and a Research Development Grant of £18.5 million; Wales had a £46 million budget; Northern Ireland spent £24 million.

14 HEFCE carries out a periodic Research Assessment Exercise (RAE) in which marks are awarded on a seven-point scale; the scores influence the block grants which are made subsequently. The House of Commons Science and Technology Committee reviewed the 2001 RAE and noted a marked improvement in universities' research performance. The members felt that the government's funding allocations for research and infrastructure support were inadequate, although there was evidence of "gamesmanship" by university departments seeking to optimise their returns.

Charities, including the Wellcome Trust, Cancer Research UK and the British Heart Foundation, are an additional source of medical research funding, spending in aggregate over £0.5 billion annually.[15]

Funding from Industry

Industry plays a part in supporting scientific research, and is estimated to have contributed 12.3% of university research income in 1999-2000.[16] HEFCE estimates that the value of industry research collaborations has grown to £242 million.[17] However, UK industry invests less than its major industrial competitors such as the US, Germany and France.[18] UK business R&D is estimated to have fallen from 1.5% of GDP in 1990 to 1.2% seven years later.

Research Infrastructure Funding

Major capital funding for research facilities and infrastructure does not come through the dual support system but from separate government budgets. After the 1998 Comprehensive Spending Review, a Joint Infrastructure Fund (JIF) was established, a £750 million partnership with the Wellcome Trust, to improve building, laboratory and experimental facilities over the three years to March 2000.[19] The Government continued this process after the 2000 Spending Review. A Science Research Investment Fund (SRIF)[20] was set up with a planned budget of about £1

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15 In 1999-2000, according to *Investing in Innovation,* the Wellcome Trust spent about £350 million on scientific research; Cancer Research spends more than £130 million per year, and in 2001 the British Heart Foundation spent £40 million.

16 Higher Education Business Interaction Survey, December 2001.

17 *Investing in Innovation,* p 32.

18 See Tables 2 and 3 above.

19 Shortly before this closing date, £600 million of awards had been made to support 110 projects in 39 universities.

20 The SRIF had three separate but complementary streams:

- £675 million came from the Higher Education Funding Council for England (HEFCE) and the OST for allocation to science infrastructure, where justified by research excellence and research income;

billion over the period 2000-04. The 2002 Comprehensive Spending Review envisaged the continuation of a discrete and sustainable capital spending stream for university laboratories of £500 million a year.

Knowledge Transfer

A Higher Education Innovation Fund, worth £140 million over three years, was provided under the 2000 Spending Review, to enable OST and HEFCE to support knowledge transfer to business and the community. Following the 2002 Review, this will be expanded to £90 million a year by 2005-06. Revenues from knowledge transfer are sometimes referred to as a "third stream" source of finance, in addition to Funding Council and Research Council income. In response to government encouragement, institutions of higher education oversaw the creation of 199 spin-off companies in 1999-2000 and the filing of 1,534 patents.[21] These figures are claimed by the government to be better than those in the US, but Americans would not agree.[22] The UK figures are a selective snapshot, taken after a period of significant government stimulus. They give no guarantee of future profitability or social benefits. There is still widespread concern about Britain's unsatisfactory record in the commercial exploitation of science.

Why does Government fund research?

It is in the interests of all that government should ensure that the UK's science and technology is healthy, dynamic and relevant. As Mrs Thatcher said in a speech to the Royal Society:

- £225 million came from the Wellcome Trust for science building proposals that had been highly-rated but not met by the JIF;
- £100 million was retained by the OST to modernise Research Council institutes and contribute to large national projects.

21 Higher Education Business Interaction Survey.

22 For the American perspective, see Chapter 5.

> It is mainly by unlocking nature's most basic secrets, whether it be about the structure of matter and the fundamental forces or about the nature of life itself, that we have been able to build the modern world.[23]

The role of research funding through universities is part of government's general responsibility to ensure that the educational system produces well-qualified and well-trained researchers, across the scientific disciplines, as seed corn for the public, commercial, academic and voluntary sectors. University research funding is intended to provide both a continuation of university education itself, and a source of knowledge and innovation for the future.

Research funding through government-sponsored institutes is more prescriptive. Institutes have scientific missions and specialities, in medicine, biotechnology, and so on. Some of the research is designed to maintain a healthy science base; some is more ground-breaking, "blue-skies" research.

Government research funding is part of a larger picture. Charities, such as the Wellcome Trust, the British Heart and Lung Foundation and UK Cancer Research, spend large sums sponsoring research, because of their charitable missions. Companies and industries sponsor research in universities and institutes, ranging from engineering and technology projects to the design of pharmaceutical products. One of the responsibilities of government is to identify market failures where research necessary to the national interest is not being funded by these independent sponsors.

Scientists value the freedom and funding to pursue basic questions with no immediate commercial applications. Nevertheless, research delivers more immediate benefits to the public at large, when there is a vibrant commercial environment and when government actively promotes the commercial exploitation of intellectual property.[24]

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23 Speech to the Royal Society, 28 September 1988.

24 As has been achieved in America by the Bayh-Dole Act of 1980, see Chapter 5.

Government sponsorship of research projects involves the use of taxpayers' money. What should be the broad elements in the government's role?

Government should:

- maintain a modern research effort through the UK's universities and research institutes; [MENTION SCHOOL EDUCATION??];
- fund basic and applied research in the public interest, where there is a lack of sponsorship from other sources (for example, research into climate change);
- support research by pump-priming or matched funding through charitable, commercial and other sponsors in the public interest;
- support an element of "blue-skies" research to enlarge the boundaries of knowledge;
- create an environment where universities and researchers have a direct and tangible incentive to make the benefits of research available to the commercial sector and the public at large;
- ensure that there will be accountability to Parliament for the money it invests in scientific research;
- seek to enhance the long-term competitiveness, and economic, social and physical health, of the UK and its citizens; and
- encourage an international perspective.

What Government should not do is to indulge in the temptation to micro-manage the national research effort.

THE RESEARCH COUNCILS

THE RESEARCH COUNCILS are at the centre of the UK's non-military scientific research.

