

Cross-Cutting Review of Science and Research: Final Report

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Executive Summary

Section A: University Science Research Funding

While the UK's Science and Engineering Base, of which university research forms the larger part, remains world class, there is now a risk that a combination of factors built up over time could threaten that position. The key challenge which this part of the review considered is how to place university science research funding on a more sustainable long-term footing.

This involved consideration of the levels of, and balance between, different funding streams as well as structural changes designed to encourage partnership between funders and to improve universities' management of research – all with a view to improving long-term sustainability.

The report analyses the weaknesses in the current arrangements:

- the Dual Support (Research Council and Funding Council) system has never been properly defined. The sector has increasingly allowed its Funding Council resources to be spread thinly in support of an increasingly wide range of research sponsors;
- at the same time, the balance within the Dual Support system has shifted as the level of support for project funding through the Research Councils has, over the last decade and a half, increased substantially faster than the level of underpinning support from the Funding Councils;
- during the same period, the volume of university research sponsored by other agencies – principally, the research charities, government departments, the European Union and industry – has also increased substantially;
- while these developments have been taking place, a public sector legacy in the higher education sector has given rise to a low-price culture in which long-term sustainability has been subordinated to the need to win short-term research funding; and
- consequently, institutions have overtraded in research, pricing at or near the margin at the expense of long-run sustainability.

This review concludes that while additional funding from government – which accounts for some 70 per cent of research funding – will be an essential component of an overall strategy to buttress and improve science research, the balance between different funding streams, and changes to the frameworks and structures governing them, will be essential in creating the right incentives and financial control going forward. In particular:

- the rules governing the Dual Support system need to be made clear – in particular how far, and in what circumstances, the Funding Council

streams can be used to support work for government departments, charities and industry;

- the need for strategic partnerships among the key sponsors of research including:
 - between the UK Research Councils (RCUK) and the Funding Councils;
 - a Ministerial forum bringing together the four countries of the UK to discuss matters relating to the science and engineering base (SEB) which are affected by devolution;
 - a strengthening of the relationship between the Government and the major research charities to improve further the strategic planning for the SEB at the highest level and a recognition by the latter of how important their contribution is to maintaining the health of the research base; and
 - some shared work by institutions and users of the research base, such as industry, on how the principles for the use of public funding for supporting research outlined in the report might be put into practice and kept under review;
- institutions should be accountable for ensuring that they recover the full costs of research, taking one year with another and including any contribution that they wish to make to these costs from internally generated funds. To do this effectively, institutions will need to develop their management systems to be better able to cost accurately at project level. Future public funding for individual institutions should be conditional upon this;
- academic pay needs to be related more closely to market forces if the UK is to maintain its leading position;
- the working assumption is that the funders and users of the research base need to contribute more, along with government, to ensure its sustainability;
- these changes provide a context for future government funding and potential increases in the form of:
 - a long-term capital funding stream for university science research, allowing institutions the time and the certainty to prepare and implement long-term research investment strategies. The capital stream should be of sufficient size to allow the sector to reduce the present backlog over about a decade;
 - an increase in Research Councils' contribution to institutions' indirect costs;

- some increase in Funding Councils' recurrent resources to improve the balance of funding streams; and
- a ring-fenced sum for academic pay focused on supporting market-based pay changes required to attract and retain the best academic talent in an international market.

Not all this can be achieved immediately. Righting the investment shortfalls of the past may take the rest of this decade. But it will be important, because of the interdependencies between them, to take forward funding and structural change in a balanced way and recognising also the competitive need for the UK to continue funding new research as well as sustaining what we have.

Section B: Knowledge Transfer

Maximising the returns from research depends upon transferring the outputs of research rapidly and effectively into the economy and society. The most important ways of transferring knowledge, technology and know-how from the science and engineering base are through the supply of highly skilled people, and through the publication of the results of research. Public support for research and knowledge transfer needs to be sufficiently sophisticated to recognise the complex nature of innovation, and the role of research in innovation.

We focused our analysis on six ways in which the returns on public investment in Research and Development (R&D) can be increased and economic performance improved by promoting the transfer of knowledge and technology:

- increasing business funding for R&D;
- building better linkages between publicly funded R&D and business needs and market opportunities;
- increasing research jointly funded by business and the public sector;
- increasing the amount of R&D and related activities undertaken for business by Higher Education Institutions (HEIs);
- increasing other work in the SEB to transfer knowledge and know-how into business and the community; and
- increasing business demand for, and capacity to absorb and exploit, knowledge and know-how from the SEB.

We found very encouraging signs that the SEB is responding to the new requirements for it to engage in work of this kind. Our recommendations are aimed at building on this by:

- using the formation of the new Innovation Group and Knowledge Transfer Steering Group in DTI to provide better coordination between their ‘business pull’ work and the ‘SEB push’ work of OST, DfES and the Research Councils. DTI needs to continue to run a flexible portfolio of generic and ad hoc schemes to promote the pull though of SEB outputs into business;
- using the formation of RCUK to ensure the Research Councils work better amongst themselves, and with other funders, at a strategic level;
- ensuring that HEIs’ applied research, and other work for industry, is properly recognised and rewarded, and that HEIs work with funding bodies to market their expertise and competence better;
- bringing together existing schemes into a third stream of funding for HEIs, allocated to DTI and DfES to support:
 - the promotion of enterprise in HEIs;
 - the infrastructure and capability to transfer knowledge from HEIs;
 - seed corn funding;

- focusing any expansion of funding in the SR2002 period on non-research intensive departments in HEIs – working in partnership with one another and with research-intensive departments as appropriate – for work to engage with SMEs and less technologically sophisticated businesses, with such work to be clearly led by users, and with Regional Development Agencies (RDAs) involved in ensuring that what is proposed is aligned with the needs of business in the region; and
- ensuring public funding for knowledge transfer is generally in the form of pump-priming funds, with the exception of clear market failures where there may be an appropriate ongoing contribution.

Section C: Science in government departments

Government needs to use, and be seen to use, high quality science and the most appropriate new technologies. The credibility of departmental policy making depends on departments having the capability to commission the right research, assess its quality, and use it effectively.

The review of research funded by government departments aimed to strengthen departments' ability to deliver on the key principles set out in 'Guidelines 2000' on scientific advice in policy making. These principles established that departments should:

- think ahead and identify early the issues on which they need scientific advice;
- obtain a wide range of advice from the best possible sources, particularly when there is scientific uncertainty; and
- normally publish the scientific advice and relevant papers.

The review of research funded by government departments focused on civil departments. The main areas considered were: the delivery of science and innovation strategies; science budget management; in-house scientific expertise; and technology and knowledge transfer. A number of issues were identified for further action, summarised below:

- government departments spend significant sums of money on R&D to support policy making, regulatory activities and delivery of objectives. It is however a small proportion of total budgets. As a result, research budgets are usually not identified early in the Spending Review process. They can also be vulnerable to cuts in the face of more urgent spending pressures;
- research needs often cut across departmental boundaries. This raises issues of budget management and co-ordination strategy. Although there are examples of strong co-ordination in some cross-cutting areas of science, procedures for allocating and accounting for budgets have not always facilitated such an approach;
- departments obtain their research and scientific advice from different sources. Increasingly, these are external. Departments must be able to commission and manage outsourced research programmes, to evaluate the quality of the research, and use the findings effectively. Those departments with significant requirements for science and science advice must also have the capability to deal with science issues at an appropriately senior level; and
- government departments have a responsibility to ensure that the research they commission is adequately exploited. Despite the higher profile given

to the knowledge transfer agenda in recent years, this review found that progress at departmental level has been patchy.

The review makes a number of detailed recommendations to address these issues. Broadly, these fall into the following areas:

- use of costed science and innovation strategies as an input to Spending Review discussions;
- early identification of research spend as part of the Spending Review process and safeguards to prevent it falling below agreed allocations;
- exploration of scope for stronger co-ordination in cross-cutting areas;
- departments to appoint Chief Scientific Advisers and to ensure they have a suitably senior role;
- the Government's Chief Scientific Adviser to be responsible for a rolling programme of review of departmental research;
- better management, development and deployment of scientific staff; and
- departments to have more strategic knowledge transfer objectives and a senior official made responsible for delivery of knowledge transfer goals and targets.

Science and Research Cross-Cutting Review

Introduction

Why this review?

1. Over the last four years, the Government has invested substantial sums of new money in science and engineering research, research infrastructure and supporting the knowledge transfer activities of the science base. This is beginning to achieve results, but some systemic problems remain to be satisfactorily resolved. Principal among these are issues relating to the funding and pricing of science and engineering research. New evidence from the Transparency Review and from other sources points to the scale of these issues and the risks they pose to the health and vitality of the UK science and engineering base (SEB).
2. This review builds upon the previous cross cutting review¹ for Spending Review 2000 in relation to higher education science and engineering research funding. It also picks up new themes which have emerged in the meantime, principally the question of how science is used by government departments.

Key issues

3. The review has examined a range of key issues facing the **SEB** in the UK:
 - **Funding of science and engineering research in HEIs:** The performance of the present Dual Support² funding arrangements, in the light of evidence emerging from the Transparency Review; the extent to which all funders of research contribute less than the full cost of the research they sponsor in universities³; further action required by higher education institutions to improve their approach to financial management and to the costing and pricing of research.
 - **Science and engineering research infrastructure.** The extent to which present and previous capital funding schemes (namely the Joint Infrastructure Fund (JIF) and the Science Research Investment Fund (SRIF) – both in partnership with the Wellcome Trust) have addressed the backlog identified by Dearing⁴ and later studies; and how infrastructure should be funded in the future to ensure university research is funded on a basis that is sustainable in the long term.
 - **Science and engineering research careers:** This strand was considered alongside the review of the supply of scientists and engineers which was

¹ www.hm-treasury.gov.uk/mediastore/otherfiles/519.pdf

² Funding Councils and Research Councils

³ Throughout this report, the terms “universities”, “higher education institutions” (HEIs) and “institutions” are used interchangeably and without any difference in meaning, to describe the whole Higher Education sector.

⁴ *Report of the National Committee of Enquiry into Higher Education: July 1997.*

carried out by Sir Gareth Roberts⁵. The cross-cutting review examined, in particular, the question of how academic pay structures should be reformed to ensure that the science base can continue to recruit the talent it needs in a competitive world market.

- **Knowledge transfer and exploitation:** The present funding mechanisms and progress towards a system which recognises, incentivises and rewards excellence in those activities that impact on business and the economy. It is also examining the relationships between the ‘science base push’ programmes and DTI’s ‘business pull’ innovation programmes and will take account of the developing regional agenda.
4. The review also considered the impact of its recommendations on arts and humanities funding, following criticisms that the previous focus on funding science and engineering had had an adverse effect on the arts and humanities.
 5. The review was also asked to examine civil research funded by government departments and, in particular, the delivery of science and innovation strategies, in-house scientific expertise, science budget management, and technology and knowledge transfer. The main aims were to ensure that government departments deliver the science required to meet their policy objectives, and to raise the quality and profile of science and technology in departments.
 6. The key elements of this part of the review were:
 - **Delivery of science and innovation strategies:** Research priorities and cross-departmental programmes; the arrangements for managing research programmes, for ensuring the quality of research and for using the results of research; the longer term requirements to address likely scenarios over the next decade; and an assessment of the research and development component of the SR2002 spending bids for departments with significant research needs.
 - **Scientific expertise:** How to improve departments’ capacity to use science to deliver objectives by improving the quality of scientific expertise within the civil service; the role and management of scientists in the civil service, and measures that might strengthen scientific capability in Government.
 - **Stronger science budget management:** The present science budget management arrangements and options for stronger central management and co-ordination have been considered. This strand of work included a review of science management overseas.
 - **Mechanisms for knowledge and technology transfer:** This involved a review of the effectiveness of exploitation policy and mechanisms for knowledge and technology transfer, in particular the effectiveness of

⁵ SET for success: The supply of people with science, technology, engineering and mathematics skills. The Report of Sir Gareth Roberts’ Review, April 2002

initiatives set out in the Baker Report on commercialisation of the research outputs of public sector research establishments.

Scope and conduct of the review

7. The terms of reference for the review were as follows:

- To consider how to maximise the benefits provided by public spending on science and research to the UK's economy and quality of life.

Terms of reference on science funding by OST/DTI and DfES:

- to review current funding mechanisms and levels, and to identify the priorities for resources across the funding streams held by the Office of Science and Technology and the Department for Education and Skills;
- to review current funding mechanisms for knowledge and technology transfer from the science and engineering base and mechanisms to promote adoption by business, and to identify priorities for future use of resources; and
- to take stock of studies commissioned or reporting since the last Spending Review, and with potential implications for resources, including:
 - the Transparency Review, on the costing of university activities;
 - the Roberts Review into the supply of scientific skills for business R&D;
 - the review of investment in university research infrastructure;
 - the Quinquennial Review of the grant awarding Research Councils;
 - the review of business support schemes in DTI; and
 - the HEFCE/OST Higher Education Business Interaction Survey.

Terms of reference on civil research commissioned by government departments:

- to assess the scientific and technological capabilities of government departments with significant research needs; to review current and planned levels of activity; and to compare both capabilities and activity levels with likely scenarios over the next decade, and to identify priorities; and
- to identify proposals for improving the effectiveness and value for money of civil research commissioned by departments, to maximise the impact of available resources; and to increase the contribution made to the Government's broad goals for the economy and quality of life, including mechanisms for knowledge and technology transfer.

8. In order to inform the review of the Science and Engineering Base, the Steering Group drew on a number of sources, principally:

- visits to 16 universities across the UK chosen to provide a cross section of the sector. Visits have usually included meetings with the Vice Chancellor and senior teams and visits to research laboratories. During all visits we

have discussed knowledge transfer, to obtain an idea of the activities that are currently being carried out using existing third stream and other resources;

- meetings and discussions with key practitioners and opinion formers in the Science and Engineering Base, including other Vice Chancellors and senior university staff, the Chief Executive of the Higher Education Funding Council for England, the Confederation of British Industry, Association of British Pharmaceutical Industries, Chemical Industry Association, Association of Medical Research Charities, Wellcome Trust, representatives of leading research charities, Universities UK, the head of a major industrial research laboratory, the North West Development Agency, the East Midlands Development Agency and associated organisations, DTI's Business Competitiveness Group, the Association of University Research and Industry Links (AURIL), university technology transfer officers, the devolved administrations, and Research and Technology Organisations;
 - the review group has considered reports including the survey of Higher Education and Business Interaction by CURDS⁶, and reports by PREST⁷ and SPRU⁸;
 - the Transparency Review and other work, including some commissioned for the cross-cutting review, such as:
 - a review of underinvestment in university infrastructure⁹;
 - a review of the relationship between the higher education sector and charities¹⁰; and
 - a study of the strengths and weaknesses of the UK Science and Engineering Base.
 - a wide range of other published and unpublished information and data about higher education research funding.
9. The review of research funded by government departments has also drawn on different sources to inform the areas under consideration. These include:
- meetings and discussions with Ministers, Permanent Secretaries and key officials in departments with significant science programmes;
 - departments' science and innovation strategies;

⁶ www.hefce.ac.uk/Pubs/hefce/2001/01_68.htm

⁷ 'Industry-academic links in the UK' by Luke Georghiou, Jeremy Howells and Maria Nedeva, PREST (November 1998)

⁸ 'The Relationship Between Publicly Funded Basic Research and Economic Performance' by Ben Martin and Ammon Salter, SPRU (July 1996)

⁹ <http://www.ost.gov.uk/research/funding/underinvest/index.htm>

¹⁰ http://www.hefce.ac.uk/pubs/hefce/2002/02_07.htm

- visits to laboratories undertaking research for Government departments;
 - meetings and discussions with people who work in large organisations outside government that have similar needs for scientific expertise and scientific advice;
 - a workshop for Whitehall personnel directors on the management and career development of government scientists;
 - a science standards seminar for departmental officials, contractors, research programme managers and external peer reviewers; and
 - discussions with Foreign and Commonwealth Office science attaches.
10. The report is structured in three main sections: science funding (section A), knowledge transfer (section B) and science in government departments (section C). Recommendations in sections A and C are included in the text of the report, whereas recommendations in section B are brigaded at the end of the section according to the organisation that would be responsible for implementing the recommendations.
11. The Steering Group is extremely grateful to everyone who has given up their time to contribute to this review, particularly the universities we visited for arranging stimulating tours of their facilities.

Section A: University science research funding

Public investment in UK science and engineering research

12. There is a body of evidence which suggests that returns generated by public investment in basic and strategic research are high. Some of this evidence was cited at the time of the previous Cross-Cutting Review of Science Research Funding¹¹. In addition, in 1986, the US Office of Technology Assessment stated that, “Every \$100 of public money put into academic science yields, on the average, a perpetual return approaching \$30 per annum in industrial, commercial, medical and other social benefits”¹².
13. The Government’s approach, as set out in successive Treasury and DTI publications, sees innovation as a key driver of improved economic performance. Flowing from that, research and development are essential elements of innovation. It is the basis on which new ideas are developed, systems improved and quality of life enhanced, by generating improvements in health and well-being, and in products and services. In a knowledge economy, science and research are key drivers of innovation and growth.
14. The Government has recognised the importance of investment in, and support for, research and innovation by setting the framework for, and creating incentives to, encourage investment in science. The Government has also increased its own investment in the science and engineering base and in the commercial exploitation of science. But as this report shows, there is a need for further reform of the structures and funding of the science and engineering base.
15. The rationale for government investment in basic science is to correct a market failure. Firms will not on their own tend to invest in early development work, nor will they normally invest in curiosity-driven, blue skies, research which is likely to result in major breakthroughs, but where the returns are uncertain. Government and industry can, though, work in partnership to address the market failures, and the Government has a role in creating the frameworks that allow these partnerships to develop.
16. Comparatively, the UK does not invest enough in research. As a proportion of GDP, aggregate UK R&D levels are still some way behind that of our main competitors, as figure 1 below shows (UK – 1.8 per cent; US – 2.6 per cent; Germany – 2.3 per cent; France – 2.2 per cent; Japan – 3.0 per cent). On present plans, Government spend on R&D by 2003-04 will still be 6.5 per cent lower in real terms than it was fifteen years ago, despite having increased by 12.7 per cent since 1997-98.¹³

¹¹ Para 22 et al, *Cross-cutting Review of Science Research Funding*, HM Treasury, 2000 (www.hm-treasury.gov.uk/mediastore/otherfiles/519.pdf).

¹² *Research funding as an investment: Can we measure the returns?* US Office of Technology Assessment, 1986.

¹³ *Forward Look 2001*, Table 2 (www.dti.gov.uk/ost/forwardlook01/index.htm).

18. Aside from the general competitive threat implied by these investments, there is a more direct threat in terms of the competition for scientific talent – likely to be particularly potent from English speaking countries.
19. In terms of its outputs, the UK Science and Engineering Base is one of the most excellent and the most productive in the world. The UK has 1 per cent of the world's population, performs 4.5 per cent of world science and produces 8 per cent of science papers which receive 9 per cent of citations. Over the long run, UK scientists win about 10 per cent of all internationally recognised science prizes. Most recently two UK scientists (who had largely been funded by medical research charities) shared the 2001 Nobel Prize for 'Physiology or Medicine' with a US researcher. The Research Assessment Exercise 2001 results published in December 2001 demonstrated a further substantial increase in the strength in depth of UK science in the period since 1996 with a large increase in the number of research active staff now considered to be operating at world-class standards. By any measure, UK science and engineering research is successful.
20. On other indicators, too, the UK SEB is a world leader. Using third party research income as an indicator of the relevance of the research base, the UK comes out first in the world. It is first too in relation to the cost-efficiency of research. One pound spent in the UK SEB yields more scientific publications and citations than the same money spent anywhere else in the G7.
21. The picture then, is of a vibrant and healthy, world-class SEB which brings substantial benefits to the nation, but whose investment levels are lower than those of our competitors notwithstanding the recent increases there have been, especially in basic research funding. The importance of research in sustaining an innovative economy and the developing competitive pressures from other countries should also be considered.

Recommendation A1: The Government should continue its commitment to increasing investment levels in basic and strategic research.

The funding gap in higher education research – preliminary observations

22. But this picture conceals a substantial underlying problem. There is now compelling evidence of a significant funding gap in higher education science and engineering research (which makes up the great majority of the UK SEB) which points to the present level of output being unsustainable in the medium to longer term
23. Evidence for the funding gap comes from a number of sources. The problem is not new. It was noted by Dearing in 1997¹⁴. The Comprehensive

¹⁴ *Report of the National Committee of Enquiry into Higher Education: July 1997.*

Spending Review in 1998 resulted in the setting up of the Transparency Review which in turn led to the implementation in higher education institutions (HEIs) of an activity-based costing system known as TRAC. HEIs will now report annually to their Funding Councils their aggregate costs relating to publicly funded and non-publicly funded teaching and research and other activities. This data shows a funding gap in both publicly funded and non-publicly funded research.