The Research Councils were established in 1994, following a Science, Engineering and Technology White Paper, as executive Non-Departmental Public Bodies (NDPBs) operating under Royal Charter. Their mission is to:

> …promote and support high quality research and postgraduate training; advance knowledge and technology, and provide trained scientists and researchers to continue to make such advances; and broaden the public's knowledge and understanding of science.[25]

These are the bodies on which Britain's scientific research excellence depends. The roles of the six grant-awarding Councils are summarised below.[26]

Biotechnology & Biological Sciences Research Council (BBSRC)
This works in the non-medical health sciences, particularly in the pharmaceutical, healthcare and food safety sectors; in addition to funding university research, it runs eight research institutes.[27]

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25 Research Council Royal Charters, 1994.

26 There is a seventh Research Council, the Council for the Central Laboratory of the Research Councils (CCLRC), which is responsible for laboratories in Oxfordshire, Hampshire and Cheshire.

27 Babraham Institute (Cambridge), Institute of Arable Crops Research (Hertfordshire), Institute for Animal Health (Newbury), Institute for Food Research (Norfolk), John Innes Research Centre (Norfolk), Institute of Grassland and Environmental Research (Wales), Roslin Institute (Edinburgh) and Silsoe Research Institute (Bedfordshire). The institutes' assets exceed £160

Engineering & Physical Sciences Research Council (EPSRC)
This is the largest Research Council. 90% of its expenditure is on individual research and postgraduate training grants in physics, chemistry, mathematics, engineering disciplines and computer sciences.[28]

Economic & Social Research Council (ESRC)
This is the smallest but, under Labour, the fastest growing Research Council, focusing on social research into scientific, national and global areas of interest.[29]

Medical Research Council (MRC)
The MRC is now at the forefront of Britain's genomics work. It spends half of its income on capital expenditure and staff in its research institutes.[30]

Natural Environment Research Council (NERC)
This supports research at home and overseas into biodiversity, global change and natural resources, with 29% of its budget going to polar science, including the £30 million annual costs of the British Antarctic Survey.[31]

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million and their annual turnover is £140 million, of which half is commissioned from the BBSRC. In 2000-01 the BBSRC awarded £80 million of research and capital grants to them.

28 40% of the research portfolio is in the "responsive mode", where a researcher can send in a proposal at any time; 25% is in response to bids for a specific category of expenditure, such as equipment or fast-stream grants; 35% is in "managed mode" – ring-fenced funding for well-defined themes and specified periods, often pursued collaboratively with industry. In 2000-01, Imperial College London was the largest beneficiary, with research programme starts valued at over £30 million. Oxford received £21 million, Southampton and Cambridge more than £18 million each.

29 In 2000-01, the largest recipient of ESRC research funds was the London School of Economics with £8.8 million, followed by Essex University with £4.6 million.

30 These include the National Institute for Medical Research (Mill Hill), Laboratory of Molecular Biology (Cambridge), Clinical Sciences Centre (Hammersmith Hospital, London), and about 35 smaller Units, as well as other research centres, mainly in London, Oxford and Cambridge.

31 NERC's fixed assets include ships and aircraft that cost £168 million.

Particle Physics & Astronomy Research Council (PPARC)
This supports research into the natural universe, contributes financially to the European Centre for Nuclear Research (CERN) and collaborates in international cosmology programmes.[32]

The 2000-01 expenditure of the six grant-awarding Research Councils, and their budgeted expenditure for 2003-04, are shown in Table 4.

Table 4

Research Council Grant-in-Aid 2000-01 and Budget 2003-04

	2000-01		**2003-04**		
	£ million	**%**	**£ million**	**%**	**% increase**
BBSRC	212	15	250	15	18
EPSRC	413	29	489	29	18
ESRC	71	5	91	5	28
MRC	320	23	387	23	21
NERC	185	13	217	13	17
PPARC	206	15	232	15	13
Total	**1,407**	**100**	**1,666**	**100**	**18**

Notes: In addition to grant-in-aid, Research Councils receive funds from other government departments, industry, charitable bodies, the European Commission and their own commercial activities.
CCLRC received grant-in-aid in 2001-02 of £2 million but was supported by funds from the other Research Councils and had total income approaching £120 million.
Sources: Research Council accounts 2000-01; DTI Science Budget 2001-04.

Some Research Councils, notably EPSRC and ESRC, award a high proportion of their funds to university researchers and postgraduate trainees; others face prior calls through running their own institutes or contributing to overseas collaborations. Consequently, the grant-in-aid shown in Table 4 does not translate evenly into actual research grants.

32 PPARC's space-related activities are co-ordinated through the British National Space Centre. The cost of international collaborations is causing PPARC to review its support for British university research.

Table 5, based on the accounts of the individual Research Councils, estimates the value of research grants awarded to the higher education sector in 2000-01.

Table 5

Research Grants awarded by Research Councils 2000-01

	Grant-in-Aid received		**Grants awarded to University Researchers & Postgraduate Trainees**		
	A			**B**	**C**
	2000-01 £ million	**%**	**2000-01 £ million**	**% of A**	**% Total**
BBSRC	212	15	132	61	17
EPSRC	413	29	355	86	44
ESRC	71	5	59	83	7
MRC	320	23	131	41	16
NERC	185	13	68	37	9
PPARC	206	15	58	41	7
Total	**1,407**	**100**	**797**	**57**	**100**

Notes: Column B shows the percentage of grant-in-aid received by the particular Council that appears from the published accounts to be passed on in awards to university researchers and postgraduate trainees. Column C shows the percentage of research and postgraduate grants awarded by each Council as a percentage of the total grants of £797 million awarded by all the Councils.
Some figures are approximate because of lack of standardisation in Research Council accounts. There may also be errors of definition or allocation between university and non-university researchers.
According to *Investment in Innovation*, in 1999-2000, 49% of Research Council funding was spent in universities, the remainder being spent largely in Research Council institutes and on international subscriptions.

Source: Research Council Annual Reports 2000-01

According to this analysis, little more than half the grant-in-aid received by Research Councils is passed on as grants to university researchers or postgraduate trainees.

These conclusions are borne out by the Research Councils' aggregate figures,[33] which show that in 2000-01 they spent:

- £586 million in research grants to Higher Education Institutions (HEIs);
- £194 million on studentships and £35 million on fellowships in HEIs; and,
- £598 million in Research Council Institutes.

MRC, NERC and PPARC, as Table 5 indicates, have struggled, to maintain a satisfactory level of research grants. At a Parliamentary Select Committee hearing recently,[34] the chairman noted that the MRC, having spent £206 million on research grants and contributions in 1999-2000, had spent £90 million less in the subsequent year and over £140 million less in the current year. MRC confessed to being "overwhelmed with proposals" and has failed to support a number of alpha-rated projects.

NERC's 2000-01 research grant spending also went out of control. Its Council complained in November 2001 that some schedules it had considered the previous May had not been brought up to date. The Council meeting of April 2002 then highlighted the need for £13 million savings to be achieved. The following day,[35] NERC summarily cancelled the next Standard Research Grant round, under which about 50 grants would have been awarded.

PPARC's ability to fund university-based research is hampered by the costs of its international collaborations, including its contribution to CERN.[36] Its cost burden was not helped by CCLRC's failure to co-ordinate an effective bid for European support under Framework 6.[37]

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33 *Science Delivers*, RCUK, December 2002.

34 Science and Technology Select Committee hearing, 4 December 2002.

35 5 April 2002.

36 The UK contributes 17.7% of CERN's budget.

37 CCLRC has been criticised within the science community for putting more effort into introducing part-time working, job sharing and career breaks than into a strategic plan.

Spending Review 2002

The 2002 Spending Review has proposed an increase in the rate of annual growth in the DTI Science Budget from the current level of 7% to just under 10% in real terms by 2005-06, bringing the budget up to just under £3 billion. The growth in Research Council funding is considerably lower, accounting for about half of the additions to the resource baseline, but has nevertheless been widely applauded.[38] The Government has responded to many voices in the science and political communities, which have argued that spending in recent years has been too low.

Some features of its package of "extras" have been exaggerated.[39] The "dedicated capital stream of capital for universities, worth £500 million per year by 2004-05" is a replacement of the JIF and SRIF infrastructure funds and is now subject to 10% matching by universities. The £120 million made available to Research Councils to cover project overheads in universities should be offset by a saving in the universities' finances. While total Research Council spending will increase, the privatisation of Qinetiq[40] will provide a saving against the Exchequer's total appropriations for military and civil science.

The directions in which the new research funds are to be applied are significant. Stem cell research is to receive £40 million over two years, sustainable energy economy £28 million, and rural economy and land use £20 million. Each of these decisions has a political element: stem cell research, because of the opportunity afforded by the Bush administration's stance against it; energy research, because of the UK government's reluctance to arrive at a

38 The total Science Budget resource additions are £10 million in 2003-04, £222 million in 2004-05 and £555 million in 2005-06.

39 Indeed, the government announced the increases twice, in both July and December 2002.

40 The MoD's sale of a 33.8% stake to the US private equity group Carlyle will raise about £150 million in addition to £50 million already realised, valuing Qinetiq at about £500 million.

clear policy for nuclear fuel production; rural economy research, because of a desire to mollify countryside communities.

Governance and accountability

However well argued these cases may have been, the Spending Review's results indicate high levels of both political involvement by government and political reaction by scientists.[41]

There is a general consensus supporting increases in funding for scientific research. What is missing is close and objective analysis by any independent and accountable intermediate body of whether the planned increases are both appropriate and properly directed, and how the funds should be applied.

How should one measure success and failure in the economic, academic and social return on government science research spending?

How effectively are the Research Councils managed by the government that finances them? How effective is the Research Councils' own internal governance? How well do we harness our inventive British genius?

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41 For a further example, see the national bio-databank project, page xx below.

CHAPTER FOUR

EXTERNAL AND INTERNAL GOVERNANCE

Research Council governance starts with the official and governmental framework created by the Treasury and the DTI. It extends through the Office of Science and Technology and the Director General for the Research Councils (DGRC). Finally, each individual Research Council has its own Board sitting under an independent chairman.

External governance

The Research Councils are sponsored by the DTI through the Office of Science and Technology. The OST's titular head is the government Chief Scientific Adviser (CSA), who reports directly to the Prime Minister. The DTI departmental structure of 2001 recorded that the CSA also reported directly to the Secretary of State at the DTI.

The Chief Scientific Adviser's main role is to advise the Prime Minister and the Cabinet on the health of the UK's science base. He also advises the government on topical and strategic issues of importance. Recently, he has advised the Prime Minister on foot and mouth disease, genetically modified foods and climate change.

The CSA is deputy chairman of the advisory Council for Science and Technology (CST),[42] the chairman being the

42 The CST, re-established in 1998, is an advisory body which brings together distinguished scientists and academics, and customers of publicly funded research from industry, academia and government, to consider:

Secretary of State for Trade and Industry as the Cabinet Minister responsible for Science and Technology.

The Council for Science and Technology, the UK's senior advisory body on the sciences, has no direct authority or influence over the Research Councils. Such link as there is, is provided by the Chief Scientific Adviser. But the CSA also has no direct authority over either the Director General for the Research Councils or the Research Councils themselves.

Director General – Research Councils

The Director General – Research Councils (DGRC) is the accounting officer for the OST budget and directly responsible for the distribution of virtually all of its funds, of which the bulk goes to the Research Councils. The role is that of a scientific administrator. He does not report to a non-executive Board, which might cement the structure and provide independent advice and monitoring. Nor does the Permanent Secretary at the DTI pay much attention to OST affairs.[43] It is impossible to determine to whom the DGRC is accountable.[44]

- the performance of the UK public and private sectors in Science and Technology in relation to current and future national needs and opportunities;
- the overall impact of the funding arrangements for publicly funded S&T, including those for research in higher education institutions;
- the effective use and exploitation of S&T by business, government and the public services to create wealth and improve quality of life; and,
- the synergy between the UK's domestic and international S&T activities and the scope for the UK to get more benefit from S&T collaboration.