24. Despite this no HEIs have yet become insolvent. This is because they have been compensating for any gap – wittingly or otherwise - in two principal ways:
 - (i) universities are cross-subsidising publicly and non-publicly funded research from other earned income, for example overseas student fees and conferences. While some element of cross-subsidy from discretionary to core activities is appropriate, some of this income is uncertain and so the cross-subsidy is not necessarily sustainable; and
 - (ii) universities have not invested in their science research infrastructure to the degree required to keep it fit for purpose. Research suggests that there now exists a maintenance and development backlog in science research infrastructure across the sector of the order of £3 billion.
25. The present research funding position is therefore unsustainable in the medium to longer term. If not addressed, it will result in a progressive deterioration of the quality of the UK Science and Engineering Base with consequences for UK competitiveness and productivity.
26. The reasons why the gap has arisen are complex and relate to past and present behaviours of all the key stakeholders involved, as listed in Table 1 below:

Table 1 – Key actors in the UK HEI research system¹⁵

Funders of the SEB	Users of the SEB	Research performers
<ul style="list-style-type: none"> • The Dual Support system funders: <ul style="list-style-type: none"> • The Research Councils • The Funding Councils • The NHS • The research charities • The European Union (Framework Programmes) 	<ul style="list-style-type: none"> • Industry • Government departments who purchase research for the purposes of policy-making 	<ul style="list-style-type: none"> • Higher education institutions

27. These behaviours – and the incentives in the present system which have given rise to them - are discussed in more detail later in this report. But our initial assessment of the position leads to the following high-level recommendations.

Recommendation A2: Government should take the lead in moving the research funding system back on to a sustainable footing. But a satisfactory solution will not be found unless all stakeholders make an appropriate contribution.

Recommendation A3: In addressing the under-funding issue, Government and other funding partners should be guided by the principle that the key aim is to fund properly excellent research wherever it is to be found.

Recommendation A4: Improving sustainability is key to the long term health of the science and engineering base. But the pace at which this moves forward needs to be balanced with the continued need for the UK to invest in new science.

28. The experiences of the recent past suggest that the problem of under-funding requires a solution that addresses the problem over time; the funding system does not react well to external shocks – even injections of funding. For example, while universities welcomed the £1 billion Science Research Investment Fund (SRIF) launched following the Spending Review 2000 (SR2000), many were troubled by the short time they were given to prepare their SRIF allocation. The lesson is that

¹⁵ It is worth, at this point, drawing attention to the distinction made in the table between the so-called “**funders**” of the SEB and the so-called “**users**” of it since these terms will be used throughout the remainder of this section of the report. “Funders” are defined to be those who, by and large, fund research for the purposes of generating public goods – that is to say non-proprietary knowledge and technologies which are freely available. “Users” are defined to be those who fund research in universities principally for their own private benefit. Throughout the rest of this section we also use the term “**sponsors**” to identify the sum of these two groups. It will immediately be clear that in practice things are more complex than this table would suggest. In particular, some “users” of the SEB, some of the time, sponsor research in funder-mode (eg industry working in collaboration with universities on high-risk research). The taxonomy shown in the table is intended to represent the bulk of the research sponsored by each group.

universities need time and greater certainty about future funding if they are to be enabled to plan their investments properly, and hence get the best value for money from them.

Recommendation A5: All funders and users of the SEB, along with the HE sector itself, should work together to close the funding gap over a number of years.

29. Later recommendations will suggest that the revenue gap be addressed within 3-4 years and the capital backlog by the end of the decade.
30. The establishment of a sustainable system for the future will depend on more than just better funding. It will require close attention to the behaviours of all the key stakeholders and the system-based incentives which drive those behaviours. In the case of the funders, a considerably greater degree of interaction will be required so that the various funders are aware of the consequences of their own and each others' behaviours on the research system. In short, the major funders need to behave more strategically, both individually and collectively.

Recommendation A6: There should be a strategic partnership between the Research Councils and the Funding Councils which should ensure that the Dual Support system is co-managed coherently in the best interests of the UK Science and Engineering Base. Government has a role in establishing this partnership.

31. The setting up of RCUK provides the platform for such a partnership on the part of the Research Councils.

Recommendation A7: The strategic partnership between Research Councils and Funding Councils should, in time, be extended to embrace other major funders of the Science and Engineering Base, including the research charities, government departments and industry, reflecting the recommendation in the recent Quinquennial Review of the Grant-awarding Research Councils that a Funders Forum be established¹⁶.

32. A particular concern in relation to a co-ordinated approach to the funding of research is the issue of **devolution**. Science is a reserved matter, while education is devolved. As a result of this, the Research Council side of the Dual Support system is funded on a UK-wide basis, while HEIs' block grants, which include a component for underpinning research capability, are delivered through national funding councils¹⁷. A critical success factor in addressing the underfunding problem is that a consistent approach be taken across the UK. Failure to achieve this is likely to lead, for example, to a false market between universities in different countries of the United Kingdom. This would be a highly counterproductive outcome. For this reason, the following recommendations are made.

¹⁶ Quinquennial Review, recommendation 1.4.
(<http://www2.ost.gov.uk/research/councils/quinquennial/press2.htm>)

¹⁷ Except in Northern Ireland.

Recommendation A8: The education departments in the four countries of the UK, together with the Funding Councils in England, Scotland and Wales should address the under-funding problem in a concerted way.

Recommendation A9: A new forum should be established at Ministerial level bringing together the science ministers from Scotland, Wales and Northern Ireland, together with the Higher Education Minister at the DfES, under the chairmanship of the Minister for Science and Innovation, who has a UK-wide remit. The forum should be shadowed at official level. Its terms of reference should include all issues relating to the UK SEB where devolution is relevant.

33. While the emphasis in this section thus far has been on research funders, the success of any attempt to address the funding gap depends as much as anyone else on the higher education institutions themselves. As we will see, a low-price culture pervades the HE sector and has significantly contributed to overtrading in research. The universities are beginning to implement some of the management tools needed to tackle this, but it will also require the willingness to do so. What is required is that in a system where flows of government funding are properly resourced and balanced, each university should seek to recover across the full range of funding sources and research sponsors, the full economic costs of the research performed, less what the institution chooses to make available from other non-publicly funded income sources. The following are therefore key recommendations in this report.

Recommendation A10: The Government should in future take the view that continued public support for research at individual institutions will depend on institutions being able to demonstrate that they are recovering the full costs of research (including contributions from other activities). To put this another way, the Government should not in future underwrite shortfalls in research funding arising because of inappropriate management decisions or inadequate management systems within institutions.

Recommendation A11: The Funding Councils should devise light-touch means of ensuring that universities are behaving appropriately when having regard to cost recovery across their portfolios of research. The aim should be to seek sufficient assurances for Government at the minimum cost to institutions.

34. In order that the system remains sustainable in the long-run, it will be necessary to do more than just place reliance on institutions to move to full cost-recovery. It will also be necessary to ensure that the demand for research which will normally attract public support within institutions does not materially run ahead of the total level of public support available, as has happened in the past. Failure to achieve this is likely to lead once again to under-recovery of costs by institutions since they, understandably, find it difficult to turn high quality research away. The only way that this can be achieved in practice is through

greater information sharing among the main research sponsors, mediated through fora such as those suggested in recommendations A6 and A9.

Recommendation A12: In return for Government accepting and acting on the recommendations for closing the research funding gap (which are set out later in this section) other funders must recognise their responsibility to provide Government and other sponsors of research with the strategic information they need about their research plans. Government will need to be able to signal clearly to other research sponsors and to HEIs when research volumes planned are inconsistent with the level of intended public support and discuss with them what action is appropriate. A forum for such discussions should be developed under the wider strategic partnership among the sponsors that is recommended elsewhere.

35. The rest of this section of the report looks in more detail at the causes which have given rise to the funding gap, the scale of the problem and the role of Government and of each of the key stakeholders in helping to put HEI science and engineering research back on a sustainable footing.

The Dual Support system

36. As originally conceived, the Dual Support system provided two complementary streams of public funding for university research.
37. Funding for universities' basic research capability, provided by the Higher Education Funding Councils pays for research infrastructure, that is to say, salaries of permanent academic staff, premises, libraries and central computing costs¹⁸. The intention is that this funding – “QR”¹⁹ – should provide research departments with:
- the freedom to pursue a certain amount of pure blue-skies research;
 - the base from which permanent academic staff can make credible proposals for research project funding from the Research Councils; and
 - the costs of training new researchers.
38. There are two further features of this funding which are important to note. First, funds are awarded to institutions on the basis of a formula driven principally by the Research Assessment Exercise (RAE) ratings of departments within institutions. (The RAE is a high level peer review process and is discussed in paragraph 128.) The formula skews funding for a given volume of research activity towards the highest-rated (i.e. the most research-excellent) departments. The degree of the skew is known as ‘selectivity’. The formula has recently been

¹⁸ See *Funding Higher Education in England*, paragraphs 55-57: HEFCE, Feb 2000

¹⁹ “QR” stands for Quality related Research funding – the name given to the largest research funding stream allocated by HEFCE. This term is used throughout the rest of this section as shorthand for the totality of research funding provided by the Funding Councils and the Northern Ireland Education Department.

altered to increase the degree of selectivity in the light of the RAE 2001 results, but the basic idea remains unchanged.

Table 2 – Degree of selectivity in the QR allocation, 1996-2001

1996 RAE rating	Funding weights in QR
1, 2	Nil
3a	1
3b	1.5
4	2.25
5	3.375
5*	4.05

39. Second, once allocations have been determined for each institution, they are then bundled with allocations for teaching and other activities into a single annual block grant. Institutions are free to use their block grant as they see fit. QR funding need not be spent in the departments that ‘earned’ it, and some universities do take strategic decisions as to how the funds are to be used, for example, to build up particular areas of expertise. There is no requirement for the funds to be spent on research at all, although the Transparency Review findings show that, overall, there is a large subsidy into research in both research and teaching intensive HEIs.
40. The other half of the Dual Support system comprises funding from the Research Councils, which are in turn funded (on a UK basis) from the Science Budget, managed by the Director General of Research Councils in the Office of Science and Technology. The Research Councils provide funding for specific projects usually for three years at a time in response to proposals submitted to them and approved through peer review. Research Councils pay the marginal costs of the project they are funding plus a contribution to attributable indirect costs which is set at 46 per cent of the costs of any staff brought in specifically for the purpose of carrying out the research in question – the ‘eligible staff costs’. Research Council grants do not pay for the staff costs of the principal investigator, whose costs are assumed already to have been funded through QR.
41. As a footnote to this description of the Dual Support system, we should note the position of the NHS. Whereas, as in table 1, government departments are shown as users of the SEB, the NHS is, in fact, an important funder of the SEB, spending, in 2001-02, £74 million on clinical and other health-related research and £401 million to meet the costs to it of research carried out by the Medical Research Council and other research funders. Its position is therefore closest to that of a Research Council and that is how it is considered in the remainder of this section.
42. Dual Support distributes decision making about research between the Research Councils on the one hand and institutions on the other, insulating the system against single-point failure. It sustains a dynamic balance between, on the one

hand, research which is strategically relevant and internationally peer reviewed and, on the other, research which is directed from within institutions which may be purely curiosity-driven or may be in rapid reaction to advances in a given field. This dynamic balance is a significant contributor to the present vitality of the UK SEB.

Recommendation A13: The solution to the problem of ensuring a sustainable research base in universities should retain and protect the principle of Dual Support.

43. However, the notion of a simple Dual Support system as described above has become increasingly illusory in recent years because of the growth in research in universities sponsored by a range of third parties. In the early days of the Dual Support system these sponsors (listed in table 1 alongside the Dual Support funders) were generally not large players and so their behaviours did not affect the system to an appreciable degree. In recent years, however, this has ceased to be the case.
44. The fact that the increasing presence of other funders has impacted on the Dual Support system is because, on one key issue in relation to the system, there is a crucial lack of clarity. It has never been made explicit whether QR funding was originally intended to be limited to supporting just blue skies research and Research Council project funding or whether it was intended, in addition, to support – that is to say, to subsidise - the research of other sponsors as well. What is clear is that QR has, gradually become the *de facto*, if inadequate, underpinning for research sponsored by a range of project research funders. This ambiguity is therefore one of the key contributors to the funding gap since it has created a situation in which universities are not incentivised to charge the full costs of research and non-Research Council sponsors likewise do not feel the need to pay more than the Research Councils. As a result, no research project sponsor group pays enough for the research that it purchases. As we shall see later in this section there have been other contributors to this state of affairs, not least: the management culture of universities; their resultant pricing behaviour; the signals from government about the national desirability of universities working with industry and others; and Government's assumed position as funder of last resort.

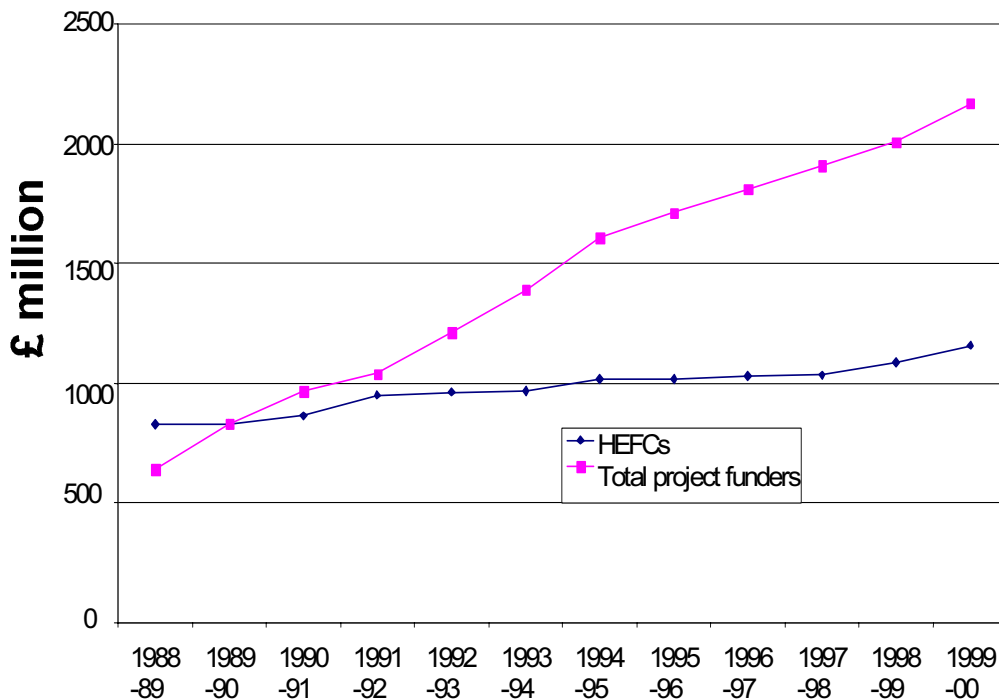
Recommendation A14: A key component of any solution to the under-funding problem should be a clear statement about the purpose, scope and operation of the Dual Support system – especially the QR component - within the wider, plural funding system that now exists.

45. The effect of the lack of clarity at the heart of the Dual Support system could have been ameliorated had the level of QR funding kept pace with the volume of project research funding that it had, in practice, been supporting. This was not the case.
46. In fact, taking the two sides of the Dual Support system alone (and treating all Science Research Investment Fund (SRIF) and Joint Infrastructure Fund (JIF) monies as if they were QR), over the 17 years to 2003-04, QR will have increased

by 28 per cent in real terms. The comparable figure for Research Councils is 65 per cent - a rate of increase 2.3 times as great.

47. On top of this internal imbalance within the Dual Support system, there has been a steady and substantial increase in the volume of research supported by all the other major project sponsors – the charities, industry, government departments and the European Union. In the late 1980s the ratio of income from all project funders to that from the Funding Councils was close to unity. As figure 2 shows, by 1999-2000, that ratio had risen to 2:1.

Figure 2 Expenditure by FCs and all project funders



48. These observations about the shortcomings of the Dual Support system set the scene for some of what follows and suggest that recommendations will be needed which, in addition to recommendation A14, address:

- a reconsideration of the level of contribution to indirect costs made by Research Councils;
- the need for a better balance to be struck – and maintained over time – between the two sides of the Dual Support system;
- the need for universities to understand the importance of recovering a greater contribution to their real costs from the range of project research sponsors; and
- the need for other sponsors of research to make a greater contribution to the costs of the research they are purchasing.

49. As we shall show, in clarifying the rules of the Dual Support system, there is a strong case for some non-Research Council sponsored research to benefit explicitly from public infrastructure support. In the next section, therefore, we consider the grounds on which public support for research should be made available and discuss how, in practice, this should operate. In the subsequent sections we shall consider the implications that this has for the various stakeholders in the system.

Principles of public support for basic research

50. We begin by restating in a little more detail the rationale for public support for basic research. Basic research is highly speculative and long term in nature. Many avenues of research will prove unfruitful, while huge wealth-generating potential (for example) can occur unexpectedly. It is therefore unlikely that industry, left to itself, will fund this form of research. Nevertheless, such research is clearly beneficial to the economy, to individuals and to society. Government therefore funds this research and, by doing so (and thereby lowering the risk), also leverages in research funds from others. The outputs Government buys through funding basic research are:

- new knowledge and new technologies as well as access to the new knowledge and technologies being created by research elsewhere in the world;
- very highly trained and skilled people; and
- knowledge transfer and exploitation.

51. All of these contribute in various ways to the delivery of significant benefits to the economy. As we have already seen, there is considerable evidence that public investment in research yields a high return.

52. In order to move towards a solution to the problem of research under-funding, it is useful to articulate the key principles, derived from the rationale set out above, which should inform decisions about the use of public funds (QR) in supporting project research. These need to be articulated in a way which is relevant to individual institutions appraising individual cases since it is at this level that decisions on the deployment of the public support provided to HEIs through QR will in general be taken.

Recommendation A15: We recommend that, in appraising the case for using their public funding (QR) to support a given piece of research, HEIs should test whether – and if so, to what extent – the following principles are satisfied:

- research should demonstrably contribute to the enhancement of the UK SEB or in some other way provide a net public good. An indicator of this may be that the results will be published openly in the academic literature and that any intellectual property generated by virtue of the research will vest in the university rather than with the commercial funder (so that revenues generated by licensing or spin-outs benefit the

university). Charity funders may, with the agreement of the university, choose to hold and exploit intellectual property themselves, or allow the university to do so;

- the funder will have a research strategy which, while recognising the advantages of having a plural funding system, nevertheless takes account of the strategy and priorities of other key funders, most notably the Research Councils and charities;
- research supported will be only of the highest quality. This implies that funders wishing to benefit from public support will need to demonstrate that they have project appraisal systems in place which seek to ensure that only high quality research is funded; and
- access to research funds should not systematically be restricted to any specific research performers or group of performers. In principle, anyone with an idea for excellent research and the means to carry it out should be eligible for funding.

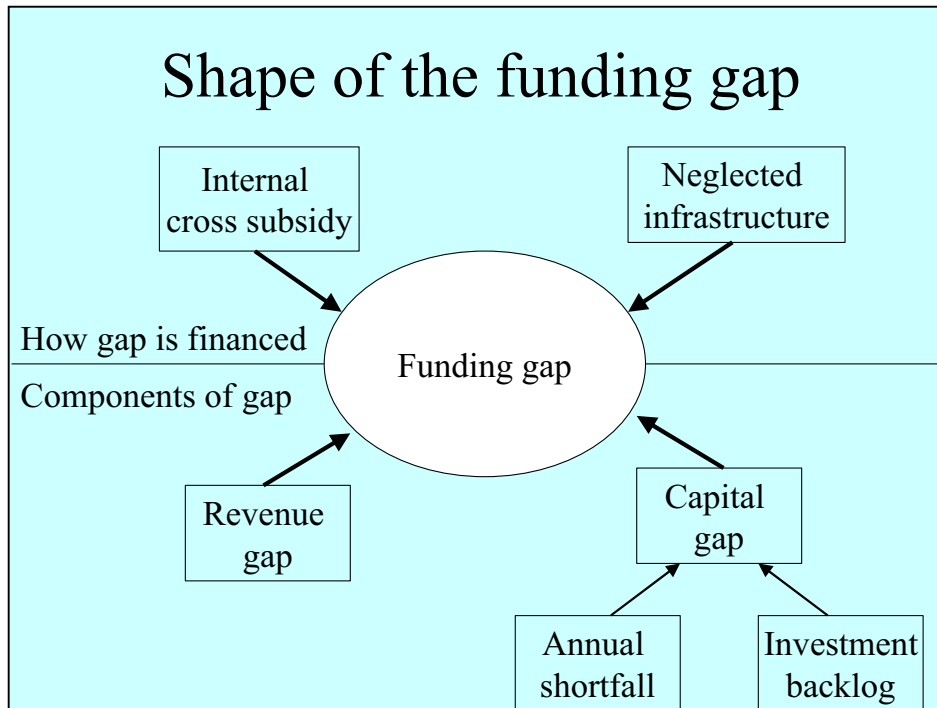
53. By providing a tool which informs the pricing of research (though this is not sufficient on its own), the application of these principles should assist institutions in the task of moving towards full cost recovery.

Recommendation A16: It is crucial that these principles be understood by all research sponsors and accepted by them as a key part of the landscape in a sustainable research system in the future. Government should make clear its support for them and an expectation that they will be applied by HEIs and accepted by sponsors as part of the quid pro quo in which the level of public support for research is increased.