43 At ministerial level, the Minister for Science is responsible for the OST and the Research Councils.

44 According to the OST, the allocations in the recent Science Budget "reflect advice given to the Secretary of State by the Director General of Research Councils, who reports to the Secretary of State on all matters relating to the Science Budget." (Introduction, *Science Budget 2003-04 to 2005-06*, December 2002.) This statement, however, supports the normal convention in such matters.

The DGRC's relationship with the Research Councils is also problematic. Although, until the creation of Research Councils UK, he chaired a forum called CERCs (Chief Executives – Research Councils), his position was by no means *primus inter pares*. As discussed below, RCUK has not enhanced his authority.[45] The Research Council chief executives are accountable to the boards of their Councils. Their control over their fiefdoms is subject to greater influence by their independent chairmen than by the Director General. There is an evident lack of control by the Office of Science and Technology over the Research Councils it sponsors.

The Treasury

Such control as exists over the OST budget is in practice exercised by the Treasury. It was the Treasury, not the DTI, that published the Government's science strategy paper of July 2002, *Investing in Innovation*. The Chief Secretary led the launch, which was held not in a government office but at the Wellcome Trust's headquarters in Euston. The Secretaries of State at the DTI and DfES were in attendance and played supporting roles. The Chief Secretary to the Treasury also undertook the regional promotion of the science strategy.[46]

Major charities, which wish to leverage their funds for biomedical research and infrastructure, talk to Treasury officials, rather than those from the Departments of Health, Industry or Education. The Treasury has driven the national bio-databank project, in which the MRC is now involved, giving the Research Council a ready excuse for failing to support alpha-rated research projects. The Treasury determines the level of PPARC support for CERN and other international collaborations.

It is reasonable that the Chancellor of the Exchequer and the Treasury should wish to exercise influence and control over departmental spending budgets. What is new is that they now

45 See page 36.

46 Similarly, the Treasury has taken over from DTI the national programmes for small businesses and entrepreneurial training.

determine DTI and OST strategies and priorities, and involve themselves in micro-management. The Chancellor and his team have become increasingly powerful; the DTI, under a succession of inexperienced ministers, has continued to lose its way and has become disenfranchised.

The Office of Science and Technology is a bureaucracy without bite. It has failed to earn respect and confidence within government. The Research Councils, whether individually or as a group, cannot look to it for any significant measure of leadership.

Internal Governance

How effective are the Research Councils themselves? The internal corporate governance, strategic planning processes, and operational and financial control of the Research Councils vary.

Each of the six grant-awarding Councils is governed by a Board of independent directors under an independent chairman. The chief executives and their management teams are monitored and advised by their Board members. In general, though, the Research Councils suffer from antiquated working practices.

Most Councils have burdened themselves with a plethora of committees.[47] There are committees for strategy, development, institutional management, scientific assessment (with separate committees for each academic discipline), and public understanding of science, as well as for audit and remuneration. Most committees are larger than their remits require, with 18 members or so. Even audit and remuneration committees typically have six members each. Committees meet infrequently, with dates governed by the university term. Most of them give rise to a blurring of responsibilities, and detract from the dynamism and accountability of management. [ARE COMMITTEE MEMBERS PAID? COSTS ETC??]

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47 EPSRC is an exception and delegates the administration of its research funding to management, requiring its Council to focus on compliance and the monitoring of the executive's performance.

A common pattern among the Research Councils is for a Council committee to be established to advise both the executive and the Council itself on what the strategy ought to be. The result is often a long strategy document which portrays an organisation that is, in part, talking to itself and, in part, seeking to justify an unsustainable wish list.[48]

This is in antithesis to the regular and acceptable pattern for complex organisations, where best practice is for a chief executive to prepare strategic options and for him and his chairman to arrive at a shared view. A strategic plan is then presented to a Board for comment and review, as part of an iterative process, and the Board advises, challenges and, eventually, approves.[49]

A feature of the Research Council strategies has been that they follow the Treasury's signals. If e-commerce, genomics or a national bio-databank are regarded by the Treasury as priority areas, intellectual challenge is put to one side. Language and themes are adapted to appeal to the latest government fashion.[50] Research Council plans are adjusted to gain access to the funds available. The criticism is not that government views are necessarily wrong, but that scientific independence and operational accountability are diminished.

Performance monitoring

Standards of financial reporting in the Research Councils are generally inadequate, if not abysmal. The Science and Technology Act 1965 requires all Research Councils to lay a formal report before Parliament each year. BBSRC's 2001 report consisted of 32 glossy pages, but devoted just one page to a summary financial statement, which was still unaudited and unsigned on the date of

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48 Research Council strategies and "road maps" *passim*.

49 See, for example, Sir Adrian Cadbury *Corporate Governance and Chairmanship*, OUP 2002.

50 For example, the MRC strategic model is now described as "From gene function to improved health", although many aspects of medical research are not gene-related.

the report's publication.[51] As noted earlier, NERC's expenditure in the same year went out of control, in spite of repeated requests by its Council for good order. [52]

The reports often have columns of data itemising the grants to different institutions, but there is no evidence that the Research Councils recognise the need to measure and monitor spending against outputs. Research grants are, of course, not necessarily awarded (nor should they be) in the expectation of a specific output. But projects should have to meet clear and specific criteria, and the peer review process should be transparent and timely. Although Research Councils may find it difficult to measure outputs in terms of research success, there is no reason why they should not measure their own administrative performance.[53]

The Quinquennial Review

During 2000 and 2001, the Office for Science and Technology carried out a review of the performance of the grant-awarding Research Councils over the previous five years.[54] [REASON FOR REVIEW? AS A REACTION TO PERCEIVED FAILURE?] The Government [OR OST?] soon announced that the Research Councils were necessary and valuable, and that Non-Departmental Public Body status was appropriate.