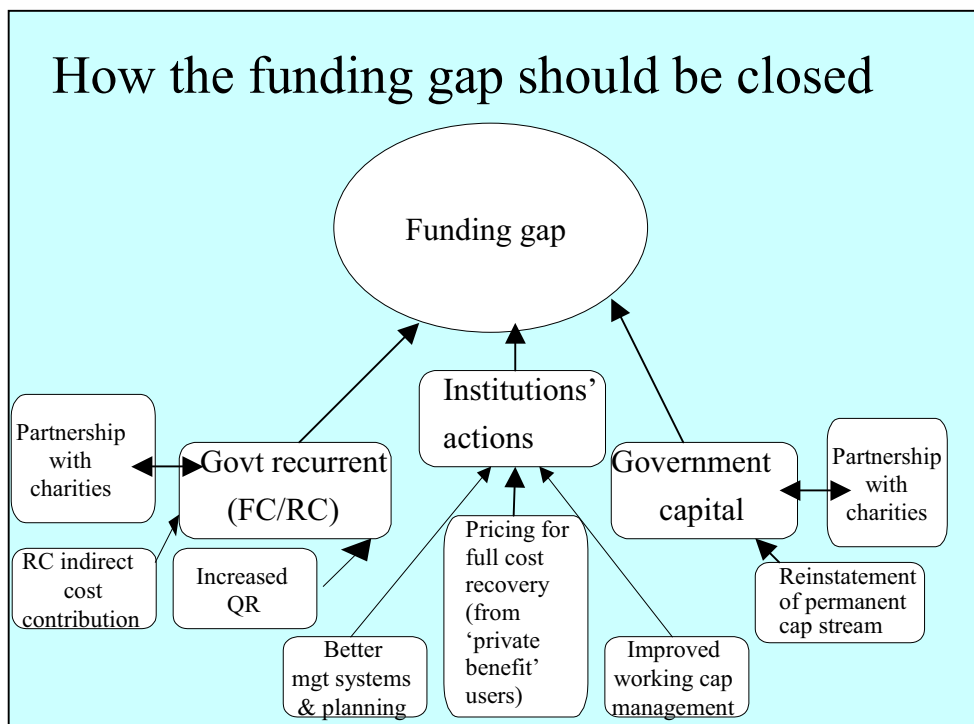
The funding gap

54. In this part we examine the shape of the funding gap and assess its scale. In later parts of this section, we address the question of how the gap should be closed.

Figure 3 below shows schematically the components which make up the gap and how they are at present financed within institutions.



55. The funding gap is the difference between the income that HEIs in aggregate receive for research and the aggregate full economic costs of that research. It may be considered as comprising two separable components:
- the shortfall in capital investment required to be made by HEIs to maintain and adequately develop their science research infrastructure. This part may itself be divided into two parts:
 - the amount which HEIs need to invest annually to maintain their existing estate fit for purpose less what they already spend on this;
 - the backlog in estate management and development which has arisen in recent years; and
 - the remaining shortfall in income required fully to cover the recurrent indirect costs of running both the research and the institution itself.
56. The gap can be measured at an institutional level and at sector level, given comparable income and cost data at institutional level. As we have noted above, the funding gap is filled at present in two ways. First, by reduced capital investment and second by internal cross subsidy from other income.
57. **Figure 4** below sets out the schema which is described in more detail in succeeding parts of this section for closing the HEI research funding gap. It provides a framework within which the problem can be addressed.



58. If the gap is to be closed for the present volume of research, increased income will be needed to finance increased capital expenditure and to increase the revenue contribution made to the indirect costs of the institution by research.
59. Before we explore means of closing the gap, we first look at various estimates for the size of the gap.

The Transparency Review

60. The existence of a funding gap in respect of research in higher education has long been suspected. Its existence has been confirmed by the data supplied by institutions to their Funding Councils as part of the Transparency Review (TR). The review was established following the Comprehensive Spending Review in 1998. In return for increased funding of research, institutions were asked to implement measures which would enable them better to account for the public research funds they were being given. The review was overseen by the Transparency Review Steering Group chaired by the Director General of Research Councils which reported to the Science and Engineering Base Co-ordinating Committee chaired by the Government's Chief Scientific Adviser. The job of implementing the review in the sector was overseen by the Joint Costing and Pricing Steering Group – a sector-owned group established by the Funding Councils and the then Committee of Vice Chancellors and Principals (now Universities UK).
61. Under the Transparency Review, HEIs were asked to implement an activity based costing system which would allow them to identify to a reasonable approximation the full costs of their main activities. The system is known as TRAC. The key activities which it costs are:

- Publicly funded teaching – T(PF)
 - Non-publicly funded teaching T(NPF)
 - Publicly funded research²⁰ - R(PF)
 - Non-publicly funded research – R(NPF)
 - Other activities – O
62. The system was piloted on nine universities before being rolled out across the sector. Roll out was achieved significantly ahead of schedule owing to the enthusiasm with which the sector took up the system. Under the system, universities were to report annually their total costs in the five categories to their funding council. Funding Councils would report the data at sector level, but institutional level data would not be made public. The first report involving the majority of the sector took place in July 2001 for the academic year 1999-2000 and the second in January 2002 for 2000-01. Future reports will be made each January.
63. A key implementation issue was how academic staff time was to be attributed to the core activities. Two problems needed to be overcome. First, most academics – especially in research – work longer than their contracted hours, for no extra pay. Second, the academic community regarded timesheet recording, common in professional firms, as anathema. For simplicity the answer to the first issue at this stage was to ignore it. This means that the cost data that the system records in some cases understate the true costs which universities would bear for the present volume of research if they were paying for academic staff time on a pro rata basis. The second problem was overcome by providing institutions with a set of options for time attribution all of which were thoroughly tested in the pilot institutions and found to provide a good approximation to the actual attribution.
64. A key feature of TRAC is that it provides a common methodology for costing right across the sector and so provides assurance that aggregation of data provides meaningful information.
65. Raw TRAC data tends to look only at short-run costs. In order to correct for this, the TRAC methodology applies two adjustments to the data as follows.
- The **Infrastructure Cost Adjustment (ICA)** represents the difference between what HEIs should be investing annually to maintain their estate and what they actually invest. It is an accounting concept which represents the difference between depreciation charges calculated at historic cost and at current cost. Institutions which re-invest the full amount at current cost levels should report an ICA of zero.
 - The **Cost of Capital Adjustment (CoCA)** is the amount required to service the capital needed for the development of future productive capacity. CoCA

²⁰ Note – ‘Research’ in TRAC includes Arts and Humanities research and no attempt is made in what follows to split this out so as to arrive at a science and engineering research figure. It is assumed that, commensurate with its overall funding levels compared to science and engineering research, that the effect of arts and humanities research on the overall picture is not significant.

has been set at 6 per cent in line with the figure currently used in the public sector.

66. These adjustments are reported to the Funding Councils alongside the costs of the five activities listed above. They are not themselves attributed to these costs.
67. The TRAC system on its own does not provide any information about the size of the funding gap for research. For that, comparable information is also required about income. When that is available, it becomes possible to see at sector level the extent to which – according to the TRAC system – universities are covering, or failing to cover, their costs in each of the five activities.

Extent of the funding gap

68. In this part, we look at what the TRAC data suggest about the research funding gap and the uncertainties, which surround this approach.

Table 3: TRAC data for English HEIs (1999-2000)

2000-01 full costs	1999-00, £k	% of total costs
Publicly funded teaching	4,790,174	43.5
Non-publicly funded teaching	607,892	5.5
Publicly funded research	2,658,892	24.1
Non-publicly funded research	1,266,731	11.5
Other	1,703,306	15.4
Total costs	11,026,995	100.0
2000-01 cost adjustments	1999-00, £k	% of total costs
Total expenditure per audited financial statements	10,294,807	
Infrastructure adjustment	273,821	2.6
Cost of capital employed	472,441	4.6
Exceptional items adjustment	(14,074)	(0.1)
Net adjustments	732,188	7.1
Total costs	11,026,995	

Source: HEFCE

69. TRAC data was reported by all HEIs for 2000-01 in January 2002 and the results are not materially different. The data shows that the cost adjustments together account for about 7 per cent of the total costs of all activities, or about £746 million.

Table 4: Comparison of costs and income for Research

	Income, £m	Cost, £m	Difference, £m	Difference, % of cost
R(PF)	2113	3288	1175	35.7
R(NPF)	726	1564	838	53.6
R(Total)	2839	4852	2013	41.5

Source: HESA

70. Extending this analysis to all five activity categories – not shown here – reveals that there is no cross-subsidy from publicly funded to non-publicly funded activities. This is an important and welcome result. However, the figures also show that while the sector appears to be in balance at the aggregate level, both publicly funded and non-publicly funded research are being cross-subsidised from income earned from non-publicly funded teaching (T(NPF)) and other activities (O).
71. The data thus suggests a gap between research income and the full economic costs of the research undertaken in 1999-2000 of around £2 billion. The authors of the TRAC system carried out a series of benchmarking exercises with institutions as part of the preparation for rolling out TRAC across the sector. As a result of their experiences with these exercises, they reached a view that likely deficit on research is more likely to be $\text{£}1.4 \pm 0.2$ billion per year. The key reason cited for the difference between the two figures was that some income properly attributable to research is probably scored in HESA data under different headings.
72. If we are to understand the implications of this funding gap better we need to get some idea of how much of the cost adjustments discussed above are attributable to R(PF) and R(NPF). Unfortunately, this is where the usefulness of the TRAC data begins to reach its limits, as an increasing amount of judgement is required.
73. According to a recent study of investment in university research infrastructure (see paragraph 79), 34 per cent of the costs of HEIs' estates are accounted for by research. One method might therefore be to multiply the total cost adjustments by 34 per cent to find the amount attributable to research. But the cost adjustments are meant to represent the annual shortfall in infrastructure expenditure. The TRAC data suggests that T(NPF) and O recover substantially more than full economic cost, while the under-recovery for T(PF) is slight. One interpretation of this is that non-research infrastructure is being adequately financed annually. If this were the case, then the bulk of the cost adjustments would be attributable to research. Under this interpretation, we might then assume that of the £2 billion annual shortfall in research, some £600 million (say) was due to infrastructure under-investment.
74. Another interpretation – possibly the more likely one – is that a level of cost recovery from T(NPF) and O greater than the surplus over full economic cost is being used to support the recurrent shortfalls in research funding, leaving the whole estate short of the annual investment levels needed. Under this

interpretation, the infrastructure component of the shortfall would be lower – at perhaps £300 million.

75. The TRAC system's authors state that the cost adjustments do not allow for the filling of the infrastructure backlog which has grown up over the last decade or so. That backlog is estimated in the university science research infrastructure study to be around £2.7 billion for buildings. The implication is that in addition to the annual infrastructure investment shortfall a further annual investment is required over a number of years to close the backlog. While the overall size of the funding gap remains uncertain, it is also clear that the process of closing the gap will rely on a range of measures other than just increased funding by Government and others. For example:

- our own analysis of the sector's finances supported by anecdotal evidence gathered during the review suggests that the sector could make significant improvements to its finances through tighter working capital management;
- while it is clear that there remains a significant infrastructure backlog, our view is that better estates management across the sector can contribute to a more efficient use of capital in the future. Given sufficient certainty about future capital income, this could include project management gains from tackling projects in a more plural fashion and potential for cheaper and more efficient borrowing; and
- if additional funding is made available to close the overall funding gap, this should improve the investment climate in the sector and enable it to lever in additional capital from other sources.

76. In relation to the infrastructure backlog, our view is that the TRAC cost of capital adjustment and the investment backlog should not be regarded as entirely separate. In practice, since it not possible to fill the backlog quickly, given sufficient funding over a long period of time, institutions will make investment decisions based on their future needs, some proportion of which will obviate the need for backlog investment. To what extent the backlog should be discounted to allow for this, however, remains an open question.

Investment in science research infrastructure

77. It is therefore helpful to consider the capital shortfall first because to the extent that specific measures are taken to address that, the size of the overall problem is reduced accordingly. The residual problem then has to be addressed through increased revenue income, some of which may still be required to contribute to closing the capital expenditure backlog.

78. The problem of chronic under-investment in science research infrastructure is well known and was clearly identified by Dearing in 1997. The Government has recognised this problem and has made significant contributions to alleviating it in previous spending reviews. The Comprehensive Spending Review established the £750 million Joint Infrastructure Fund (JIF) in the period 1999-00 to 2001-02, while the Spending Review 2000 set up its successor, the £1 billion Science

Research Investment Fund (SRIF)²¹ which will run throughout 2002-03 and 2003-04. Both programmes were partnerships between OST, DfES, the education departments of the devolved administrations and the Wellcome Trust.

79. In order to better understand the scale of the remaining problem, OST commissioned a study of Science Research Infrastructure²². The study reviewed the past investment in UK universities and colleges, assessed the extent of remedial investment required and set out the conditions needed to enable HEIs to manage their infrastructure on a sustainable basis in the future. This concluded that:

- the remaining backlog of science research infrastructure investment, after JIF and SRIF amounts to about £3.2 billion (buildings, £2.7 billion and capital equipment, £0.5 million);
- the amount that universities ought to be reinvesting in their science research infrastructure each year to stand still is around £350 million²³ per year, of which it is estimated that they are at present spending about half. Further investment is needed on top of this to ensure that the best research groups continue to have access to (increasingly sophisticated) world-class facilities;
- JIF and SRIF have been essential and valuable, but have made only a modest contribution to solving the overall problem. JIF, in particular, was directed to the creation of new cutting-edge facilities, and indeed, because it did not fully fund projects, this has had the effect of diverting investment away from routine, but key, institutional infrastructure. SRIF was designed to give universities more freedom to decide their own priorities, but is likely, to a more limited extent, to have similar effects; and
- the solution should include a longer term capital funding stream.

80. The study, which was based on detailed case studies at 20 institutions and a sector-wide survey, noted the reasons why the backlog appears to have arisen. It paints a picture in which chronic under-funding has been exacerbated by a series of external perverse incentives and cultural and managerial issues within the HE sector, including:

- the development over time of a low-price culture, driven by incentives in teaching and research to increase volume for marginal increases in funding;
- the fact that nearly half of the university research estate was built in the post-war expansion of the 1960s, much of which is at or nearing the end of its useful life; and
- the public sector culture which has pervaded the HE sector. This has led, among other things, to a mindset which thinks of budgeting annually rather

²¹ £100 million of which was set aside for capital investment by Research Councils in their institutes.

²² *Study of Science Research Infrastructure; a report for the Office of Science and Technology* (www.dti.gov.uk/ost/sosri/Chapter1.pdf), J M Consulting, December 2001.

²³ This is equivalent to 4 per cent of the science research infrastructure asset base of £8.8 billion.

than for the long term and which treats estate management as a relatively low priority.

81. Furthermore, the demands of a modern building, which include the costs of meeting health and safety, disability and other legislation, and other needs such as air conditioning, have resulted in new buildings costing significantly more than the buildings they are replacing, or modernising. Modern buildings also cost more to run. We were told on one visit, that the cost of running a new biochemistry building was 40 per cent higher than the building it replaced.
82. Our own discussions with a similar number of senior officials from a range of UK universities tend to support these findings. From universities' point of view, the key issues in relation to infrastructure funding would appear to be as follows:
- there is a desire to return to the position up to the mid-1990s, with an ongoing stream of funding for infrastructure. Universities recognise that in the long run they should be required to make their own capital investment allocations from an adequate stream of recurrent income and stand or fall by their decisions. But many – including some of the large research-intensive universities – recognise that the sector is not yet capable of behaving in a sufficiently commercial way to make this realistic in the short term;
 - such a capital funding stream should provide continuity in a way which neither JIF nor SRIF has so far done in order to enable a greater degree of forward planning;
 - arrangements should incentivise universities to invest in a range of projects including unglamorous bread and butter maintenance and renewal. The short term nature of both JIF and SRIF and the need for matching funds in the case of the latter (despite its improvements over JIF in other respects) tended to push investment towards higher profile projects. Subsequent arrangements need to define and monitor this balance more carefully to ensure that the essential, but unglamorous, infrastructure work is undertaken;
 - universities recognise that they need to be incentivised to behave properly and that they need to be accountable for their investments. But they do not wish to see an invasive and costly audit process. We agree with this and wish to see the accountability mechanism made as light-touch and cost-free as possible; and
 - universities need to be able to plan their capital investment over the long term. Without the certainty of long term funding, universities are incentivised to adopt a piecemeal approach to refurbishment and new development. This approach is more expensive, in the long run, than wholesale, planned refurbishment and development.
83. We accept the sector's arguments for a reinstatement of the capital funding stream for research and that it is too soon to consider a recurrent funding solution. We also accept the arguments that in order to plan infrastructure investment properly against a broader institutional strategy, universities need time to plan and

certainty about funding over a significant period. With these thoughts in mind we make the following recommendations.

Recommendation A17: Government should re-instate an earmarked capital funding stream for research infrastructure with the strong expectation that it will be available indefinitely and that no less than three years' notice should be given of it being substantially changed.

Recommendation A18: The capital stream should be allocated by means of a formula based on overall volume and quality of research, as with the current Science Research Investment Fund, and the allocations should be set firmly for a number of years at a time. There should be caps and safety nets in place so as to smooth the effects of changes in allocation at institutional level between allocation periods.

Recommendation A19: Universities should be free to make their own research infrastructure investment decisions. But they should be encouraged to do so with a regard to the views of their major project funders, in particular, the Research Councils whose role in contributing to the health of the UK SEB gives them a legitimate interest in the provision and distribution of infrastructure within the HE sector. It will be important for such funders to recognise the need for universities to invest in support infrastructure and not simply front-line research facilities.

Recommendation A20: The earmarked capital stream should be set at a level which:

- allows the present infrastructure backlog to be adequately tackled by 2010;
- narrows the gap between the present levels of annual investment in maintenance and a level which would ensure that the substantial majority of the research estate is maintained fit for purpose;
- takes account of the contribution that some funders will make to long-term costs of research when universities recover the full economic costs of research from them or when such funders otherwise enter into strategic partnerships which involve contributions to infrastructure.

Recommendation A21: As part of the process of accounting for their use of this infrastructure funding stream, universities should be able to demonstrate that investments are dealing with both the backlog and underpinning infrastructure and not simply for creating ever greater research volume capacity. We recommend that HEFCE consider asking university auditors to verify this.

84. The principle of own contribution which has been adopted in SRIF has had advantages and disadvantages. On the whole the disadvantages have related to the

way in which SRIF has been operated, while the advantages are more generic. The main advantage has been that universities have been forced to think hard about their own investment priorities. The main disadvantage has been that the need for own resources on a short timescale has distorted internal decision making and cash-flow. There has been limited time to interest third parties.

Recommendation A22: Universities should be required to find not less than 10 per cent matching funds for the new capital funding stream.

Recommendation A23: The own-contribution requirement should be waived where universities are able to demonstrate genuine inter-HEI collaboration on investment projects along the lines developed for SRIF.

85. The problem of research infrastructure cannot be considered in isolation from similar issues in teaching since much of the HE estate involves some degree of dual-use.²⁴ The same buildings can contain both teaching and research facilities, the same facilities are sometimes used for teaching and research, and the boundary between the two activities is in any case sometimes blurred, as when undergraduates carry out independent research projects in research facilities as part of their courses.

86. Sir Gareth Roberts' review of science and engineering skills supply has identified poor quality teaching laboratories as a key problem, which is undermining the development of the up to date science and research skills required for academia as well as the wider economy.

87. If teaching and research infrastructure funding are artificially kept apart, investment decisions will be sub-optimal from the point of view of the returns to individual institutions.

Recommendation A24: There should be increased investment in teaching laboratories in higher education. Teaching and research infrastructure funding streams should be designed with sufficient flexibility to allow individual institutions the ability to co-manage them sensibly in the context of local needs and priorities. In particular, it should be possible to vire between the two streams in any year without limit so long as the original balance is recovered within three years.

Recurrent funding – general

88. Having established an earmarked publicly-funded capital stream, universities need to generate sufficient income to cover:

²⁴ *Study of Science Research Infrastructure* (www.dti.gov.uk/ost/sosri/Chapter1.pdf), J M Consulting, December 2001.

- any remaining capital requirements; and
- the direct and indirect recurrent (short-run) costs of research.

89. Subsequent parts of this section discuss how this should be done, with reference to the framework shown in figure 4. But before proceeding with the detail, we make the following general recommendations in relation to cost recovery.

Recommendation A25: Having made clear to the HE sector its responsibility for recovering the full costs of research from all sponsors taken together, the Government should signal also to research sponsors what is expected of them in the drive to achieve long-run sustainability of the Science and Engineering Base.

Recommendation A26: HEIs should understand and accept that a degree of internal cross subsidy from profit-earning activities into research within universities is healthy and indeed is to be expected in institutions with a strong research mission. The expectation should be that this will continue, though the extent to which it continues will be a matter for individual HEIs in the context of their own cost-recovery strategies.

Recommendation A27: The HE sector and the Funding Councils should consider building on the principles for public research support recommended earlier in this section by developing guidelines to help institutions to develop more robust pricing strategies. This should be done as part of the project (see recommendation A34) to build on the present TRAC management accounting systems. Any such guidelines should make clear that, subject to the overall requirement in relation to cost recovery, universities are free to take a view on the value to them of non-cost considerations on individual projects when negotiating prices.