The Council for Science & Technology set up a subgroup to advise the OST on the Review. The subgroup, led by Professor Dame Julia Higgins, focused on the mission, structure and governance of the Councils.

The CST saw no reason to change the number of the Research Councils or to amend the mission statements in the Royal Charters. But it identified as a "key issue" the "distinctive roles

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51 It is not surprising that when, in 2001-02, BBSRC sold assets valued at £1.3 million, the proceeds were remitted to OST and not entrusted for more rewarding investment to BBSRC.

52 See page 17.

53 The US National Science Foundation does this in considerable detail. See Chapter 5.

54 It should have taken place in 1999, but was delayed.

and missions of the Councils as a group on the one hand, and of the OST on the other." It urged that:[55]

- the existing systems and structures should be strengthened to "improve the Councils' joint working on cross cutting matters" and the Councils should be accountable for their joint responsibilities; and,
- the OST should "focus more sharply and clearly on its overarching role as the Science Budget holder" by improving its assessment and reporting of the results of funded research and the extent to which the science and engineering base was fit for the UK's present and future purposes.

It added two points in qualification of its earlier acceptance that all was well:

> The Councils' existing charters make no reference to their collective responsibilities … and yet this set of joint responsibilities is crucially important, not least in view of the fact that the Councils are increasingly engaged in collaborative programmes.
>
> Regardless of their number, the Council's boundaries need to be kept under continuous overarching review.

The establishment of Research Councils UK

The CST asked the Quinquennial Review Steering Group to give serious consideration to the establishment of a new overarching strategic management structure, which it termed for convenience the *Board of the Research Councils*.[56] Following a debate between the

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55 Letter from Dame Julia Higgins to Dr Richard King, Quinquennial Review Team Leader, 19 June 2001.

56 The CST was impressed by its visit to Sweden in July 2001 where the Swedish government had introduced a new Swedish Research Council (SRC) had replaced five former research councils and had assumed responsibility for supporting fundamental research in all scientific fields. The Council was sponsored by the Ministry of Education and Science, which was developing performance measures

OST, the DTI and the Treasury to consider the possible creation of a co-ordinating body with significant independence from government. The result was the emergence on 1 May 2002 of a new body called Research Councils UK.

Research Councils UK was to be "a new strategic partnership that will champion research in science, engineering and technology across the UK."[57] Research Councils UK would work "alongside" the Office of Science and Technology and would develop new areas of collaboration in key scientific fields. It would also build on areas where Research Councils were already working together, such as cross-disciplinary programmes and helping researchers turn science into business.

The DGRC commented:

> Research Councils UK will develop a common framework for research, training and knowledge transfer that will sustain an internationally competitive science base and ensure effective exploitation for economic and social benefit. The new partnership will also provide a focus for dialogue with stakeholders, including universities, government, business, charities, other research funders, international organisations and the public.

The terms of reference for Research Councils UK were published on a new website:

i. to define the overall strategic framework for research, training and knowledge transfer funded by the Research Councils, and provide input into the wider strategy for the whole Science Budget;

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for it. It was governed by Board of eight distinguished research scientists appointed by fellow researchers through an electoral college system. The Irish government had come to a similar conclusion, setting up the Irish Research Council for Science, Engineering and Technology (IRCSET) in 2001 as an independent and autonomous body under the aegis of the Department of Education and Science, and governed by an independent Council.

57 DTI Press Release, 1 May 2002.

ii. to provide a single focus for the Research Councils' collective dialogue with stakeholders;

iii. to promote timely and inclusive involvement of the Research Councils with the Office of Science and Technology (OST) in policy and strategy development;

iv. to secure cohesive and collective working amongst the Research Councils, and between Councils and OST;

v. to help the Research Councils to respond collectively to requests from Government for independent scientific policy advice;

vi. to secure harmonisation or commonality of operational and administrative functions.

By implication, the Government recognised that, as currently structured, the Research Councils were:

- not operating within a strategic framework;
- not providing adequate input to national strategy or policy;
- not speaking or working collectively or to time.

But disagreements across departments and between ministers meant that the new RCUK was to have no powers. Far from stimulating a novel and productive dynamic tension, the government shied away from its new creation.

RCUK's terms of reference had the following rider:

> Research Councils UK will adopt a collegiate approach to decision making, working in the best interests of the UK science and engineering base. The establishment of Research Councils UK does not affect existing lines of accountability, each Chief Executive remains responsible for his or her own Council's strategic framework for research, training and knowledge transfer funded by the Research Councils, and to provide input into the wider strategy.

The co-ordinator of CERCs had become co-ordinator of RCUK. He remained budget holder for OST. There was to be no independent Board and no change in the lines of responsibility. RCUK was to have no greater authority than the forum it replaced.

During recent months, the *modus operandi* of RCUK has emerged. Its principal forum is the RCUK Strategy Group consisting of the Research Council chief executives and the DGRC. Its culture remains embedded in the civil service ethos. Its agenda follows what it sees to be ministerial priorities: stakeholder relations, an "engagement matrix" for engaging with the Regional Development Agencies, diversity and equality in higher education, and the review of the dual support system.[58]

It is preparing a "vision for science," but the vision's stated purpose will be to "describe national priorities" rather than identify new ones.

RCUK is a new acronym, but a lost opportunity.

[58] Agenda and Report, December 2002,

THE AMERICAN WAY

THE US HAS THREE principal agencies for research and development in non-military science and technology. The National Institutes of Health support medicine and clinical research and are a division of the US Department of Health and Human Services.[59] The Technology Administration is a division within the Department of Commerce.[60] The National Science Foundation (NSF) is responsible for research and postgraduate training in science and engineering generally.[61]

The NSF is an independent federal agency, created by Act of Congress in 1950. It funds research and education in science, technology, engineering and mathematics. Its scope is similar to that of the UK's EPSRC, ESRC, NERC, PPARC and the non-human research of BBSRC. But it has a larger role in the field of education. Its 2003 budget request was for $5 billion and, as shown in Table 6, its Research and Related Activities absorb nearly $3.8 billion of this. The NSF accounts for less than 4% of federal research and development spending, but supports about 50% of

59 The National Institutes of Health (NIH) comprise 27 separate Institutes, ranging from Ageing to Genome Research, and the 2003 budget request is for $27 billion. It covers areas similar to those covered by the MRC and the human-related activities of BBSRC, but much more extensively.

60 The TA was discussed in the author's earlier CPS paper *A Department for Business* which recommended changes in the DTI's approach, some of which are now being implemented.

61 As described below, the NSF also has a role in science and maths education in schools and universities.

the non-military research at US colleges and universities, and delivers 23% of total federal funding for basic research at academic institutions.[62]

Table 6

NSF Budget Requests 2003
($ millions, rounded)

	People	Ideas	Tools	Admin	Total
Biological Sciences	50	419	52	4	526
Computer & Information Science and Engineering	53	329	139	6	527
Engineering	78	399	4	6	488
Mathematical & Physical Sciences	117	597	222	5	942
Geosciences	35	413	235	8	691
Office for Polar Programs	5	74	223	3	304
Social, Behavioral & Economic Sciences	11	143	38	3	196
Integrative Activities	5	48	58	0	110
Total	**354**	**2,422**	**972**	**35**	**3,783**

Note: People: "developing a diverse, internationally competitive and globally engaged workforce of scientists, engineers and well-prepared citizens."
Ideas: "enabling discovery across the frontier of science and engineering, connected to learning, innovation, and service to society."
Tools: "providing broadly accessible, state-of-the-art and shared research and education tools."
Totals may not add because of rounding.
Source: National Science Federation.

62 NSF's share of federal funding for basic academic research is: 35% physical sciences; 42% engineering; 44% environmental sciences; 59% mathematics; 65% biology (non-health related); 84% computer science, and 100% anthropology.

The NSF has far greater autonomy than RCUK. It is led by a Director who is appointed by the President for a six-year term, while a Deputy Director is responsible for day-to-day business. A National Science Board of 24 is appointed by the President from leaders of the science, engineering and education communities. Members serve six-year terms, and continuity is provided by one-third of the membership being appointed every two years.

The annual budget is approved first by the President's Office of Management and Budget (OMB) and then by Congress. Once it is passed, the NSF Board and management are accountable for achieving the agreed programmes.

Each NSF research area is controlled by an Assistant Director, who competes for funds and esteem with other directors, while operating within an integrated system.

Research Funding

Most of NSF's research funding is granted in open competition. In October 2000, NSF became the first government agency to conduct all essential business electronically, using an award-winning system. By 2001, it was handling 99% of all proposals in this way. In that year, it received 32,000 proposals, initiated 130,000 reviews, awarded 6,000 graduate research fellowships, received 21,000 grantee progress reports, took 7,000 other post-award actions, processed 13,000 requests, and delivered $4 billion of funds electronically.

It continues to evaluate about 32,000 proposals each year through a competitive process, and makes about 20,000 awards in total, of which 10,000 are for new projects. About two-thirds of the awards are for research grants and one-third for postgraduate training. The average duration of each research grant is three years and the average annualised award size is about $125,000.[63] Currently, NSF gives direct support to 213,000 people, including

63 This figure cannot be converted directly to a UK equivalent, as it covers certain direct costs and overheads not hitherto met by the UK Research Councils.

researchers, post-doctoral fellows, trainees, teachers and students. NSF has an impressive knowledge of its quantitative outputs.[64]

Each research proposal is sent to up to five unpaid assessors for review, and a minimum of three independent reviews is required. The NSF avoids assessment committees and favours remote peer review. It sees itself as a tightly-focused central agency operating within a simple framework, and uses 50,000 specialist scientists and engineers each year for review, funding assessment and progress reporting. In 2001, 88% of all basic and applied research funds were allocated to projects that underwent competitive merit review.

The reviews follow the Merit Review Criteria approved by the National Science Board in 1997. There are two simple criteria:

- What is the intellectual merit and quality of the proposed activity?
- What are the broader impacts of the proposed activity?

Education

The US faces similar problems in maths and science education to those of the UK – a shortage of qualified teachers and PhD graduates, a low take-up by pupils and students, particularly female, and uncertainties about the curriculum. In some respects, the American problems are worse. In 1999, 10% of 24-year-old graduates in the UK took their first degree in the natural sciences and engineering, a higher proportion than any other industrialised country. In the US, the figure was 6%.[65]

The US government has delegated some of the responsibility for improving science and maths standards to the NSF.[66] Of the

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64 See also note 62.

65 Source: US National Science Board. The ranking is UK, Finland, South Korea, France, Japan, Taiwan, Norway, Canada, Sweden, Netherlands, Germany, Ireland, Spain, US, Switzerland, Italy, Belgium Mexico, China.

66 There is a federal Department of Education. However, public universities and colleges come under individual states, and schools are managed by local School

total NSF funding of $5 billion, some $900 million, or 18% of the total budget, is allocated to Education and Human Resources. Officials believe that the shortcomings in maths and science education have become more severe over the past few years. Young children are interested in science until about aged 10, but then lose interest as the syllabus becomes more rigorous. There is a sharp drop-out rate at 14, particularly among girls and minorities, with a further fall-off at undergraduate level. NSF plans to spend $374 million in 2003 on improving science and maths education of schoolchildren from pre-kindergarten to Grade 12. Science and maths disciplines are to be supported by "vertical and horizontal integration" – for example, humanities students might be encouraged to do projects on river pollution or the illness of a family-member. The NSF aims for all students to have algebra by the eighth grade; otherwise, it believes, too many doors will be closed to them.

Public awareness

The NSF monitors adult awareness of science and seeks to improve it. For example, its research shows that in 2001 over 20% of the public understood the term *molecule*; about 45% knew that lasers did not work by focusing sound waves, that electrons were smaller than atoms, and that humans did not live at the same time as dinosaurs; only half understood that the earth went around the sun once a year; three-quarters knew that radioactivity was not all man-made and that light travelled faster than sound; and nearly 80% knew the continents were moving slowly on the face of the earth. 44% used television as their main source of information on science and technology, while for specific scientific issues, 44% referred to the internet and 24% to books.