Contribution of the main project funders to the costs of research

90. In this section we look at the contributions that the various sponsors of HEI research make to the costs of their research. To set the scene, figure 5 illustrates the relative contribution to higher education research income by the major research sponsors.

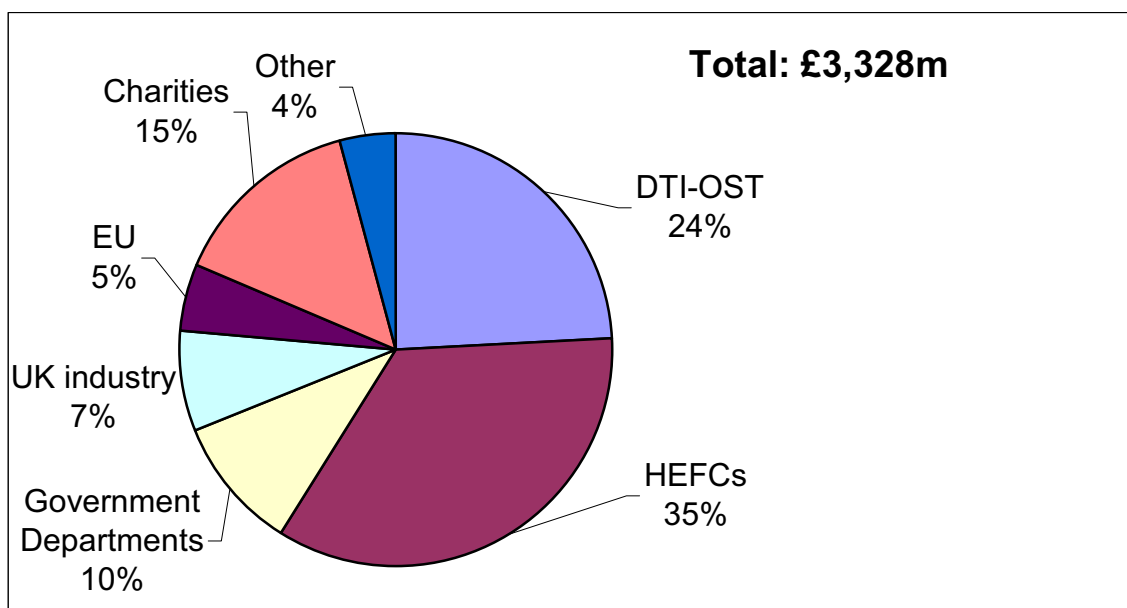


Figure 5 – UK HEIs' sources of research income, 1999-2000 (SET Statistics)

The Research Councils

91. The Research Councils together provide the largest source of project and related funding for research in HEIs. Their total investments in research are summarised in table 5 below.

Table 5: Destination of Research Council funding, 1999-2000

Destination of RC funding	Funding level 1999-2000, £m	%
HEIs		
• <i>Project & Programme Grants</i>	528	
• <i>Units and centres</i>	20	
• <i>Studentships</i>	164	
• <i>Fellowships</i>	35	
HEIs total	747	49
RC Institutes	550	36
International subscriptions	106	7
Other	110	7
Total	1511	

Source: SET Statistics, Table 5.2

92. Prior to 1992, the Research Councils paid only the direct marginal costs of their research. The 'Dual Support transfer' of 1992 moved about £150 million per year from the Funding Councils to the Research Councils to allow the latter to pay for a greater range of direct costs and to contribute 40 per cent of eligible staff costs to the indirect costs of research. This figure was subsequently raised to 46 per cent in two stages.

93. The review has heard evidence from universities and a range of research sponsors that the present arrangement whereby the Research Councils contribute 46 per cent of eligible staff costs to the indirect costs of their projects is problematic. It is substantially lower than the full indirect cost level in most institutions. Given the increasing range of research which QR has in practice to support, it is almost certainly the case that Research Council-funded research is no longer fully funded from the public purse. In addition to this, there is a widespread view, shared by some of the SEB users, that the 46 per cent figure has become a *de facto* benchmark for other funders and users of the SEB. Increasing the Research Council contribution to indirect costs would therefore have a number of very significant advantages. These include:

- sending a strong signal to other SEB funders and users that they need to contribute more to the costs of research;
- helping to reduce overtrading by sending increased funding to the point where the research costs lie;
- by ensuring that research funding more closely follows costs, allowing greater emphasis to be placed on the role of QR in funding genuinely blue skies research in the best departments; and
- sustaining the present degree of selectivity in HEI research funding while at the same time providing lower-rated departments with an incentive to continue to seek Research Council funding even in the face of falling QR income.

94. There are two basic approaches which could be taken to increasing the Research Council contribution. Firstly, the base on which the contribution is calculated could be broadened. This could be done in one of two ways or in some combination of the two:

- first, the indirect cost contribution could simply be applied to a wider range of existing direct costs within project grants; or
- second, the range of eligible direct costs could itself be extended, by, for example including an element of the research grant to cover the costs of the principal investigator, or a contribution to infrastructure costs (in the form of a space usage charge) and the contribution calculated on this broadened base.

Secondly, the base for the calculation could be left as it is at present ('eligible staff costs') and the percentage raised.

95. The two approaches are conceptually different and so it will be necessary to weigh up which brings the greater advantages. Some of the relevant considerations are as follows:

- as we shall see later, the charities are strongly opposed to contributing in undifferentiated fashion to indirect costs (as opposed to making specific contributions). The price signal sent to the charities by changing the present

Research Council cost contributions is therefore likely to be relatively weak and its impact unlikely to be sensitive to the form it takes;

- on the other hand, the price signal that would be sent to users of the SEB, principally industry and government departments, is likely to be much stronger. In this case, since the present arrangement provides a benchmark of sorts, the most powerful signal of change would be to retain the present formulation, but move the benchmark much closer to the full economic cost level that universities will need to recover from users in many cases if they are to fulfil their new cost recovery responsibilities; and
 - the risk with extending direct costs to include the time of the principal investigator is that the principal investigator's salary, at present a given under QR, will come to be considered as soft funding, to be bid for from research sponsors. Such a move would run counter to the recommendations to be made by the Roberts Review in respect of the insecurity and lack of career structure engendered by the present proliferation of contract research posts in universities.
96. An important adjunct to this is that there is a significant proportion of Research Council funding in universities other than project funding, which attracts no significant contribution to indirect costs, for example, PhD training and research fellowships. In any change to the present arrangements, these funding streams should not be ignored.
97. The precise details of what the level of increase should be and how it should be presented are beyond the scope of this study and further work will be needed in due course to quantify what is needed and to design new arrangements. With that in mind, the following recommendations are made.

Recommendation A28: The overall price payable by Research Councils should be increased significantly, consistent with the additional funding universities receive through the Dual Support system from Funding Councils. The increase could be phased in over time.

Recommendation A29: The new arrangements should be designed so as to have the maximum impact on the behaviour of other research sponsors in respect of the amount they pay for their research.

Recommendation A30: Further work is needed to quantify more clearly what is needed and to design new arrangements. This work should include consideration of:

- those Research Council funding streams which at present attract little or no indirect cost contribution²⁵;

²⁵ This recommendation will have direct cost consequences in respect of the Royal Society and Royal Academy of Engineering fellowships which are funded through the Science Budget.

- the question of whether a significantly increased level of funding through the Research Council route would advantage particular disciplines at the expense of others; and
- the effect of any changes on the overall balance and rationale of the Dual Support system.

Charities²⁶

98. The activities of the research charities have a big impact on the research scene in the UK, most notably in the area of biomedical science. The top ten Units of Assessment in terms of charity income are all in biomedical science and the largest by far is hospital-based clinical sciences. According to the Association of Medical Research Charities, its 111 members invested £552 million in medical research in the UK in 1999-2000. This compares with research spend by Research Councils in HEIs in the same year of £747 million²⁷. Over the period 1996-2000, a little more than three-fifths of this research money was invested in HEIs with a further 3 per cent going to charities' units based in HEIs²⁸. According to HESA statistics, quoted in a recent report to HEFCE, in 1999-2000, charity-funded research in universities totalled more than £480 million. A decade earlier, the equivalent figure was just £156 million²⁹.
99. The charity research scene is dominated by the Wellcome Trust, an asset-backed medical research charity. In 1999-2000, the Wellcome Trust was the second largest charity, by income, in the UK. In 2000 it invested £280 million in research – more than half the AMRC total and only a little less than the investment made that year by the Medical Research Council. The most notable feature of Wellcome Trust funding in recent years has been its rapid growth. Between 1996 and 2000, investment in front line research more than doubled. The Trust has published plans to spend some £2.8 billion on research and research infrastructure in the period 2000 to 2005 (not all of which will be spent in HEIs)³⁰.
100. The recent merger of the Imperial Cancer Research Fund (ICRF) and the Cancer Relief Campaign to form Cancer Research UK brings a second major player into being. Its work complements that of the Wellcome Trust which does not involve itself in cancer research.
101. The quality of the research sponsored and performed by the charity sector is as good as anywhere else in the UK SEB. This is illustrated by the fact that the 2001 Nobel Prize for Physiology and Medicine was won by three scientists, two of whom are based at the ICRF's laboratory in London.

²⁶ Where not otherwise specified, information in this section is sourced from *Research relationships between higher education institutions and the charitable sector: A report by JM Consulting to the HEFCE on mapping and good practice*, HEFCE 2001, http://www.hefce.ac.uk/Pubs/hefce/2002/02_07a.htm

²⁷ *SET Statistics*, table 5.2, published by OST at <http://www2.dti.gov.uk/ost/setstats/data/5/setstats2001-tab0502.htm>

²⁸ Figures from (i) AMRC's *Statement on Funding for University Research*, Feb 1999 and (ii) AMRC's submission to this review.

²⁹ Despite this increase, the proportion of university income accounted for by charities barely changed throughout this decade.

³⁰ *Planning for the Future: The Wellcome Trust 2000-2005*. The Wellcome Trust.

102. The charities are also important sources of capital for HEIs. Wellcome have contributed some £525 million to HEI science research infrastructure in partnership with Government through JIF and SRIF and, on behalf of the biomedical research community are contributing to the costs of the new Diamond synchrotron machine. AMRC's figures suggest that some 10 per cent of what their members spend, on average, goes towards buildings and major capital grants.
103. What is the objective of charities' research and how does that influence its nature? The research charities – especially in the biomedical field – sponsor research whose goal is clearly to generate knowledge which will benefit the public. In our view, this makes them funders rather than users of the SEB. It can be argued that the charities provide an independent stream of research funding which is by and large indistinguishable from the sort of research which could be carried out under a Research Council project grant. The Wellcome Trust, for example, sees its role as 'to help the **state** find cures for disease and to increase knowledge for the health and benefit of humankind'³¹. In many respects, again, especially in the medical field, the research programmes of the charities complement those of the Research Councils and the NHS. But the charities pose a conundrum for Government since:
- they are resolutely unwilling to pay the indirect costs of the research they sponsor in HEIs. The charities regard the provision of basic research infrastructure as the responsibility of Government; and
 - the substantial growth in the resources at their disposal in recent years (principally driven by the spectacular growth of the Wellcome Trust) compounded by universities' propensity to overtrade has contributed significantly to the present funding gap.
104. While the AMRC stress the heterogeneity of charity funding mechanisms given the size of, and number of individual players in, the sector it is possible to discern some clear characteristics. In some respects, the project funding provided to HEIs by the charities compares favourably with the equivalent funding from the Research Councils (although it will almost always be less in total on a like-for-like basis). For example, when funding projects, the charities are willing to contemplate providing some direct costs (though expressly none which relate to infrastructure) which fall outside the scope of the present Research Council arrangements. Furthermore, as we have already noted, the charities are willing to make specific capital investments in universities where they see the specific need, or wish, for example, for their own strategic purposes, to exercise greater influence over a research programme.
105. We believe that the objectives of Government and the charities with regard to funding the SEB are consistent and complementary. We therefore believe that the two parties should aim for a closer relationship in the future. In return for provision by Government of the basic infrastructure which charities need in HEIs, the charities accept their responsibilities both to pay a proper contribution to the

³¹ Mike Dexter, Director of the Wellcome Trust, speech made in April 2000 to Save British Science.

costs of their university research and to share with Government and other key funders their expenditure plans and research priorities. The recent publication by the Wellcome Trust of its five year forward strategy is a welcome move down this road.

Recommendation A31: Government and the charity sector should consciously seek to work more closely in partnership with the aim of putting university research back on a sustainable footing and ensuring greater complementarity of their respective research missions and portfolios.

Recommendation A32: In return for the Government making explicit HEIs' freedom to provide support for charity funding from their public infrastructure funding (QR and capital – see recommendation A15) and for improved levels of Government investment, the charities should fund at least the full direct costs of the research they sponsor. They should remain willing to pay more than this – current or capital - where research meets a key strategic need of theirs which does not match in timing or volume the needs of other major funders or institutions.

Government departments

106. Government departments are significant users of the SEB. In 1999-2000, they spent some £337 million on R&D in UK HEIs, some 12 per cent of HEIs' total research income.
107. Unlike charities and Research Councils, however, departments fund research by and large to inform and improve their own public policy making in furtherance of specific departmental objectives. Like industry (see below), they are therefore predominantly users of the Science and Engineering Base rather than funders of it. Government departments are not motivated by the health of the science and engineering base (except in so far as they have strategic interest in the existence of the necessary research base to deliver their needs); nor is their research in any sense part of a national research strategy; and nor is it necessary for the science always to be the best available. Many pieces of work simply seek an answer to a question and need to be fit for purpose rather than ground-breaking.
108. Government policy is that departments should secure the best value when placing research contracts. Most departments state that they do not have a policy on contribution to indirect costs. In practice, however, the approach varies considerably. For example:
 - a department reported, “in general, it is possible to get evidence that any such costs will be genuinely incurred and not a hidden profit, and negotiate them down to around 20 per cent”;
 - in contrast, a second department stated, “overheads are normally accepted at the rate quoted”;

- a government agency said, “we expect to pay the indirect costs of carrying out research as part of the declared overheads for a project. The overheads can be as much as 80 per cent of the direct costs”.

109. We have discussed the changes planned in HEI research funding with government departments’ Chief Scientists in the context of the strand of work in this review on the Government’s use of science. In general, the message that universities need to recover full economic costs from users of the SEB – including government departments - has been accepted, and the implication that this will mean increased prices in some cases been acknowledged and understood. The picture is not entirely straightforward, however, since not all government department sponsored research is funded purely for departments’ own benefit and where there are likely to be spillover effects, it will be for universities to decide whether – and if so, to what extent – this should be reflected in the price (and hence the extent to which government departments’ work should be supported by public infrastructure funding). We have outlined earlier in the report the rather different position of the NHS.

Recommendation A33: Government policy – to secure best value for money - need not change, but departments’ assumptions about what prices will contain needs to adjust to the changed context. (See recommendation C16 which relates to the responsibility of departments to ensure the science base is able to meet their future needs.)

110. It is difficult to estimate the increased level of funding needed to maintain the present volume of government department research at full economic cost (the worst case). One estimate we have seen – based on an interpretation of sector-wide TRAC data and data from an individual Russell group university - suggests that the shortfall may be around 70 per cent of the price currently paid by Departments. This is accounted for by a shortfall in contributions to indirect costs and to the time of the principal investigator. Taking the 1999-2000 figures quoted above, this would suggest that full economic cost for the research sponsored by government departments that year would have been around £570 million – a difference of £240 million. To the extent that the research sponsored would have been considered eligible for public support at an institutional level, this shortfall would have been reduced.

111. The HE sector has welcomed the principles of the Transparency Review and implemented the TRAC methodology ahead of plan. It has stated its hope that a quid pro quo for this will be that public sector research funders and purchasers will accept TRAC as the basis of establishing the true costs of research and thus a basis for pricing.

Recommendation A34: Government departments should agree that TRAC methodology should in future be used as the basis for determining the full economic cost of their research. This will require on the part of the HEIs (see recommendation A42 below) a willingness to build on the foundations laid by TRAC to develop project costing systems.

Industry

112. Industry spent about £290 million on R&D in HEIs in 1999-2000. Industry interactions with the SEB are complex and highly heterogeneous, ranging from near-market application-specific development back up the chain to basic, high-risk research, from which there can be significant public spillovers in terms of knowledge and technologies made freely available through the literature. Industry also recognises that its support for research in universities is a contribution to training, and provides an opportunity for it to identify potential future recruits.
113. During the course of the review we have spoken to a range of industry and sector representatives and to the research directors of some of the major UK firms. Once again, we have found that practice with regard to negotiating HEI research contracts varies enormously – as these three examples – all from significant UK multinationals with significant R&D budgets attest:
- the Head of R&D of a major international group with a big UK presence said that universities should simply get their costings straight and then charge the commercial rate for what they do;
 - the R&D director of a major UK plc said that her company paid what the Research Councils pay;
 - another R&D manager said that the question of price was complex and depended on the degree of risk that the company was exposing itself to and how the benefits of discovery were to be shared between the company and the university.
114. This last point is important and was a view we heard widely both within industry and within the HE sector. The general message was that we should not assume that all – or even most – of industry’s interaction with the SEB constituted simple purchasing of research outputs. One of the Russell Group universities went so far as to suggest that this approach could form the basis of a common understanding between industry and the sector which could inform better pricing decisions.
115. One final, commonly-made point is worth recording. Industry and universities seemed to agree that it is not enough simply to trade off intellectual property (IP) ownership rights against full economic cost when setting price. From the universities’ point of view, revenue from IP was seen as being highly contingent and when it did occur, would do so with a considerable time lag. This made it very difficult to value. Industry pointed out that proper protection and exploitation of IP was of itself a very expensive and specialised area and one which most universities were not yet well equipped to handle professionally.

Recommendation A35: Prices for contract R&D for industry should reflect the value given and received by each side. This means HEIs should charge at least full economic cost.

Recommendation A36: The HE sector and relevant representatives from industry should consider getting together to set out some broad

guidelines to assist both sides in approaching the issues of costing and pricing industry-sponsored research.

European Union

116. The European Union Framework Programmes (FPs) provide the fifth and smallest HEI project income stream, amounting to around 5 per cent of total HEI income in 1999-2000.
117. Despite their relatively small size, FP participation is considered important by universities as it provides access to additional funding and to new overseas research networks. The UK traditionally does well from FPs in terms of *juste retour*. Nevertheless, European Union income has contributed to the present unsustainable HEI research funding position since it too fails to cover full economic cost. The Sixth Framework Programme (FP6), which runs from 2002-2006, will be agreed by mid-2002 and it is now too late to influence the level of costs covered.
118. The indirect cost contribution which is payable under FPs is calculated in one of three different ways depending on the degree to which robust management accounting systems are in place in funded bodies:
- **Full Cost, actual overhead rate:** total eligible costs using a real rate of overheads - for organisations with analytical accounting systems. Commission contribution in this case is 50 per cent. Industry participants must use this model.
 - **Additional Cost:** 100 per cent funding of the additional direct costs of the research (e.g. temporary staff hired for the project, consumables, computer usage etc) plus a sum totalling 20 per cent of these additional direct costs to contribute to the indirect costs ('overheads') – for organisations operating only a basic level of accountancy. Most UK universities choose to use this model.
 - **Full Cost, flat overhead rate:** total eligible costs using, in respect of overheads, a lump sum amounting to 80 per cent of the eligible personnel costs – for organisations whose accounting system enables identification of the direct costs relating to research, including that of its permanent personnel, but which cannot identify overheads with a sufficient degree of precision. Commission contribution in this case is 50 per cent of all eligible costs

Recommendation A37: Government should press the Commission to accept TRAC as the basis of calculating European Union indirect cost contributions to research on the basis of the full cost models. It should do this in time for FP6. However, Government should also seek to ensure that the Additional Cost model is retained alongside the Full Cost models.

119. It will be clear from this that the contribution made by the European Union is considerably less than that which is already made by the Research Councils. The European Union argues that their funding is intended to be matched by funding at the national level and so achieve a greater alignment between the European Union and national research strategies. The implication of this is that either the Government or the universities should have to find the difference. In practice, as with other under-recovery, the shortfall has been found by spreading the QR a little more thinly and using internal cross-subsidies and reducing infrastructure investment.

Recommendation A38: The Government should accept the need to support European Union Framework Programme research in UK HEIs through QR and infrastructure funding and should therefore take this into account when setting the levels of overall public support for research. For future Framework Programmes, the Government should seek to negotiate a greater element of cost recovery.

Funding Councils' funding for research

120. As pointed out above, (paragraphs 45 to 47), over the last 15 years, the increase in Funding Councils' QR funding, even including infrastructure contributions from the OST, has fallen well behind the growth in Research Council funding and even further behind growth in total project funding.

121. Increased contributions to indirect costs from Research Councils and better recovery of full costs by institutions, which recommendations A10 and A28 set out, will help to tackle the issue. However, the sector needs an adequate amount of QR funding to provide the balance of full costs, to give a proper diversity of funding routes and to allow institutions to carry out research on their own initiative – and an amount that provides a sufficiently powerful incentive for institutions to manage their research actively to improve quality. This suggests a need to increase core Funding Council resources for research to reverse some of the relative decline and prevent the gap opening further (see recommendation A17).