Boards. In order to provide stimulus from Washington and promote policy innovation in specific areas, the President and Congress habitually use federal agencies as pump-primers.

These findings are less important to a UK observer than the methodology. The Americans use statistical benchmarking as a means of measuring performance and driving progress.

The NSF perspective

NSF officials see their organisation as a tidy operation with uniform systems and easy interactions in a single building outside Washington DC. They believe strong top management and a unified budget process has produced good results over a 10 to 15 year period. Co-ordination has allowed rapid progress to be made across and between different topics, including climate change, high-performance computing, advanced materials, biotechnology and genomics.

Major initiatives are usually limited to five at any one time, in order to be fully resourced and sustainable. Older initiatives are culled as new ones are introduced. This followed a stressful period in the early 1990s, when many initiatives failed to win extra financial support from Congress and were only sustained by being allowed to eat into the core funding of university-based research.

The US's scientific research effort is not merely successful in absolute terms, but generates wide social and economic benefits. This is not just a matter of management, but of attitude. An official describes the ethos in the following terms:[67]

> American science takes advantage of competitiveness and creativity, with an emphasis on the individual rather than the institution. In the US, there is more interaction and movement between government, academia and business. The senior leadership in other countries are too involved in saying what ought to be done, rather than making it happen or participating in the result.
>
> Here, people don't worry about individuals making money from national research. The policy used to be that intellectual property belonged to the government. Congress said that was wrong, because it hindered innovation and potential benefits to the public. Universities are

67 Conversation with the author, 29 May 2002.

now free to make their own rules and usually share the commercial benefit of their patents. Many scientists form companies with their universities' help, and professors can work part-time in each.

At one time, scientists spent their careers working up the institutional ladder. Now, the top positions are advertised in open competition, and the trend is for scientists to become mobile.

Broader Issues

These comments raise broader issues. What are the characteristics that seem to make the American research scene more vibrant and effective than in the UK? American experts on science policy and innovation have suggested that the following points are significant:[68]

- There is, of course, the sheer weight of money. The US public sector R&D budget for 2003 is estimated at $116 billion, of which $27 billion will go to the NIH for biomedical research. The volume of research funds provides multiple sources of funding and a more expansive approach to research and salary levels. There is no perceived need or desire in the US to evaluate and rank university competence in specific fields in accordance with the elaborate sets of criteria of the UK's Research Assessment Exercise.[69]
- There is the view taken by Congress that intellectual property rights (IPR) should not be hoarded by the State or its institutions. The Bayh-Dole Act of 1980 not only left ownership of federally funded IPR with the universities, but expected them to file patents, award licences to small businesses, and encourage commercial collaborations.[70]

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68 Notes to the author, 10 and 11 December 2002.

69 See Note 14 above.

70 200 US universities are involved in technology transfer, adding about $40 billion to the economy in 1999 and supporting 260,000 jobs. Prior to Bayh-

- These factors are supported by a culture in which research professors talk the language of business and industrial firms are keen to supplement their in-house research capabilities with more fundamental university-based research. Venture capital funds are available from aggressive private-sector professionals, who are trained in commercial risk management and willing to take a hands-on role in their investments.
- There is a density of talent and concentrated expertise in specific universities and areas in the US, that is only now being matched in the UK.
- There is generally a less restrictive regulatory environment in the US, which helps stimulate research with the greater promise of financial return.[71]

Table 7 summarises, on the basis of this and earlier chapters, some of the differences between the American and British approaches.

Dole, fewer than 250 US patents were issued to universities each year; in recent years, they have exceeded 2,000.

71 A reverse example of this occurred in stem cell research, which the Bush administration has curtailed. The UK is now taking leadership in this area and is attracting US scientists.

Table 7

The American Way

	USA-NSF	UK-RCUK
Independent agency	Yes	No
External chairman	Yes	No
Independent board	Yes	No
Strong top management	Yes	No
Integrated organisation	Yes	No
Delegation with accountability	Yes	No
Fully electronic processes	Yes	No
Simple funding criteria	Yes	No
Schools education remit	Yes	Ineffective
Public education remit	Yes	Ineffective
Flexible Intellectual Property Rights	Yes	No
Business culture	Yes	No

CHAPTER SIX

CONCLUSIONS

BRITAIN'S SCIENCE IS LAGGING. This is not because our scientists lack talent, for they are among the world's best, but because they are being let down by a poor system. There is every reason to fear that the UK will fall further behind the US and give ground to other international competitors. The governance, organisation and structure of Research Councils UK must move forward from its present state of uncertainty, compromise and unaccountability.

The idea of a single overarching body to co-ordinate Research Council strategies, policies, activities and operational standards was correct. Advances in knowledge have made the old subject divisions archaic. The natural environment cannot be considered in isolation from the world beyond the ionosphere. Biotechnology is part of medicine. Complex information on the natural and life sciences cannot be analysed or synthesised without Information and Computer Technology.

Climate change, genomics and stem cell research, and e-science, all require cross-disciplinary strategies and programmes – what the NSF calls "vertical and horizontal integration." Benchmarking and the application of best practice should be as cross-cutting as the scientific subject-matter.

Problems with RCUK and OST

How should an overarching science body fit within the network of public institutions in the UK? What should be its locus in government, its constitution, governance and remit? One must start with the present institutions, – Research Councils UK and the Office of Science and Technology.

CONCLUSIONS

To describe RCUK as accountable to the Office of Science and Technology is to misread what actually happens. The RCUK Strategy Group is a forum for the DGRC and Research Council chief executives. Its terms of reference have progressed from CERCs, but the body is, in essence, little different. If anything, the increased centralisation has strengthened the civil service agenda and weakened the focus on science.

The role of the DGRC, as accounting officer for the OST and both a would-be leader of RCUK and *primus inter pares* of its Strategy Group, is flawed and confused. The future of the UK science and research communities is in the hands of two weak organisations, – a disenfranchised OST and a powerless RCUK.