122. A permanent capital stream distributed according to quality and volume will contribute significantly towards this. While capital funding cannot directly fund research projects carried out by HEIs on their own initiative, it can be used to provide underpinning infrastructure and, if its distribution is quality related, it also helps as a motivator for institutions.

Recommendation A39: Core research funding should increase in order to ensure the appropriate balance with the dual support system. A permanent capital stream can make a significant contribution to this.

Recommendation A40: Future spending reviews should take account of the need to maintain the broad balance of the Dual Support system. In addition, when QR levels are set in the future, regard will need to be paid to the strategic plans of other funders as shared with Government as suggested in recommendation A12.

The role of HE Institutions in a sustainable research base

123. HEIs have a pivotal role to play if their research funding is to be put back on a sustainable footing. In return for willingness to invest more to improve the sustainability of the Science and Engineering Base, Government has a right to expect the sector to take steps to tackle aspects of its own behaviour which have contributed to the problem. Principal among these is the practice of pricing below full economic cost – the “low-price” culture. We have already recommended that institutions should be given a powerful incentive by Government to recover the full costs of their research in aggregate.

Recommendation A41: In making HEIs accountable for recovering the full economic cost of all research, Government should seek to minimise the costs of compliance by implementing a simple, low-cost mechanism which would give it a reasonable degree of assurance. An example might be a statement by an institution’s external auditors that taking one year with another, the full economic costs of research were being met sustainably.

124. The implementation of TRAC has given universities a powerful tool for better understanding the true costs of their key activities and for managing themselves more strategically. Universities now need to tackle the low-price culture and Government and the sector need to send more powerful price signals to users of the SEB.

Recommendation A42: HEIs should put in hand quickly measures to ensure that they are able to identify the true costs of research at project level and by funder. They should build on TRAC as a management tool rather than just a reporting mechanism.

Recommendation A43: To assist the sector in delivering this next phase of development, HE representative bodies, key research funders and Government should develop the work started under the Transparency Review to embed robust and consistent management information systems across the sector.

Recommendation A44: As a result of these measures, HEIs should aim – quickly - to be able to demonstrate that each of their main businesses (or all of their businesses taken together) are sustainable. This should be driven by sound business planning incorporating realistic income projections.

125. The evidence from the review points clearly to degraded infrastructure being both the most visible symptom of the presently unsustainable funding position and the major threat to the viability of the SEB.

Recommendation A45: In return for the proposed injection of capital, HEIs should develop a research infrastructure strategy setting out the purposes to which they intend to put their funding. In using public funding, priority should, in general, be given to remedying basic

infrastructure and maintenance backlogs first since it is in general more difficult to attract third party contributions to this sort of investment.

126. The review has come across evidence that HEIs do not manage their working capital as well as they should. For example, we have seen evidence of a failure of institutions to claim for grant payments on time – and in some cases, at all. This imposes unnecessary financing costs on the sector which could be better used in support of front-line activities.

Recommendation A46: The HE sector and institutions should review – and then take steps to improve - its performance in managing its working capital.

127. In exploring the financial position of the HE sector, the review has found that the data held by the Higher Education Statistics Agency (HESA) is not always of the sort which allows the financial position of institutions to be assessed effectively. It does not reflect developments in accounting practice.

Recommendation A47: The Funding Councils should review the appropriateness of the existing financial data which HESA gathers and publishes.

Reforms to the RAE and quality related research funding

128. The research assessment exercise (RAE) and its use in determining QR funding have been very successful in driving up the quality and productivity of the research base. But in some areas a rethink is required. The RAE is a UK wide system, but the way in which the results are applied to funding differs across the UK. The specific examples and recommendations here refer to the system operated by HEFCE. The devolved administrations and other Funding Councils may wish to examine the way their own systems work and to tackle any similar issues.

RAE context

129. The 2001 RAE found a significant increase in the quality of research since the last exercise in 1996. A higher proportion than ever of UK researchers are operating at international levels of excellence: 55 per cent of staff returned to the exercise are working in departments rated 5 or 5*. An element of the improvement could be due to institutions getting better at presenting themselves for the RAE. However, the top grades were confirmed by international referees, and separate work, looking at the strength of UK research as measured in citations of academic papers, shows a substantial improvement in the UK's research standing since the mid 1990s. This suggests that the bulk of the RAE improvement is genuine.
130. The 2001 RAE results have shown departments improving their ratings, and highly rated departments growing in size. The improvements meant that, within the existing funding, it would not be possible for HEFCE to continue to provide

the same amount of funding as before for a given volume and quality of research. An extra £170m in real terms would be required to do this.

131. In response, HEFCE has discontinued another research funding line, 'generic research', which it had already concluded was not achieving its objectives, and put the £20m freed into QR. DfES has made £30m available from underspends to provide extra help in 2002-03, to avoid too great a reduction in unit funding for internationally competitive departments before the outcomes of the Spending Review are known. Taking these increased resources into account, HEFCE decided to steepen the gradient of selectivity so as to maintain the unit of resource for 5* departments, impose a moderate cut in unit funding for 5 departments, reduce unit funding for 4 and 3a rated departments more considerably, and cut funding from departments rated 3b altogether.
132. The administrations in Scotland and Wales have been able to provide a greater proportion of the extra funding required and therefore the consequences of the RAE are less acute there.
133. As a result of the constraints on funding in England, some institutions which have improved their performance at 3 and 4 level, but have few departments rated 5 or 5*, will see a decrease or only a small increase in funding. The implications for regions vary. The North-East has done well in the RAE – Durham and Newcastle universities in particular - and will see an above average percentage increase in funding despite the increased selectivity, as will the South West where Bristol and Exeter have done well.
134. The RAE results and HEFCE's decisions on implementation mean that research funding in England will be more than ever skewed towards the best quality departments, many of which are concentrated in the research-intensive universities.
135. The Higher Education Funding Councils will be reviewing the RAE and HEFCE has also indicated that it will be reviewing research funding as part of a wider review of funding mechanisms. There are some areas that these reviews should examine - some long standing, others highlighted by the recent RAE.

RAE / QR and over-trading

136. The RAE and QR mechanisms do, at present, play a part in encouraging some of the behaviours that jeopardise quality in the longer term.
137. HEFCE's Fundamental Review of Research Policy and Funding noted that because HEFCE grant is linked to volume, but not to investment in infrastructure, the system 'provides an incentive to increase the volume of research without an equivalent investment in the infrastructure.'³²
138. Recommendations A10 and A41 propose measures to discourage over-trading, but they need to be coupled with a parallel look at the distribution of QR. The

³² HEFCE Review of Research, 2000 – para 190.

continuing capital line will play a part in ensuring that institutions have ring-fenced funding to maintain and enhance their infrastructure. The Funding Councils should usefully look at this issue further in reviewing the RAE and research mechanisms to see if the perverse incentives can be further reduced, perhaps by looking again at the 'minor volume measures' – such as postgraduate research students and non-academic research staff - which are, at present, updated annually and may incentivise institutions to expand their activity.

Recommendation A48: In reviewing the RAE and research funding, the Funding Councils should aim to reduce the current incentive to over-trade and to under-invest.

Selectivity issues

139. QR funding motivates institutions and puts resources where they are most likely to yield a good return by selectively funding the best research. In the context of the 2001 RAE results there are some particular issues relating to selectivity and the extent to which QR encourages and funds quality improvement in different types of institution and in weak as well as strong subjects.

Quality and funding gradient

140. There are 7 quality ratings in the current RAE: 1, 2, 3b, 3a, 4, 5 and 5*. In 2002-03, research in only 4 of those ratings – 3a and above - will attract any funding from HEFCE. Less than 1 per cent of departments received a rating of 1 and only 17 per cent received a rating of 3b or below. This is a natural consequence of institutions becoming more selective in the research they support and submit to the RAE but suggests that the scale needs to be reconsidered and shortened.
141. At the same time improvement has resulted in bunching around the top ratings: 39 per cent of departments, containing 55 per cent of research active staff, are now rated 5 or 5*. This raises questions about the continued effectiveness of the mechanism as a motivator for institutions to improve. The unit funding for 5* departments in a subject can even decrease where, for example, there are new 5* departments in that subject and a similar sized sum of money for the subject as a whole has to go further. The categories need to be looked at in future and, perhaps in a shorter timescale, the funding gradient needs to be examined to ensure that QR retains its ability to incentivise world class research and concentrate funding where it is likely to generate the best results.
142. The RAE implementation has resulted in increased funding for research-intensive institutions because that is where the 5* and 5 rated departments tend to be concentrated. There is not, for 2002-03, enough funding available substantially to reward improved departments in the middle of the quality scale because the unit of resource has had to be cut. For 2002-03 HEFCE decided not to distinguish between improving and static - declining 3 - rated departments in awarding funding but rather simply to provide some funding for 3a rated departments and none for those rated 3b. This question of differentiating according to direction of movement may be one to reconsider. More generally, we can see that the 3a rating

will become temporary for any department, which is either improving its research record and will move up to a 4 rating, or which is in decline to 3b and will lose its funding. We do not see the 3a rating as a target which a department should aim for.

143. While new universities have not as a group lost out in the RAE implementation, there has been a redistribution of resources within the group. Many new universities argue strongly that some research activity is important in maintaining their other activities. If the RAE results were fully funded, that is the unit of resource for each quality rating were restored to 2001-02 levels, then the largest increase in resources would go to new universities.

Weak but critical disciplines

144. A separate issue concerns whole disciplines where there is relatively little research funding. As 3b rated departments are no longer funded in the RAE, the distribution of funding by subject has also changed because the share going to each UoA will be determined by research active staff rated 3a or above. This emphasises still more a point which has been highlighted in the past: how to look after important disciplines which receive relatively little funding either because they are weak, or because they are new, emerging subject areas.

Recommendation A49: HEFCE and the other Funding Councils should look again at the appropriate gradient of funding between quality ratings, taking into account affordability and the need to provide encouragement for top quality departments as well as to help those below them that demonstrate the potential to improve. In the longer term they should look at the ratings themselves, and whether there need to be as many as at present. They should consider how best to fund weak and emerging critical disciplines in order to develop improved capability where it is both required and sustainable.

Possible biases in the RAE / QR system

145. The RAE has been a successful incentive mechanism but as with any formula funding mechanism there are some types of behaviour that are encouraged in the system and others which are discouraged – however marginally. The review has identified a number of possible biases which need to be looked at:

- subject balance;
- interdisciplinary research;
- applied research and secondments;
- patterns of research activity;
- unhelpful RAE / QR tactics; and

- partnership between institutions.

Subject balance

146. The division of QR funding between each subject is done by volume with a quality cut off, as mentioned above. Volume in departments rated 3a or above, weighted by cost, is used to divide up total funding between subjects. The change in QR from 2001/02 to 2002/03 is shown Table 6 below.

Table 6: QR by broad subject group

Broad subject groups	2001-02 Mainstream QR Quanta (£million)	2002/03 Mainstream QR Quanta (£million)	Difference	% difference	% of 2001/02 total	% of 2002/03 total
Clinical Subjects	122.1	124.8	2.6	2.2	15.9	14.8
Subjects Allied to Medicine	56.7	70.8	14.1	24.9	7.4	8.4
Sciences	244.4	260.2	15.8	6.5	31.9	30.9
Engineering Subjects	88.7	87.6	-1.0	-1.1	11.6	10.4
Social Sciences	112.4	136.2	23.8	21.1	14.7	16.2
Humanities	81.8	98.2	16.4	20.0	10.7	11.7
Arts	32.7	39.3	6.6	20.2	4.3	4.7
Education	28.0	24.1	-3.9	-13.8	3.6	2.9
Total	766.8	841.2	74.4	9.7	100.0	100.0

Note: These are provisional figures for 'mainstream QR' funds only. Funds exclude funds for Oxbridge college-employed research active staff and funds for the supervision and tuition of postgraduate research students for both 2001-02 and 2002-03. GR funds were terminated after 2001-02, and are excluded from this analysis.

Source: HEFCE

147. This has caused something of a shift in the balance of QR funding. Only education and, to a lesser extent, engineering have seen an actual fall in QR funding between 2001-02 and 2002-03. However, clinical subjects and sciences have also seen a reduction in their share of the total funding. Subjects allied to medicine, social sciences, arts and humanities have all seen larger percentage increases in their QR funding, and increases in their share of the total.

148. The question is whether the shift in the balance of funding between subjects is driven by relevant factors, such as academic priority setting, external demand, and the link between research and teaching, or whether there are factors within the funding system itself that tend to skew activity over time. It has been argued for

example that it is cheaper to expand activity in arts, humanities and social sciences and therefore institutions concentrate on building up these areas.

Inter-disciplinary research

149. There remains a concern that the subject-based RAE process does not give proper weight to inter-disciplinary or multi-disciplinary work, often at the leading edge of research. The 2001 RAE has included new guidance and new mechanisms – umbrella panels and cross-referral of submissions – which attempt to deal with this concern. The Funding Councils need to assess the extent to which these mechanisms have worked. If they have been successful, this should be made clear to the HE sector in order to motivate inter-disciplinary researchers. If not, the Funding Councils, with Government, should look at reinforcing this research still further.

Applied research

150. There is a similar concern that the RAE does not give proper weight to applied research. Under the principles set out in A15, institutions will be able to use their QR funding to work jointly with research sponsors to carry out applied research, including work with businesses. It is important, therefore, that the results of this collaborative applied research are given their proper weight in the RAE. However, there has been a general concern that basic research which results in conventional research products – articles in peer reviewed journals – counts for more in the RAE than applied work.
151. The performance of applied research should be closely looked at in the 2001 RAE to see the extent to which (for example) non-traditional products are present in successful submissions. If the problem is largely one of perception then this should be made clear. If not, further corrective action is required, particularly given discussions of industrial funding of research with wider benefits in paragraph 112. Contract research for industry is not eligible for subsidy according to the principles set out in recommendation A15, and recommendation B3 below proposes a new system for assessing and celebrating contract research for industry. In this context, it may be best for contract research to be excluded from consideration under the successor mechanism to the RAE.
152. It has been observed that the RAE provides such a strong incentive to produce good quality research that other activities, in particular time consuming ones, could be neglected. For example, secondments to business might reduce the quality of an academic's output or reduce the quantity of research products below 4 between RAEs and are therefore discouraged by the RAE. It may be that in the context of the other changes there is a way to reduce the disincentive, for example:
- to allow work carried out during a secondment (so long as it is research based) to be submitted as a 'research product' with the same confidentiality which can currently be attached to contract research for industry; and

- to explicitly allow academics who have undertaken secondments to submit ‘personal statements’ explaining why they have provided less than four research products.

Patterns of research activity

153. Conversely some academics may be restricting their output to four products artificially, which could impact on research outcomes. HEFCE could helpfully examine the case for freeing up the RAE so that a larger portfolio can be submitted if that would be more appropriate for the individual researcher concerned.

Recommendation A50: The Funding Councils, in the review of the RAE, should carefully evaluate the 2001 exercise and take further steps to ensure that the system does not discriminate against applied research, interdisciplinary research, or secondments to industry.

Unhelpful RAE / QR tactics

154. The RAE leaves a good deal of discretion to institutions in the proportion of academic staff which they designate ‘research active’ and submit to the RAE. This produces a trade-off between volume and quality:
- the number of research active academic staff forms a significant part of the volume multiplier used in determining RAE-based funding, and is not updated between RAEs, unlike the ‘minor volume measures’
 - choosing only the best staff in a discipline may help an institution get a higher RAE rating and therefore more resources via the quality multiplier.
155. This therefore becomes a matter of RAE tactics. Institutions may submit few staff and receive a high rating. They would not receive much of a volume multiplier for their academic staff but would be able to claim for other research staff, postgraduate research students and income from charities. The proportion of staff submitted is made public (with a letter, A – F, added to the RAE grade).
156. There is a concern that institutions with pockets of good quality in a discipline may submit only a few staff to the RAE, and then gain a high rating and relatively large amounts of funding. To the extent that other, poorer parts of the department’s work were then funded, this would undermine the overall policy of focusing resources on excellence.
157. There were only 39 departments scoring more than 4 with less than 60 per cent of staff submitted in 1996, compared with 133 in 2001 – a sharp rise, although this is still only a small proportion of departments rated 4 or better, and there are still only five departments scoring 5* with less than 60 per cent of staff submitted.
158. One possibility would be to set a minimum threshold for the proportion of staff that must be submitted to the RAE. This is difficult however because there is only a loose correlation between RAE UoAs and actual university departments,

and therefore the assignment of staff to UoAs is somewhat arbitrary and could be manipulated. Another option could be to again look at the ‘minor volume measures’. For instance, an institution might not be able to claim for more than a certain number of postgraduate research students per research active member of staff. This would minimise the extent to which an institution could profit by submitting a small number of staff, but again might run the risk of distorting departments’ behaviour.

Partnership between institutions

159. If changes to the system did result in less funding going to departments with only a few leading research staff, it might bias the system against pockets of research excellence and against top quality staff working in less research intensive universities. This might be corrected by formalising a system of ‘Research Partnerships’. Talented academic staff in departments that are not, overall, of top quality would form partnerships with a department in another institution and be put forward as part of their RAE submission:

- this would be as an alternative to the weaker department submitting in that discipline;
- the QR funding for the researchers concerned would go to their home institution;
- the incentive for the better institution would be to improve its chances of a good score in the RAE by including other talented staff; and
- the incentive for the weaker institution would be to gain some QR income and to retain talented researchers, who could benefit other research and teaching in that institution.

Recommendation A51: The Funding Councils should look again at the increase in the number of departments rated highly in the RAE but submitting a small proportion of their staff, and should aim to tackle the potential problems arising from this, perhaps by setting a limit to the amount of total research volume which can be deemed to be generated by each research active member of staff. As an alternative way of funding small pockets of excellence, institutions could be encouraged to develop research partnerships where academics from one institution could form part of another’s RAE submission.

Arts and humanities research

160. While the remit of the cross-cutting review is around science research, many of the issues are also common to arts and humanities research and recommendations on science in higher education will inevitably have consequences for these subject areas. There is, furthermore, a potential for adverse effects if these disciplines are ignored. The review therefore looked briefly at issues around arts and humanities research.

161. The interaction between arts and humanities research and the economy has been less well studied than the economic benefits of science research, but the issues are similar. Arts and humanities research can benefit a range of sectors, including creative industries such as entertainment, design, software, publishing and advertising, together with the legal, cultural, heritage and tourism sectors. The area contains some substantial sectors of the economy, some strong in exports, for example:

- the tourist industry is one of the largest in the UK with annual expenditure by UK and overseas visitors of £45 billion, and employing 1.8 million people. 35 per cent of overseas tourists in London say that arts and cultural activity have greatly influenced their decision to come;
- it is estimated that design-related activity within the UK is worth some £26.7 billion, employing some 1 million people in around 240,000 companies;³³
- the legal sector employs 230,000 people and has a total value of £7 billion; and
- UK artists had a 16 per cent share of the world music market in 1996, and exports of £1.5 billion.

162. Meanwhile research progress in humanities disciplines can promote better understanding of social problems, with indirect benefits for the economy. There are also quality of life benefits that are less tangible but nevertheless generate a return on the investment – the development of the UK as a rational and culturally rich society. And research also underpins education by improving the stock of knowledge and understanding and helps recruit international students who are, in part, attracted by the quality of research in the UK. Nearly 20 per cent of overseas postgraduate students study in arts and humanities, worth some £400m to the UK economy. They also constitute potential recruits to UK business.

163. Funding for arts and humanities research is growing from a low base. In 2003-04 the Arts and Humanities Research Board will have around £43m to spend on research and £27m on postgraduates, including associated running costs, when projected contributions from around the UK are included. This compares with equivalent figures of £30m and £23m in 2000-2001. But estimated funding per active researcher is still much lower for Arts and Humanities Research Board funded disciplines – at £2,750 in 2002-03 - than in those funded by the ESRC -

³³ Creative Industries Mapping Document, DCMS 2001

£4,269 - and of course only a fraction of those for EPSRC, which are estimated at £23,620. And there is evidence of much high quality research which cannot be funded at present - in 2000-01, 65 per cent of all alpha-rated applications for AHRB research grants went unfunded. This suggests that an increase in volume would not mean a decrease in quality.

164. Funding via the AHRB also helps drive innovation in arts and humanities research by providing an alternative funding source to QR which is the major source of funding for these disciplines. Following the creation of the AHRB, there has been more scope to carry out innovative research with particular grants – encouraging more use of project teams rather than the traditional model of the lone scholar. There has also been an expansion of the postgraduate funding – previously limited to humanities – into art and design disciplines. And in addition to responsive mode research grants, the AHRB is proposing more strategic programmes with potentially far-reaching benefits including:

- a seven-year programme, ‘Designing for the twenty-first century’, in partnership with the Engineering and Physical Sciences Research Council (EPSRC);
- work on the changing culture of science, in the context of current concerns about the relationship between science and society; and
- collaborative awards for students in the creative and heritage industries, similar to the successful Co-operative Awards in Science and Engineering (CASE) run by the Research Councils.

Recommendation A52: There should be a moderate increase in funding for arts and humanities research, to continue the growth in the availability of project funding alongside continued growth in science project funding.

165. The last Spending Review provided ring fenced funding for science infrastructure. This required a contribution from institutions, but this limited or even reduced the availability of funding for investment in the research infrastructure for arts and humanities. Recommendations A18 and A19 reflect some of the advantages and disadvantages of the requirement for a contribution.

166. Arts and humanities research requires buildings, basic amenities, and libraries; some disciplines require specific equipment; and most or all disciplines require ICT facilities in order to keep up to date and progress their research. Some have particular ICT needs e.g. to digitise original source materials to allow access to researchers around the world, or to advance computer aided design techniques. While costs do not approach those for ‘big science’, infrastructure is a key part of successful arts and humanities research and is growing more important as techniques become more sophisticated. A study of arts and humanities infrastructure estimates a £0.5 billion backlog for research in these disciplines.

167. If funding for research infrastructure were extended to arts and humanities disciplines, the bulk of the investment would still be science based. It has been estimated that if infrastructure funding currently ring fenced for science were to be extended to all subjects at the same rate, the funding would need to rise by about 7 per cent.

Recommendation A53: The continuing stream of capital funding proposed in the review should, proportionate to relevant income flows, encompass arts and humanities research as well as science.

168. Some knowledge transfer takes place from research in the arts and humanities; and the Higher Education Innovation Fund (HEIF) has allocated funds to general capacity building in the HE sector which should benefit arts and humanities disciplines as well as science and technology. Some awards have been specific to arts and humanities research, such as the HEIF award to the Surrey Institute of Art and Design for a creative enterprise initiative. But ways in which the benefits of arts and humanities research, whether economic, social or in terms of quality of life, are realised are less well understood compared to science and technology. We believe more work is needed to understand the processes better and how they can be encouraged and strengthened.

Recommendation A54: The Arts and Humanities Research Board should further investigate the benefits which accrue from the exploitation of research in the arts and humanities, and how those benefits can be quantified and maximised, bearing in mind the discussion of the proper role for Government in section B.

Academic pay

169. Excellent research depends on outstanding people, and therefore on institutions' ability to recruit and retain the staff they need. There has been an erosion of the relative position of the HE sector in terms of pay. Between 1998 and 2001, the pay of university teaching professionals increased, in real terms, by 0.3 per cent, compared to a 7.0 per cent increase in public sector pay and an 8.3 per cent increase in pay across all industries and services³⁴. This relative decline in pay matters to the extent that it is causing increasing recruitment and retention difficulties in particular areas.

170. The most recent evidence comes from the February 2002 Universities and Colleges Employers Association 4th annual staff recruitment and retention survey. 18.1 per cent of HEIs reported that they "more often than not" had difficulty filling academic posts compared with 5.8 per cent in the first survey in 1998-99. There are growing difficulties in recruitment in particular subjects where there is competition for qualified staff in the wider economy such as: ICT; business and economics; engineering; education; and the professions allied to medicine. Case study work with a subset of institutions found that a high proportion of recruitment exercises in some subject areas were resulting in an unfilled post, or in

³⁴ Source: New Earnings Survey

the appointment of a member of staff who did not fulfil all the requirements of the post – including 46 per cent in computing / IT, and 37 per cent in mathematics.

171. Sir Gareth Roberts' review of science and engineering skills supply has also identified uncompetitive and inflexible academic pay as a barrier to the recruitment of high quality teaching and research staff in particular areas.
172. The 2000 Spending Review started to address the issue, when £330m was provided over three years to assist recruitment and retention of staff and to modernise the systems used to manage human resources in institutions. But further steps need to be taken if problems about pay are not to gradually undermine the quality of the research output.
173. Institutions have to be more flexible and competitive in the salaries they offer to professors (although practice varies), where this can be afforded. But salaries for lecturers – including pay for more experienced staff as well as starting salaries – still tend to be rigid and too low to attract the staff required in some disciplines. This is partly a matter of resource but also of structure. The demands of the modern – and international – labour market mean that there has to be a move towards a more market-related pay system, with salary differentiation related to the supply and demand for particular subjects.

Recommendation A55: Further resources should be made available for pay in higher education institutions, to ensure that HE institutions can meet the demands of the market. It is far more common now for there to be variation in professorial salaries, but there is less variation at lower levels. This needs to change. There should be an explicit presumption that institutions should use any increase differentially to pay the rates required to recruit and retain key staff, and set this out in their human resources strategies, so that their salary policies are altered to reflect national and international market forces.

The British Library

174. The British Library has an important role to play in supporting scientific research in the UK. It supports both public and private research by providing access to its scientific reading rooms, and through its document supply service. In 2001, the Library provided over one million scientific, technology, medicine and engineering documents to higher education institutions and industry in the UK. In addition, five million scientific journals, monographs and patents are consulted each year in the reading rooms. The Library estimates that the opportunity cost saving to HEIs of its provision is £50m per year. It has potential to provide particular benefit to SMEs, who are less able than large companies to hold substantial collections of scientific journals and other publications.
175. The Library is facing pressures from increases in publishing output (running at 10 per cent per year) and from inflation in the cost of publications (around 7 per cent per year). It is also considering how best to meet increasing requests for information to be supplied electronically, and has estimated that it would cost

around £4 billion to digitise its current collection. This would not be the most efficient way of managing its collection, so the Library has identified priorities for digitisation to focus on the most useful and relevant parts of its collection. The Library is currently funded by DCMS and receives an annual grant of around £86m. It also receives around £28m per year from provision of services, largely the document supply service, which charges at cost for its standard service, but offers value added services such as express delivery for a premium charge. The work of the library is also of relevance to the work of both DfES and DTI/OST, but it is not currently directly funded by those departments, although HEFCE and the Library did launch a strategic alliance in March 2002. Sir Brian Follett, as chair of the Research Support Libraries Group, is conducting a review entitled 'Researchers' Use of Libraries and other Information Sources: Current Patterns and Future Trends', which will report later this year.

Recommendation A57: The three departments which have a direct interest in the work of the British Library should discuss with each other and the Treasury how they might better contribute to its work. The recommendations emerging from the Follett Review should be considered alongside the totality of the British Library's bid to the Spending Review in order that priorities are identified which would add most value for universities and the private sector.

VAT on university research

176. A recent ruling by the European Advocate General (in relation to a case against Germany) has advised that all commissioned research – research undertaken under contract for payment - should be subject to VAT. The European Court of Justice (ECJ) will consider the advice shortly, and is expected to follow the Advocate General's advice. In the case of research conducted by industry, the company commissioning the research is able to reclaim the VAT, so will not face additional costs as a result of the ruling. Research and Funding Council grants for research would not be subject to VAT since they are not a payment for a specific service. Charities operate in a similar way to other research grant providers, and do not normally commission a specific piece of research for which they expect to receive a pre-defined service. It is, however, likely that some research commissioned by government departments, charities and universities might become subject to VAT if the ECJ rules on the basis of the Advocate General's advice³⁵. The Treasury and Customs and Excise will need to watch the position carefully.

³⁵ There is a list of "eligible services" for which Government Departments can claim refunds of VAT on services contracted out for non-business purposes. This list includes research for the Health and Safety Executive and research "of the kind normally carried out for DEFRA and the Food Standards Agency".

Section B: Knowledge transfer

Part 1 – Main Findings

177. Section A has set out the evidence for the returns from investment in research. Maximising these returns depends upon transferring the outputs of research rapidly and effectively into the economy and society more widely. This in turn depends upon a clear strategy to promote innovation. This section covers knowledge transfer from the science and engineering base; Section C addresses knowledge transfer from research commissioned by other government departments.
178. The Government has set out its policy for science and innovation in the White Paper Excellence and Opportunity³⁶. Following reviews³⁷ of the DTI's role, structure and priorities and the way it supports business, the department is now forming a new Innovation Group and recruiting a Director General Innovation. The DG Innovation will lead the development of an Innovation Strategy to drive up sustainable productivity and competitiveness in British business.
179. Exploitation of the science and engineering base (SEB) plays a vital role in successful innovation in a modern, knowledge-driven economy. This has been recognised by:
- business, which looks to the SEB for highly skilled staff, technology and ideas. In a joint report³⁸, the TUC and CBI recently urged employers, trade unions, academics and other public and financial institutions to work together to develop flexible, coherent and efficient networks to support R&D and innovation in the UK;
 - the SEB and HEIs which are showing an increasing commitment to, and engagement in, work to transfer knowledge and skills into the economy (see below);
 - the Government in previous spending reviews and the developments described above; and
 - the European Union - a recent ECOFIN study into European R&D and Innovation³⁹ concluded that member states need to consider improving the flow of knowledge across economies and between research institutions and industry.
180. As required by our terms of reference, we have reviewed current funding mechanisms for knowledge and technology transfer from the science and

³⁶ Cm 4814, July 2000

³⁷ DTI Review: <http://www2.dti.gov.uk/dtireviews.html>

³⁸ CBI/TUC joint productivity report, October 2001
(<http://www.cbi.org.uk/ndbs/content.nsf/B80E12D0CD1CD37C802567BB00491CBF/4D6F922DC3C97B3B80256AFB00361F81?OpenDocument>)

³⁹ Report on research and development (EPC report to ECOFIN, January 2002)
<http://ue.eu.int/emu/en/index.htm>

engineering base and mechanisms to promote adoption by business, and identified priorities for the future use of resources.

181. The most important ways of transferring knowledge, technology and know-how from the SEB to business and the community are through the supply of highly skilled people, and through the publication of the results of research. The findings in Section A of this report show that the UK SEB already produces more high quality publications per unit of input than almost any other in the world. The recommendations in that section are aimed at sustaining and further strengthening that performance. At the same time, the Roberts Review⁴⁰ is putting forward recommendations to improve the supply of graduates and post-graduates to the SEB and business.
182. Knowledge transfer from the SEB to business depends on:
- the capabilities of the SEB and the extent to which it is orientated towards the needs of business;
 - the technological capabilities of business and its propensity to innovate; and
 - the coverage and strength of the links between them, where culture is an important factor.
183. The role of business is crucial. Anything that strengthens the technological and innovation performance of business will have an effect on knowledge transfer from the SEB. The whole of the DTI Innovation Budget is therefore relevant to knowledge transfer, but in this review we have concentrated on those DTI schemes which interface directly with the UK SEB.
184. We have considered various analyses of knowledge transfer and the ways in which outputs from the SEB find their way into new products, processes and services. We have noted that there are many instances that fit within a traditional “linear model” of basic research leading in turn to strategic research, applied research, development, production and marketing. We have also noted that recent analyses have emphasised that much research can contribute to both scientific and technological knowledge at the same time, i.e. that research can simultaneously be basic and applied. Indeed, some have suggested⁴¹ that the main contributions to scientific knowledge will increasingly come from research that is multi-disciplinary and focused on a practical problem or issue. Underlying this thinking is the increasing role of scientific understanding in innovation in a knowledge-based economy.
185. These ideas have been supported by much of what we have heard from those involved in research and innovation in HEIs and business. Those discussions have frequently emphasised the complexity and non-linearity of successful knowledge

⁴⁰[http://www.hm-](http://www.hm-treasury.gov.uk/documents/enterprise_and_productivity/research_and_enterprise/ent_res_roberts.cfm)

treasury.gov.uk/documents/enterprise_and_productivity/research_and_enterprise/ent_res_roberts.cfm

⁴¹ The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies by Michael Gibbons, Camille Limoges, Helga Nowotny, Simon Schwartzman, Peter Scott and Martin Trow

transfer, and the critical importance of promoting synergies within all types of research and between all types of research and business. Many businesses look for academic partnerships primarily with HEI departments excelling in ‘basic’ research, and many such departments are succeeding at transferring outputs from ‘basic’ or ‘strategic’ research directly into profitable enterprises.

186. Public support for research and knowledge transfer therefore needs to be sufficiently sophisticated to recognise the increasingly complex nature of both innovation, and the role of research in innovation, in the knowledge-based economy. Against this background, we have focused on six ways in which the returns on public investment in R&D can be increased and economic performance improved by promoting the transfer of knowledge and technology. These ways (which are not mutually exclusive) are:

- i. increasing business funding for R&D;
- ii. building better linkages between publicly funded R&D and business needs and market opportunities;
- iii. increasing research jointly funded by business and the public sector;
- iv. increasing the amount of R&D and related activities undertaken for business by HEIs;
- v. increasing other work in the SEB to transfer knowledge and know-how into business and the community; and
- vi. increasing business demand for, and capacity to absorb and exploit, knowledge and know-how from the SEB.

187. In the discussion that follows, we refer to a number of schemes that fall within the broad portfolio of DTI Business Support. The future of that portfolio is currently under review⁴². Our findings and recommendations in relation to particular schemes are intended to provide an input to that review.

Business funding for R&D

188. Much of the research and development that businesses require at the applied end of the research spectrum offers sufficiently direct benefits to them to make public funding unjustified. Businesses need to invest in such research and development work themselves to survive in increasingly sophisticated markets. Unsurprisingly, evidence⁴³ suggests that firms which invest in research and development (R&D) have higher levels of productivity and innovation.

189. In addition to the direct outputs of such investment there are also wider benefits. There is evidence that business investment in R&D improves businesses’ ability to engage with the SEB and to identify and exploit outputs from publicly funded research. For example UK pharmaceutical, aerospace and

⁴² See footnote 37, the detailed conclusions of the DTI review of Business Support are expected in <http://www2.dti.gov.uk/dtireviews.html>

⁴³ Lichtenburg and Siegel (1991) and McGuckin, Streitweiser and Doms (1998)

healthcare sectors have higher R&D intensities⁴⁴ than international competitors and have good links with publicly funded research, while UK R&D intensity averages are about half those of international averages.

190. Business investment in R&D in the UK lags badly behind that of almost all of our main competitors, with the UK ranking 10th in the OECD for adjusted business enterprise expenditure per capita, down from 6th in 1986. This is an important barrier to successful knowledge transfer from the SEB to business. The proposed extension of tax credits for R&D is an important development, but needs to be complemented by continuing efforts to persuade business of the importance of such investment (see section 6 below).

Publicly funded research

191. The benefits of much research at the ‘basic’ and ‘strategic’ end of the spectrum are insufficiently certain or immediate for it to justify direct funding by business. This is the work on which the public funding discussed in Section A of this report correctly concentrates. While this research may not be of direct or immediate benefit to business, much of it will lead in time to exploitable outputs, and it is important that decisions about publicly funded research take account of business needs and market opportunities. With the increasing complexity of the nature of research and the innovation, the time to market may be shortening considerably.
192. Since the implementation of Realising Our Potential⁴⁵, the Research Councils have been working increasingly closely with business and other users. This has allowed them to take account of the needs of users in decisions about Council funded research. The location of OST within DTI has, at the same time, helped the Minister for Science and Innovation and the DGRC to take account of the needs and opportunities of business. The DTI’s proposals for business support and for the Science Budget in its Analysis of Resource for SR2002 have both been informed by commissioned studies of the strengths and weaknesses of the UK SEB⁴⁶ and of scientific and technological needs of British business⁴⁷ and of the matches and mis-matches between these.
193. The DTI funded Foresight Programme looks at possible influences and scientific and technological developments over the next 10 to 20 years and the threats and opportunities that these will provide for UK industry, research and society. Following a review, the programme is being refocused in order to best ensure it meets the key challenges of the future. The new programme will focus more clearly on science and technology; it will look at fewer areas of activity at a time, to allow deeper analysis and to ensure greater impact; and it will be more

⁴⁴ R&D intensity is the ratio of R&D expenditure to sales. For data see “An assessment of UK Industry’s R&D investment and Technology Requirements”, report by Quotec for DTI and www.innovation.gov.uk/projects/rd-scoreboard/analysis.htm

⁴⁵ Cm2250, May 1993.

⁴⁶ ‘Industry-academic links in the UK’ by Luke Georghiou, Jeremy Howells and Maria Nedeva, PREST (November 1998)

⁴⁷ Report referred to in footnote 44

flexible in order to accommodate emerging issues. The objective of the programme will be to engage and influence the decisions of research funders, business, and government departments, to make better use of science and technology to exploit future opportunities and handle long-term challenges.

194. The formation of RCUK and of the new Innovation Group and Knowledge Transfer Steering Group in DTI provide an opportunity to strengthen further the links between the scientific plans of the Research Councils and the needs of business.

Jointly funded research

195. While some research is clearly appropriate for either business or the public sector to support, there is a range of work of shared benefit that justifies and may depend upon joint funding by business and Government. Such work needs to be led either by public funders (at the more strategic end) or by business users (at the more applied end), depending on the balance of benefit and on the abilities of the different parties reliably to identify needs and opportunities.
196. The Government supports publicly led jointly funded research primarily through the Research Councils. This is done both through specific schemes, and through generic research grants. For the Engineering and Physical Sciences Research Council (EPSRC), for example, which supports a large number of scientific areas with direct interest to industry, 40 per cent of all research grants are for projects with industry partners. The industrial contribution to EPSRC projects (in both cash and kind) is over £100 million per year. Most industrial support is not the result of direct schemes but as a result of normal research grants, where the peer review process takes account of the possibility of industrial co-funding.
197. The principal dedicated means of public support for jointly funded research, through the Research Councils and government departments, is the LINK scheme. LINK programme areas are chosen in close consultation with the user community, and all projects require part funding by specific user partners. The content of LINK is thus largely user-led. Government has committed £585m to LINK since 1986, with over 2300 companies participating. Government expenditure was £41m in 2000-01 (just half from Research Councils and the remainder from government departments). This public expenditure was more than matched by industry. The whole LINK scheme is currently subject to a strategic review. Evaluations of particular programmes have shown impressive results, e.g. in the Surface Engineering LINK programme the latest indication is that commercial sales to 2005 will reach the order of £420m compared to total government input of £5.6m. There would appear to be a strong case for continuing LINK and developing it to further improve value for money in ways that may be identified in the current review.
198. As well as the Research Councils' substantial use of LINK, their increasingly close relationships with their users have allowed them to develop work with users in ways tailored to their particular remits and user communities. In some cases,

they have developed ways of funding research jointly with users in addition to LINK, e.g. the Natural Environment Research Council (NERC)'s CONNECT scheme and the Particle Physics and Astronomy Research Council (PPARC)'s Industrial Programme Support Scheme. In total the Research Councils spent over £25 million on collaborative research in 2000-01.

199. In addition to these formal schemes, public funding is provided for jointly funded research when an HEI chooses to use part of its general government funding for research (via HEFCE's block grant) to offset part of the costs of research undertaken for or with business customers. Concerns have been expressed in the past, including in the previous cross cutting review of science funding, that the RAE, which drives the allocation of such funds, does not take adequate account of high quality work of this kind. Those we have spoken to welcome the changes that were introduced to the 2001 RAE to address this. However, they also argued that more should be done to ensure that whatever arrangements are used in the future to allocate HEFCE funds for research give appropriate recognition to high quality research across the full range of work whose costs it is agreed that HEIs may use such funds to defray. So, where HEIs properly use HEFCE research funding (QR) to make an appropriate contribution to the costs of industry funded research that offers wider benefits (in accordance with the principles set out in Recommendations A15), such research must be appropriately recognised and valued in the HEFCE system (recommendation A50).
200. We have also considered whether more could be done to promote the involvement of HEIs in jointly funded, user-led research, particularly amongst the non-research intensive departments that win little or no research funding from HEFCE. We can see that greater involvement of such departments – working in partnership with one another and with research-intensive departments as appropriate – could help to expand the capacity of the HEI sector to reach out to SMEs, and less technologically sophisticated businesses, and engage with these in research, technology development and application, and consultancy. Another benefit of such work, indeed of any fruitful HE-business interaction, is likely to be in increasing the quality and relevance to industry of the training carried out in the HE Sector. But such funding needs to be proportionate and not undermine others, such as the Research and Technology Organisations (RTOs), who are successfully exploiting this market.
201. We therefore believe that existing third stream funding should be expanded somewhat, further to promote and catalyse work of this kind in HEIs, with:
- funding clearly targeted on departments or groups of departments with the motivation and skills needed to work in these ways, and to develop sustainable portfolios of such work in the medium and longer term;
 - the work supported clearly led by users, as demonstrated by a willingness to pay, either by users directly and/or by those representing their interests;

- RDAs involved in ensuring that what is proposed is aligned with the needs of business in the region and in providing funding alongside or instead of that from users; and
- funding primarily for pump-priming HEI work for business that may, over time, become fully funded by business customers - with the exception of clear market failures such as useful work with SMEs that would not otherwise take place.

Work by HEIs for business

202. HEIs conduct a substantial and growing amount of R&D, technology development and application, consultancy and training for business. The proportion of HEI's research income (including both contract and collaborative research) coming from industry increased from 10.9 per cent in 1995-96 to 12.3 per cent in 1999-2000⁴⁸, compared to a USA figure of 10.1 per cent in FY 1999. Consultancy income rose from at least £51.8 million in 1998-99 to £60.2 million in 1999-2000, but the actual amounts are likely to be higher than those reported.
203. Such work is mutually beneficial. Working with industry helps HEIs understand industry problems and feeds new and challenging problems back into the HEI environment – to the benefit of both research and teaching. In addition to the immediate benefit to business of the work undertaken, contact of this kind helps businesses understand and use the people, knowledge and know-how that HEIs can offer. There is thus a strong case for further expanding these activities.
204. Unless there is a clear justification for a contribution from public or private funds, HEIs should recover at least the full costs of this work from the customer. (Recommendations A35 and 36). A strong signal of the relative public/private benefit will be the ownership of any intellectual property generated by the work. Full cost recovery in itself should provide an important incentive for undertaking such work, particularly when it aligns with the general mission of the HEI and/or generates a surplus that can be applied to that mission or used to improve incentives for staff (see below).
205. A number of institutions that are strong in these areas have told us that departments and staff who engage in such work lack proper recognition. They argue that, in the absence of any appropriate measures of quality and success in this area, potential business customers use the RAE - in their view, mistakenly - as an indicator of a department's success and quality. We have referred earlier to the importance of future assessments of publicly funded research in HEIs taking full account of work that is properly jointly funded with business. We believe there is also a need for a simple system to be developed and disseminated to measure and celebrate the quality and volume of HEI departments' more applied work that is fully funded by business.