In such circumstances, it is understandable that the Treasury should seek to influence and monitor the budgets of individual Research Councils. But it is a poor process of government.

OST must, however, accept some of the responsibility. Institutions and people earn authority by the way they conduct themselves. OST has been weak and its weakness has been aggravated by the well-intentioned intervention of the Council for Science and Technology. A *Board of the Research Councils* can achieve little if its design is not fit for purpose.

In setting up Research Councils UK, the Government and DTI officials failed to remember the lessons of the immediate past. The combination of weak governance and ineffective boards has led to the discrediting of organisations like Consignia and Railtrack. New names do not lead to the Promised Land.

The Government's decision that RCUK should not impact existing lines of accountability showed more than just ineptness and a lack of confidence. It signalled a lost opportunity for British science. It was positively damaging to the effectiveness of the new umbrella body, which at first sight promised so much and on second viewing can deliver so little.

It is absurd that the Director General – Research Councils has only a collegiate relationship with his chief executives, that he is not supported by a non-executive Board, when the chief executives are, and that there is no direct link between CST, the UK's foremost scientific advisory group, and RCUK. In Sweden, America and Ireland, these necessary conditions of good governance have been built into the constitution of the research organisations.

A UK Science Foundation: learning from the American way

Without much improved governance of Britain's science base, there can be no superior performance. The establishment of an authoritative, over-arching body for UK science and scientific research must therefore be a priority. Such a body should do far more than act in a co-ordinating and advisory role. It should be freed from civil service culture, and take a strategic and managerial lead in stimulating and harnessing British scientific genius. For the sake of argument, this body might be called the UK Science Foundation (UKSF). How would it work?

Locus

Where UKSF sits in the hierarchy of government is much less important than that it should operate effectively and that its sponsoring department should be committed to its success. UKSF could be sponsored by the DTI, as at present, or by the DfES.[72] If the DTI were to act as sponsoring department, it would need to pay serious attention to its responsibility, something that has been notably lacking. UKSF should not be sponsored by the Treasury, as this would reinforce the undesirable trend in the present government for economic centralisation.

Constitution

UKSF should be a properly constituted Non-Departmental Public Body with a high degree of independence. The US National Science Federation is accountable, not just to its Board, but to the President's Office of Management and Budget, and to Congress. Similarly, UKSF should operate as an autonomous unit, but be

72 The new Irish Research Council, IRCSET, comes under the Department of Education.

accountable to Parliament for its programmes and to its sponsoring department for its finances. The priority is that it should be discrete and accountable, and so should its executive management.

Governance

UKSF should be governed by a Board which sits under an independent Chairman. The DGRC's successor as chief officer should report to the Board, but his executive responsibility for leadership of the organisation should not be in doubt.

It is inadvisable that the Government Chief Scientific Adviser should chair UKSF, because of the close working relationship he has with the Prime Minister and Cabinet of the day.

The Council for Science and Technology has potentially a much greater contribution to make to national science policy than it does today. Selected members of the Council for Science and Technology should have seats on the Board of UKSF, as should other distinguished scientists and industrialists.

Remit

UKSF should take over the work of OST and RCUK. It should develop new strategies, policies and budgets for Britain's science and scientific research, and present them to government for approval. It should set overarching scientific priorities for the Research Councils and design universally applicable criteria for the assessment of research proposals.

It should analyse the UK's science and scientific research spending, seeking to categorise and define expenditure and outputs, and to determine measures for success or failure in the use of public funds.

It should challenge the preconceptions of the Research Councils. It should review the current structure of the Research Councils and recommend necessary change and integration.

UKSF should monitor the Research Councils' peer review and delivery processes, recognising that the traditional committee structures and timetables are outmoded. It should require

Research Councils to be accountable for general efficiency, timeliness, best-practice electronic implementation and the delivery of programmes.

UKSF should play an important role in pump-priming and developing new initiatives for national science education in schools and among the wider community.

It should have a specific role in raising public awareness of science and measuring the results of such programmes.

UKSF should, while not jeopardising the long-term nature of its remit, seek to improve the UK's international competitiveness.

It should, in particular, address broader issues, such as the release of intellectual property rights, knowledge transfer, the stimulation of commercial collaboration with a view to creating public benefit, and the development of more productive relationships between research professionals and the venture capital market.

UKSF's mission should be to restore leadership, dynamism, focus, prestige and substantive achievement to Britain's lagging scientific establishment.

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The average cost per pupil at a state school in Britain today is between £4,500 and £5,000 a year – and is set to rise by 6% a year for the next four years. If all the money followed the child, all state schools would have a sum equivalent to the independent sector. So why not free all state schools from government, and give them the same legal status and autonomy as an independent school? New schools would be able to open and existing ones to expand, where there is demand. Parents would then have direct control over their child's education. Government would be seen as a funder and regulator, not a provider, of education. Teachers would be seen as responsible professionals. LEAs would become service providers, catering to the needs of schools which want them, on a competitive basis. And most important of all, those children who currently have no choice but to endure the low standards and low aspirations that characterise failing inner-city schools would be set free of a system that has failed them.

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The great divide in British politics is now clearer than ever: the divide over the moral and practical case for the size of the state. Those on the centre right should explain – consistently and repeatedly – why policies of tax and spend will not deliver. They should advocate a pro-growth agenda to argue that tax cuts can mean that households can afford to pay for services directly. The examples of Canada, Australia, Holland and Ireland all suggest that reducing the proportion of GDP that is spent by the state can go hand in hand with both increased living standards and improved services. The centre right in Britain must regain its intellectual self-confidence; must communicate a consistent message on why the Government's tax and spend policies will fail; must reclaim a growth agenda; and must argue for limited government.

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The Secretary
Centre for Policy Studies
57 Tufton Street, London SW1P 3QL
Tel: 020 7222 4488 Fax: 020 7222 4388
e-mail: mail@cps.org.uk Website: www.cps.org.uk