⁴⁸ These figures exclude QR

206. It is also important that HEIs reward and incentivise staff appropriately for contributions to this side of the institution's work. Such incentives should be designed in particular to reward and promote entrepreneurial behaviour, as well as rewarding staff appropriately for more passive contributions to HE-business interactions. HEIs should recognise that they may need to offer higher salaries to attract sufficiently experienced technology transfer staff. The Government has recognised that the expansion of activity it is funding in this area may lead to shortages in supply of such staff. It has therefore set aside funding to develop and provide training.

Other work to transfer knowledge out of the SEB

207. In addition to the work described above, the Government has taken steps to promote the transfer of knowledge and know-how out of the SEB and into business and the community through earmarked knowledge transfer funding from DTI and DfES for the following programmes:

- **The Higher Education Innovation Fund (HEIF)**, covering England only, administered by HEFCE, built on the previous DfES/DTI HEROBC (Higher Education Reach Out to Business and the Community) scheme. HEIF provides support for the continuing development of capacity in universities to respond to the needs of business and the community, in particular small and medium enterprises (SMEs). HEIF funding of around £78 million has been awarded to 89 applicants. This funding was allocated on the basis of advice from a panel chaired by the Director General of Research Councils, and including representatives of DTI, DfES, HEFCE, RDAs, HEIs and business. The panel took into account the views of experts within DTI, Government Offices, RDAs and HEFCE regional consultants. We believe that the role of RDAs in advising on how a bid fits with regional needs should be strengthened in the next allocation process, particularly in the context of recommendation B11. Scotland and Wales have their own schemes to encourage knowledge transfer from the science base⁴⁹.
- **University Challenge (UC)**, which has created Seed Funds in the university sector to encourage the exploitation of research by funding the early stages of project commercialisation. There are now 15 established seed funds and five new funds arising from the second round.
- **Science Enterprise Centres (SEC)**, which are aimed at embedding an entrepreneurial culture in science and technology faculties. They are doing this primarily by promoting the teaching of enterprise to scientists at all stages of their careers, but some are also engaged in facilitating the commercial

⁴⁹ The Scottish Enterprise and Lifelong Learning Department set up the Proof of Concept fund in 1999. The fund, which is wholly funded by the public sector, has a total value of £30 million. It has provided grants to 44 projects in Scottish Universities, Research Institutes and NHS Trusts. The fund is targeted at early-stage ideas, which have typically reached patent level, and could lead to the creation of new businesses, or licensing innovative technologies. The Welsh Knowledge Exploitation Fund is a £4 million scheme set up in 2000 to aid Welsh universities and Further Education colleges exploit new discoveries and support technology transfer.

exploitation of technology. There are now 13 established SECs involving some 58 HEIs.

- **The Cambridge MIT Institute (CMI)** brings together the expertise of two of the world's most renowned and respected research universities. CMI is running joint educational and research initiatives aimed at improving entrepreneurship, productivity and competitiveness in the UK economy. CMI shares its work with other UK HEIs, particularly the SECs, through the National Competitiveness Network.
- **The PSRE (Public Sector Research Establishment) Fund** was established to boost the capacity of PSREs and NHS trusts to commercialise their research, and also to increase their access to seed funding in a similar way to University Challenge. The first round of the competition has funded one Seed Fund and 15 capacity building projects.

208. A total of £110 million of additional funding was allocated to these schemes in SR2000 over the period 2001-02 to 2003-04. In addition, the Research Councils themselves spend a total of at least £5 million⁵⁰ annually on similar activities such as:

- two joint Business Plan Competitions;
- various industry fellowships schemes; and
- IPR exploitation.

209. New actions being considered include joint company/Research Council calls for proposals, co-funding of research chairs, co-funding of major research centres and Entrepreneurial Fellowships.

210. All of the earmarked knowledge transfer funding is relatively new and it is too early to measure its direct impact. There are, however, very encouraging signs that the SEB is responding to the new requirements for it to engage in work of this kind. Thus, 199 spin-off companies were created by HEIs in 1999-2000 compared with an average of 67 per year in the previous 5 years, and patents filed increased by 22 per cent from 1,259 in 1998-99 to 1,534 in 1999-2000⁵¹. While cultural change is difficult to measure, we believe HEIs are engaging positively with this agenda. All the universities we visited recognised the importance of knowledge transfer and in 1999-2000 92 per cent of HEIs employed specialist staff to support commercialisation.

211. There are also positive signs from the first rounds of UC and SEC. UC has been highly effective in terms of generating new spinouts: 105 new spinouts were

⁵⁰ This figure does not include all expenditure in Research Council Institutes, which is not necessarily allocated centrally to knowledge transfer. It also does not include the expenditure of MRC Technology – a separate entity which manages MRC IPR for an annual fee (largely to cover MRCT's relevant salary costs.). In 2000-2001 total expenditure of MRC's Commercial Fund was £6.9m, though much of this represents awards to inventors and revenue shares paid to third parties.

⁵¹ Higher education-business interaction survey, December 2001, available at www.hefce.ac.uk

formed and 43 patents strengthened or expanded in the first two years (year ending July 2001). In their second year of operation 14 UC funds attracted over twice as much additional funding as the total amount of their own funds that they committed (£12 million). However, the economic impact will take time to show. Early measures of activity are encouraging from SEC, with 5900 science and technology undergraduates exposed to additional enterprise teaching in the first two years, and over 850 at postgraduate and professional level. The centres have also helped to generate 500 new business ideas, over 80 of which have led to early stage businesses.

212. We have examined a number of studies of HE-Business interaction, including the HEBI survey, a study by PREST⁵², the emerging findings of the work on measuring third stream activities commissioned by the Russell Group of Universities and the established AUTM⁵³ survey. While progress has been made on measuring knowledge transfer across the HE sector, we have concluded that the emerging picture is not yet sufficiently clear to allow future funding to be allocated on a formula basis according to simple metrics. We agree with the authors of the HEBI survey that extreme caution is needed in setting narrow models of business interaction, or applying only a few indicators. Indeed, a formula might generate perverse incentives (e.g. too much of a focus on short term number of spin-offs rather than long term economic benefit) and stifle innovation. Broader knowledge transfer, such as helping SMEs to innovate may not be well suited to measurement by metrics. Another factor is the time lag between successful commercialisation and actual impact, making linking funding to performance against simple metrics difficult. We look forward to further such surveys to establish trends in such indicators – though some of the indicators are likely to fluctuate from year to year rather than show a smooth trend. Further work is needed, recognising the breadth of activities that needs to be pursued to underpin successful exploitation of the wide range of knowledge and know-how that resides in the SEB.
213. We believe there is a strong case in the meantime to maintain and in some cases increase funding for these activities to sustain momentum and build upon success. In particular, we believe the increases in third stream funding referred to in Section 3 above should be complemented by further funding for University Challenge. (Recommendation C13 refers to further funding for PSRE in the science in government section.)
214. We also believe there is a need to improve the coherence and co-ordination of all this work. Running the four competitions for HEIF, PSRE and the second rounds of SEC and UC together in parallel last year was an important step in this direction. This co-ordinated framework allowed bidders to make a strategic choice about the funding strands for which they wished to bid. More should be done. Centrally managed funding needs to be drawn together into a single, ongoing ‘third stream’ of funding for HEIs covering the full range of publicly funded activities that can assist successful exploitation. The work of the Research Councils also needs to be given more outward coherence and co-ordinated more

⁵² “Knowledge Transfer Trends in UK Universities”

⁵³ AUTM is the US Association of University Technology Managers

clearly, through RCUK, with that being supported through the centrally funded schemes.

Increasing business demand for SEB outputs

215. The DTI funds a number of schemes designed to increase business demand for, and capacity to absorb and exploit, knowledge and know-how from the SEB. While much of this work seeks to promote two-way communication and exchange between business and the SEB, the schemes all aim to encourage business to pull SEB outputs through into new products and services, and thus to complement the work described in section 5 above (Other work to transfer knowledge out of the SEB) to incentivise the SEB to push its outputs into business. They also recognise that since the market for knowledge is global British business needs an awareness of developments overseas and a capacity to access foreign technology.

216. The main generic schemes of this kind are:

- **Faraday Partnerships**, introduced in 1997, aim to create links between business and the research base that will result in new products and processes coming to market more quickly. Eighteen Faraday Partnerships⁵⁴ currently exist, with the results from a final bidding round this year, bringing the national network to a total of 24. Each Partnership comprises a core of two or three organisations such as an independent research and technology organisation and a university, together with a range of other key players, serving a distinct sector of economic significance for the UK. They cover fields as diverse as electronic displays technology, sensors, plastics, technical textiles, green chemistry, advanced industrial mathematics and new materials. Each Partnership receives about £1 million over four years in underpinning research support from a Research Council together with about £400k per year from DTI to offset infrastructure costs. Current annual DTI spend of £6.3 million is expected to rise to about £12 million in two years time. EPSRC is contributing about £5million in 2002-03 together with contributions from DEFRA, the Biotechnology and Biological Sciences Research Council (BBSRC), NERC and PPARC.
- **TCS** (previously known as the Teaching Company Scheme), involves high quality graduates working in companies, normally for two years, on projects that are important for the future success of the participating companies. TCS facilitates knowledge transfer, provides business-based training and development for graduates and feeds industrial and business relevance back into HEIs' teaching and research. There are currently around 920 individual TCS Programmes (92 per cent of current Programmes involve SMEs). TCS benefits from funding by DTI, DH, DEFRA, the devolved administrations and the Research Councils. Total public sector expenditure on TCS in 2001-02 is likely to be in the region of £23.4 million with the Research Councils contributing about £6.5 million and DTI about £14.2 million.

⁵⁴ www.faradaypartnerships.org

- The Small Business Service **SMART** scheme (worth £22.6 million in 2000-01) provides grants to help individuals and small businesses research and develop technologically innovative products and processes or buy external consultancy to improve their use and exploitation of technology. Since the scheme began in the late 1980s over 4,000 businesses have benefited from awards. An independent evaluation in 2001 found that thanks to SMART-supported R&D projects there was an extra £500 million in the economy last year, an extra £270 million exports and employment was more than 8,000 higher. 94 per cent of participants said they could not have pursued their objectives without SMART and many innovative products which would not have been developed without SMART support are now on the market and achieving sales.
- The **International Technology Service** (ITS) enables UK firms to benefit from the technological expertise of leading countries around the world through missions, secondments, technical information and on-the-ground contacts. In 2001 over 6,000 firms were directly assisted through the service, which cost about £6.5 million. The ITS supports around 30 to 35 technology missions each year comprising a leading academic and 6-10 businessmen who focus on developments in a particular technology in a target country and then report back on and disseminate their findings. The ITS also employs a network of 16 International Technology Promoters, businessmen experienced in technology transfer in the country in which they operate. The target technologies are ICT, Life Sciences, Precision Engineering and Environmental/Renewable Technologies and six International Technology Promoters focus on North America, five on Europe including Russia and five on Asia Pacific (specifically, China, including Taiwan and Singapore, Japan and Korea). Technology transfer for SMEs is also supported through International Secondments to enable SMEs to put a key member of staff into a foreign company or research institute in order to understand better the technology in question.

217. These schemes have achieved considerable popularity amongst those who have participated in them and there is a growing range of evidence of impact from formal evaluation. A Review⁵⁵ and Evaluation⁵⁶ of TCS is being concluded. An independent evaluation of the ITS revealed that two thirds of mission participants have brought forward the adoption of new technology. Interim evaluation of Faraday Partnerships will commence shortly, as individual Partnerships complete their third year of DTI support. Informal feed back from industrial users has been positive, although it is taking a little time for the change in working culture between the SEB and business that Faradays require, to become fully embedded. Informal feedback from those involved – not all of whom were convinced of the value at the outset – has been generally positive. An indirect benefit of all these schemes is their likely effect on the overall funding for R&D within the businesses concerned as they learn of its benefits from their participation in the specific activities supported.

⁵⁵ TCS Review 2001 carried by a Panel chaired by Professor David Wallace, Vice-Chancellor of Loughborough University

⁵⁶ Evaluation of TCS: SQW Ltd 2002

218. While these schemes offer considerable flexibility across sectors and technologies, they do not provide the full range of support that may be needed for particular provisions to ensure business pull-through of all new knowledge and technologies, particularly key disruptive and emerging technologies emerging from the cutting edge of science. Ad hoc approaches will be needed to ensure success in some cases. For example, DTI is currently considering the case for building a nanotechnology fabrication facility where public funding may be justified given the expense of the facility, the distance from market and the large range of businesses that might benefit.
219. Representatives of business have also told us that many businesses find it difficult to identify the right department or the right person who might be able to help them with a particular problem. We believe that moves to improve the recognition of HEI work with business and the increased funding for ‘third stream’ activities should go some way towards remedying this problem over time. We also believe that the HE sector could do more, collectively, to make its expertise available and accessible to businesses.
220. If the UK economy is to get maximum benefit from the outputs of the SEB, the DTI needs to continue to run a flexible portfolio of generic and ad hoc schemes to promote the pull through of SEB outputs into business. As with support for pushing knowledge out of the SEB, however, there is a need to improve the coherence and co-ordination of these schemes that DTI funds, both within themselves and between them and fuller range of business support that DTI provides (the general relevance of which to knowledge transfer has already been noted). DTI is pursuing this through the new Knowledge Transfer Strategy Group.

Access to information about university research activity

221. The lack of a central resource for information about research carried out in UK universities was raised by some of the industry representatives we spoke to. While it is clear that many links between industry and universities are based on personal contacts and long-term arrangements, it is difficult for companies new to an area of research (especially SMEs) to determine which universities are carrying out research in their area of interest. The RAE scores provide some general information about excellence, but this is only updated every 5 years and does not provide sufficient detail to meet the needs of industry.
222. The Scottish Enterprise and Lifelong Learning Department has provided funding to SHEFC to set up the Scottish Research Information System (SRIS) at www.scottishresearch.com. This site brings together information about the research produced across HEIs in Scotland and provides links to current work by individuals and topic areas, in addition to links to research groups carrying out work. The establishment of the website was funded with a £300,000 grant from the Scottish Executive, and is maintained by further grant funding to a contractor (Solon). There are currently 6,000 records on-line, with plans to expand this to 20,000. SHEFC is currently negotiating with the Scottish Executive for funding to

expand the database to cover non-HEI research centres in Scotland, for example those funded by the Research Councils.

223. In England, HEFCE are planning to publish the RAE data from 2001 on their website, but this will not provide the same level of detail as www.scottishresearch.com. The data will be from 2001, and there are no plans to update the data.
224. Other sources of information about research conducted in universities outside Scotland exist. The Research Councils have set up www.nest.ac.uk, as a gateway to Research Council sponsored research projects. The American Community of Science (COS) database www.cos.com is a research database covering several different countries. It incorporates BEST (British Expertise in Science & Technology) and CRiB (Current Research in Britain). HEFCE is also working with COS on number of projects, for example COS hosts the HEFCE database, ChinaExperts, which is designed to help UK enterprises that are developing businesses in China. Invest UK has www.ukresearchanddevelopment.com which is primarily aimed at overseas industry. These websites currently provide disparate information and are not widely known. There is likely to be benefit in the creation of a single source of information which is well known and easy to use, such as www.scottishresearch.com

Promotion of the UK science base and research environment overseas

225. Whereas the UK invests around £16 billion annually on R&D, generating some 3,500 patents in the USA and 5,500 patents in Europe each year, the total investment in R&D by OECD countries exceeds £275 billion annually which generates annually around 130,000 patents in the USA and 75,000 patents in Europe. The market for knowledge has become global and, with the speed of technological development in knowledge-based industries, it is rare for any one company to have the technological capability to take forward product development from its own knowledge base. It is therefore essential that British business becomes more aware of developments overseas and develops a capacity to access foreign technology. Furthermore, it is through such technological collaboration with leading partners that UK firms can penetrate overseas markets and recoup on the economies of scale required to develop new knowledge based products since the UK market is rarely sufficient in itself to justify the investment.
226. The UK has a positive environment for research, supported by the legislative framework (for example, allowing stem cell research) and a number of measures to encourage enterprise and innovation. These measures, such as provisions on capital gains tax, provide one of the best environments in the world for investment in small research companies at an early stage. This framework needs to be fully understood and appreciated overseas.
227. Invest UK, part of British Trade International, is active in promoting the UK science base overseas. Its staff in British Missions overseas work closely with science and technology attachés (where they exist) to ensure potential and existing

inward investors are aware of the UK's research strengths. Invest UK also works closely with the Regional Development Agencies (RDAs) to identify regional strengths, making use of RAE scores, UK academics, and the International Technology Service to identify universities of interest to their clients. Overseas companies tend to identify Oxford and Cambridge as the leading research institutions in the UK. While both of these universities are excellent in many areas, they are not necessarily best placed to meet the needs of all investors. However, initial visits by Invest UK's clients to Oxford and Cambridge have provided Invest UK with opportunities to arrange visits to centres of excellence at other UK universities. Invest UK also promotes partnerships and collaboration between overseas companies and UK universities and centres of excellence. For example, working with the UK Development Agencies, Invest UK and its sister organisation, Trade Partners UK, showcased UK leading R&D in the ICT field at Cebit, the premier global ICT exhibition. Invest UK also has a website which provides information, targeted at overseas companies, on the UK science base.

228. Large companies may have the resources to monitor global technology developments but SMEs simply do not have that ability. The DTI's International Technology Service raises awareness of, and facilitates access to, overseas technology through a number of mechanisms. They arrange around 600 one-to-one meetings for UK business each year, and business then decides how best to progress their interests. In collaboration with BTI, this service is being developed further. BTI is giving greater focus to global technology partnerships and is developing a better mechanism for handling overseas enquiries about the possibility of working with UK firms on technology developments. Technology transfer for SMEs is also supported through International Secondments to enable SMEs to put a key member of staff into a foreign company or research institute in order to understand better the technology in question. Departmental support is limited to 50 per cent of the cost of the project and the average cost amounts to around £25,000 per project. At present, some 50 projects are supported this year but this is likely to rise to 80+ as the inward secondment pilot (whereby the SME can bring in an overseas expert for a period) is extended.

229. The importance of domestic knowledge transfer to these international activities, and vice versa, are manifest. Companies capable of engaging with the UK science base should be able to engage with sources of knowledge anywhere, and companies which have been encouraged to innovate through international links are also encouraged to deepen their innovative capacity and engage with the UK science base.

Science and the Regions

230. Existing spend on science research (through the Funding and Research Councils) is fundamentally organised on a national basis using classic excellence criteria. This should, of course, continue as it remains the best way to secure both value for money and ensure that the UK's innovation agenda is appropriately underpinned. This may result in the under representation of particular disciplines or regions, or both in combination. The Review is clear that there should not be a requirement for a particular geographic or disciplinary pattern. To do so would be liable to compromise science objectives to the detriment of UK innovation. But

there may be national or regional advantage in investing in areas of potential excellence. HEFCE is considering how it might support capacity building activities.

231. In the regions, the RDAs will be best placed to match the needs of regional industry with the existing and potential science base in the regions. Through their Regional Economic Strategies, they are able increasingly to understand the strengths and weaknesses of the region, and the future direction of economic development. This knowledge can be used, perhaps (but not necessarily) with some funding from the RDA and additional funding levered in from elsewhere to support the science base, where it has potential to grow, to stimulate knowledge transfer - perhaps as we have suggested in section B, by having an enhanced role in the allocation of HEIF - and by developing connections between industry, particularly SMEs, and the university sector.
232. As each region, and regional science base, is at a different stage of development, there should not be a mandated scheme to force RDAs to adopt a particular model of interaction with the science base. This would limit innovation in the development of relationships. Rather, the framework should be set, in HEIF and in the way in which RDAs identify their priorities, which allows regions to harness the knowledge and experience of the RDA for the benefit of science and research. The RDAs will do this best where they themselves or through their own partners commit resources. However, there may be a case for encouraging such activity by the dedication of a small dedicated funding stream.
233. A sustained investment will enable the regions to recruit more scientists and develop new facilities in order to further enhance existing research strengths and to make them more sustainable. In turn, the enhanced research base would enable those regions to participate more successfully in knowledge transfer activities, and boost regions' attractiveness for high value added business investment, furthering cluster development.
234. There are, of course, concerns about the sustainability of the current national volume of research. Developing science capacity within the regions would need to avoid overlapping and to maximise co-ordination. The areas of potential research would need to be verified through independent research and will need to be co-ordinated with HEFCE and the Research Councils to ensure that the national priorities are met as well. The creation of the RCUK this year - which will give the Research Councils a collective strategic voice - will have an important role to play in co-ordinating activities across the country. The research will also need to be selected by Regional Science and Industry Councils - as already established in the North West and the North East - or equivalent bodies who will be charged with developing science and research strategies for the region, and will need to look carefully at research strengths and opportunities.
235. With the advent of the Single Pot funding system, the Regional Development Agencies will be in a more favourable position to put their own funding directly into capacity building. Indeed, we would recommend that any additional funding considers whether the RDAs should be asked to match funds provided from the centre. However, if the centre were to hold a limited budget in support of a few

key research centres, it would then be in a more favourable position to lever contributions and to moderate the selection process, thereby preventing different regions chasing potential Centres of Excellence in the same areas.

Part 2 - Recommendations

236. The preceding analysis and presentation of findings has been structured around the processes involved in successful knowledge transfer between the SEB and business. The recommendations here, which flow from these findings, are structured according to the organisational arrangements to which they relate.

General

Recommendation B1: Effective knowledge transfer from the SEB is essential for the UK to reap the maximum benefits from public investment in the SEB. Effective knowledge transfer requires a careful mix of public and private action. Public funding should be carefully directed to areas of market failure in line with the above analysis. We recommend further increases in public funding for knowledge transfer, within this framework.

Research Councils and RCUK

Recommendation B2: The Research Councils are the main source of public funds for the SEB and have a key role to play in promoting knowledge transfer. In line with their Royal Charters, they should continue to:

- take account of user needs in their strategic planning and funding decisions;
- fund research of relevance to their remits and importance to users jointly with users when the expected balance of public and private benefits justifies this; and
- promote knowledge transfer from their grantholders and Institutes.

Recommendation B3: The establishment of RCUK provides an opportunity for the Research Councils to work better together on these issues at a strategic level. Likewise, the formation of the new Innovation Group and Knowledge Transfer Strategy Group and appointment of a Director General Innovation in DTI provide an opportunity for RCUK and DTI to work together more closely at a strategic level. RCUK should make these areas an early priority. The Quinquennial Review⁵⁷ of the Research Councils recommended the creation of an earmarked knowledge transfer fund for the Research Councils. This should also be taken forward by RCUK, on the basis of a strategic overview of the Councils' current portfolio in this area. The overall aims of all this work should be to:

- ensure user needs are taken into account in the development of the RCUK forward vision for Research Councils' support for science;
- build on current achievements in jointly funded research;
- build on current achievements in knowledge transfer, particularly from their Institutes;
- achieve more strategic and rapid participation in schemes such as LINK and Faraday; and

⁵⁷ QQR of the Research Councils at: <http://www.ost.gov.uk/research/councils/quinquennial/index.htm>

- achieve greater co-ordination and synergy between Research Councils' work on knowledge transfer and that supported through 3rd stream funding to HEIs (see recommendations below).

DfES, HEIs, UUK and HEFCE

Recommendation B4: DfES should ensure that HEIs work through UUK and with HEFCE and RCUK to develop indicators to measure and celebrate the quality and volume of HEI departments' applied research, technology development and consultancy work of direct benefit to, and fully funded by, industry. HEIs should also be encouraged to provide appropriate incentives and rewards for their staff to become involved in work of this kind.

Recommendation B5: HEFCE should, working with other providers of research information (including Invest UK and Universities UK), consider establishing a database similar to that operated by SHEFC, which would provide detailed information about the range of research projects and interests of research groups across the sector.

Recommendation B6: DfES should ensure that HEFCE's review of research assessment procedures and related funding formulae to implement the development of the Dual Support system, as proposed in Section A of this report (recommendation A50), takes appropriate account of high quality research of all kinds that research funding distributed by HEFCE may properly be used to support, including that jointly funded with business.

Third Leg Funding

Recommendation B7: A further clear signal should be given that third stream funding is intended to form a permanent component of funding for the HEI system from now on, reconfirming the Science and Innovation White Paper commitment that HEIF would be "a permanent third stream of funding for universities".

Recommendation B8: Current funding for HEIF, SEC and UC should be brought together into a third stream of funding for HEIs, allocated to DTI and DfES, to support:

- work to promote enterprise in HEIs and businesses and to promote networking between the HEI and the user communities for the outputs of research;
- the infrastructure and capability to transfer knowledge from HEIs into business and the community through applied research, technology and knowledge development and application, and consultancy; and
- the formation, through seed corn funding, of companies to spin out new knowledge, or the development of commercial enterprises to pursue the activities in the point above.

Support for all these activities will generally be through pump-priming, except in cases of clear market failure where there may be an appropriate ongoing contribution.

Recommendation B9: If possible, there should be a modest increase in funding in SR2002 for the infrastructure and capability to transfer knowledge from HEIs into business and the community through applied research, technology and knowledge development and application, and consultancy. In addition, it will be important to ensure that seed corn funding continues to be available for a further period until returns from early ventures begin to make the activity self-sustaining.

Recommendation B10: The next round of funding should be awarded for a three year period. HEIs should be asked to propose a programme of work within the classes of activity set out in Recommendation B8 above. They should be asked to make clear how this would build on existing strengths and achievements (including from funding allocated in past rounds), and to propose measures by which their progress and success could be judged. They should also be asked how third stream funding has been, or will be, replaced over time with earned income, or to explain the underlying market failure that is being addressed.

Recommendation B11: Any expansion of funding in the SR2002 period for the activities described in section 2 of Recommendation B7 should be focused in particular on non-research intensive departments in HEIs – working in partnership with one another and with research-intensive departments as appropriate – for work to engage with SMEs and less technologically sophisticated businesses in research, technology development and application, and consultancy, with:

- funding clearly targeted at departments or groups of departments with the motivation and skills needed to work in these ways, and to develop sustainable portfolios of such work in the medium and longer term;
- the work to be supported clearly led by users, as demonstrated by a willingness to pay, either by users directly and/or by those representing their interests;
- RDAs involved in ensuring that what is proposed is aligned with the needs of business in the region and, where appropriate, in providing funding alongside or instead of that from users; and
- funding primarily for pump-priming HEI work that may, over time, become fully funded by customers - with the exception of clear market failures such as useful work with SMEs that would not otherwise take place.

Recommendation B12: OST and DfES should work with funding bodies and the HE sector further to develop metrics for knowledge transfer to:

- help the sector manage its own knowledge transfer activity;
- help funders and the Government as a whole to assess value for money, both at project and programme level; and

- inform the future allocation of funds, though recognising that a simple formulaic allocation of funds is unlikely to be possible for some time.

DTI and Treasury

Recommendation B13: OST and the new Business and Innovation Groups in the DTI should work through the new DTI Knowledge Transfer Strategy Group to improve the coordination of funding for knowledge transfer through SEB push and business pull.

Recommendation B14: The review of DTI Business Support should ensure that new arrangements can continue to support and promote jointly funded research and business capacity to pull research through into markets, in ways similar to those that have proved successful in the current LINK, Faraday, TCS, SMART and ITS schemes. New arrangements should also allow for ad hoc, innovative forms of support for these activities where this is required to ensure success with a particular technology and/or sector.

Recommendation B15: Invest UK requires access to information, in a useable format, to enable it to identify world class research being carried out in the UK which is of relevance to its clients and thus contributes to meeting its objective of maintaining the UK's position as the largest recipient of inward investment in the European Union. Recommendation B4 should go a considerable way towards addressing this. OST, the Research Councils and universities should also consider whether they could develop more systematic ways of working more closely with Invest UK, to provide it with the information it needs. Invest UK and the UK Development Agencies should also consider how they can continue to improve the quality and relevance of the information they share to ensure that opportunities to link UK universities with overseas firms are not missed due to lack of information; and should continue to identify, and work with, universities across the UK (see recommendation B4).

Recommendation B16: The Treasury, working with OST, Invest UK and the Inland Revenue, should consider how information about the UK's positive environment for research, encompassing legal and fiscal measures, can be better promulgated internationally. We should use the British Council, the scientific attaches and ITS to get this message over better. This work should be coordinated and pushed forward by the Committee on International Science and Technology (CIST) chaired by the CSA.

Recommendation B17: Consideration should be given to developing a regional science investment fund which would facilitate a time-limited development of research and technology capacity, which could then migrate to conventional excellence driven funding. The funding would be directed at emerging or sub-critical regional research strengths and needs, which would need to have demonstrable regional exploitation potential and the prospect of longer term sustainability. The investment funding would pick up potential excellence, thus complementing the formulaic approach of the RAE which

rewards existing excellence. It would not compromise the basic principle that science funding should be determined on the basis of excellence. Its primary focus would be on pre-competitive technologies and inter-disciplinary application research rather than seeking to underpin blue skies research.

Section C: Science in government departments

Introduction

237. As part of the drive for evidence based policy and improved service delivery the Government needs to use, and be seen to use, high quality science and the most appropriate new technologies. Research programmes funded by government departments make a very important contribution to policy formulation. Even though the outcomes of the research itself cannot always be predicted, departments must be able to commission the right research, assess its quality, and use it effectively. The credibility of departmental policy making generally will be undermined if individual policies are perceived to be based on poor, or the wrong, science. The reputational risks of failure are therefore high.
238. Significant sums of money are involved. Total spending by government departments on research and development was nearly £4 billion in 1999-2000. This review focuses on the £1.35 billion spent by civil departments. Science base funding by Research and Funding Councils, by comparison, was in the order of £2.5 billion in the same year.

Scope

239. This review focuses on science and research in civil departments and their agencies: the Ministry of Defence has been consulted. The review covers physical, life and social sciences, and technology.⁵⁸

Main Findings

240. ‘Guidelines 2000’ on scientific advice in policy making⁵⁹ set out the key principles applying to the development and presentation of scientific advice. The key messages were that departments should:
- think ahead and identify early the issues on which they need scientific advice;
 - get a wide range of advice from the best sources, particularly when there is scientific uncertainty; and
 - publish the scientific advice and all relevant papers.
241. Success criteria developed in this review of science in government departments build upon those principles and include:

⁵⁸ The implications of these recommendations for the physical and life sciences and for the social sciences may differ in some respects and are recognised in this report.

⁵⁹ Office of Science & Technology, July 2000

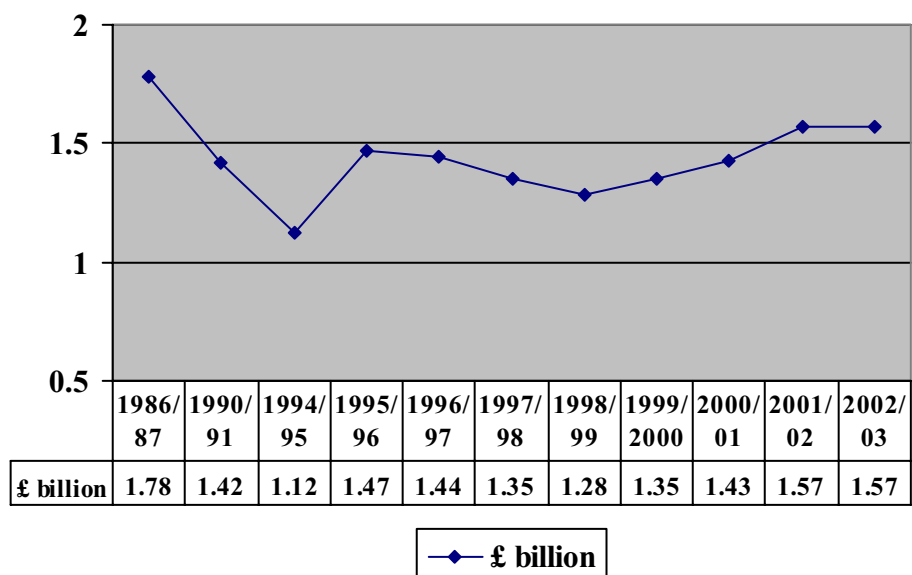
- effective horizon scanning so that issues involving science, or where science could be involved, are identified in advance;
- effective arrangements for deciding what current or potential science could benefit the needs of the department and hence whether new research is needed, including management of existing knowledge, synthesis of existing research, links to other government departments and the research base in the UK and internationally;
- strong procurement process, in line with Office of Government Commerce (OGC) standards, run by expert research programme managers;
- commitment to excellence in research, recognising that most research for government departments is ‘problem solving’ rather than ‘blue skies’. It needs to be fit for purpose, and carried out to high standards. Second rate research produces results of limited or no value;
- arrangements for critical use of the results of research and scientific advice. Competent, engaged people are essential: to understand how new information fits in to the existing body of knowledge, and to ensure policy and delivery are critically reviewed in the light of new findings and that information presented to Ministers and the public accurately reflects research findings;
- strong arrangements for procuring scientific advice, in line with the new Code of Practice for Scientific Advisory Committees;
- publication of results and debate about what they mean; and
- effective knowledge sharing and transfer arrangements, in line with Science and Innovation White Paper commitments.

242. Most departments can demonstrate that many of these features are in place. But all agree there is more that could be done, and that action is needed to create a dynamic for improvement in effectiveness.

Budgets

243. High quality outputs require adequate inputs in terms of money invested in research. There has been a general decline in spend on civil research and development by government departments through the 1980s and 1990s (see figure below). This trend has now been reversed. The decision in SR 2000 that the research spend of the main civil departments should at least be maintained in real terms has made a significant contribution. This improvement needs to be sustained.

Figure 6: Net Government expenditure on R&D by civil departments in real terms



Source: Forward Look 2001

244. Departments need to take a more strategic approach to setting R&D budgets. One of the commitments in the White Paper ‘Excellence and Opportunity: a science and innovation policy for the 21st century’ (July 2001) was that departments should publish science and innovation strategies which set out the broad framework within which research programmes and other science related activities are carried out. This has been an important step in linking research and development to delivery of departmental objectives and showing how value for money is achieved. The department’s published science and innovation strategy ought to become the document on which plans for future research spending are developed.

Recommendation C1: Departmental published science and innovation strategies should be costed, including actual and projected costings for research and development in the current Spending Review period and beyond, and this costing should be provided to the appropriate Treasury Spending Team, and copied to OST.

245. Departments are free to determine what proportion of their budget they spend on science. Research spend typically represents a very small proportion of departmental budgets (1 per cent or less). Because it is such a small proportion of the overall budget, research spending is usually not separately identified until late into, or even after, the Spending Review process, and does not normally form a significant part of discussions between the Treasury and departments. At present

therefore, there is little central influence or challenge over what proportion of their budgets departments choose to spend on science.

Recommendation C2: Departmental Analyses of Resources submitted to the Treasury and early Spending Review discussions between the Treasury and departments should, in future, clearly identify the research component. Departments should agree research budgets for the SR period with the Treasury, in consultation with OST, before settlement letters are issued. The working assumption, as in the last SR, should be that expenditure on research will at least be maintained real terms.

246. Departments buy some of their research from universities, although the proportion involved varies between departments. The Transparency Review has investigated pricing strategy for research carried out in HEIs (see Section A). The recommendation that HEIs should recover full economic costs for much of the research placed by government departments will impose additional costs on the procuring departments.

Recommendation C3: Based on the recommendation in Section A of this report that HEIs should recover full economic costs for much of the research undertaken for government departments, departments need to ensure that their future costings fully take account of the cost implications of the Transparency Review, for any research contracts they intend to place with HEIs.

247. As a form of investment, research spending can be even more vulnerable to urgent spending pressures than capital investment in buildings and equipment because its outputs are less tangible and more uncertain, although the outcome is often of major long-term importance. One element of this review was to look at how the agreed investment in science could be safeguarded. In SR 2000, departmental settlement letters were an important step forward in identifying science allocations separately for the main departments. A similar commitment should be included in SR2002, but with added protection for the investment by ensuring that any changes in the agreed spending programme can be monitored and reviewed centrally. However, the arrangements need to permit a level of flexibility, to recognise that research priorities can change during the course of the Spending Review period.

Recommendation C4: Departments should not transfer resources from, or fall below, the agreed research and development allocation as set out in the settlement letters without seeking permission from the Chief Secretary to the Treasury in writing, and consulting the Government's Chief Scientific Adviser.

248. These recommendations are intended to ensure adequate inputs for research. The other recommendations in this report focus on improving the effectiveness

with which those resources are used. They support the Cabinet Office programme for improved delivery and build on recommendations from the Performance and Innovation Unit ‘Adding It Up’ report which focused on use of social science and analytical capacity.

Competence – scientific expertise in departments⁶⁰

249. Departments need scientific advice in order to underpin their policy making and regulatory activities, and in some cases to deliver programme objectives. Such advice can be provided by external or internal experts, or informed by the output of research programmes commissioned by the departments. Departments need scientific expertise in order to:

- interpret scientific issues simply and clearly;
- harness and synthesise existing research;
- identify their research requirements accurately;
- procure science of high quality and relevance;
- manage out-sourced research programmes;
- understand the findings of research programmes and appreciate their policy implications; and
- evaluate scientific advice from external sources and identify the implications for policy.

250. Departments with a significant requirement for science and science advice also need to have the capability to consider science issues at an appropriately senior level in the wider context of the department’s work. In practice, this requires representation and strategic direction at the top end of the department. There is a need for an individual, a Chief Scientific Adviser, who can ensure that the department’s scientific activities are well directed and that policy is soundly based on good science, and to be the department’s scientific spokesman to the outside world. Such a person will need active experience at the cutting edge of science, in order to ensure they have the appropriate credibility both within and outside the department.

251. In order to ensure all these functions are fulfilled, the individual concerned will need to be able to operate at the appropriately senior policy making and operational level, which will normally be departmental strategy board level.

⁶⁰ The recommendations on competence are about physical and life sciences. Comparable arrangements already exist for social and economic research. The balance of need for top level advice on physical and life sciences and social science issues will vary between departments. The aim is to ensure that departments get input from both angles, and that necessary connections are properly made.

252. Such a person may not be easy to find from within the civil service: posts should go to open competition. MOD, the Department of Health, DEFRA, DTLR and DTI have taken this approach. Not all Chief Scientific Advisers need to be full time. Indeed, there is value in senior scientists working with Government keeping at least a foothold in an active research group, so that they do not lose touch with the latest developments.

Recommendation C5: Every department which conducts or commissions an appreciable amount of research, or uses science should have a Chief Scientific Adviser, accountable to the Secretary of State and Ministers for science procurement and advice within the department. Departments which rely heavily on scientific and technological input across the range of their activities need a more or less full time Adviser, with a place on the department board. Other departments will not necessarily have places on strategy boards, but should ensure that the Chief Scientific Adviser meets the board several times a year, and spends enough time with the department to understand its work.

253. In order to ensure that appropriate standards are maintained in the selection of departmental Chief Scientific Advisers across Whitehall, there needs to be a central overview of the type of appointments which are being made, in order to ensure that appropriate selection criteria are being met.

Recommendation C6: The Government's Chief Scientific Adviser should be involved in the appointment of departmental Chief Scientific Advisers, so he can ensure that appropriate criteria are being applied across Government.

254. In order to discharge their function adequately, Chief Scientific Advisers will need appropriate support from scientifically qualified staff. In the period up until the 1980s when departments ran their own laboratories, they used those laboratories as a supply of scientific talent to meet their needs for scientific expertise. Most departments no longer run their own dedicated research organisations, and rely on outsiders for this function. Consequently they have lost an important source of supply of experience scientific talent. And little effort is now made to take a systematic view on the areas of policy that need scientific input, or the critical mass of scientists needed at the science/policy interface.

255. Departments can overcome this problem to a large extent by developing and maintaining their own in-house supply of scientific expertise. However, in-house staff who are no longer or have never been active as practising scientists are unlikely to be at the leading edge of their disciplines. Departments often need to look to external sources to make up shortfalls in their level of scientific expertise, either by appointing practising scientists with the required background, or by shorter-term expedients. Departments already use secondments and short-term contracts to keep expertise up to date. This should be encouraged, along with more long-term partnerships between departments and research establishments. For example, the Office of Science and Technology (OST) is working with the

Royal Society to encourage top young scientists to spend a period of time advising departments on scientific aspects of policies and programmes.

Recommendation C7: Departmental Chief Scientific Advisers should be accountable to Ministers and the departmental top-level board for the level of scientific expertise in the department.⁶¹ They should review regularly the deployment of that expertise, report to the Board on whether that resource is optimally deployed, and make changes when needed.

256. The disappearance of a separate science group in the civil service and the move to unified grading has meant most departments no longer offer a separate career structure for their scientifically qualified staff. Most departments do not maintain personnel records in a form which makes it easy to identify their scientifically literate staff, and scientists are generally managed on the same terms and conditions as administrators. As a result, scientifically qualified staff may move out of the areas where their qualifications or background were relevant. The opportunity to keep such staff in touch with latest thinking and to tap into their expertise is then lost. In contrast, government social scientists (economists, statisticians, social researchers and operational researchers) are more actively managed as specialist groups, and have professional grades and networks within which they operate.

Recommendation C8: Chief Scientific Advisers will need to work in partnership with their department's personnel function to review and categorise posts in terms of the requirement for scientific expertise. Departments should maintain records on specialist staff in order to be able to identify their scientific qualifications and experience.

257. Practical opportunities for staff to refresh themselves by returning to active research may be limited. However, managing research programmes offers those involved an opportunity to keep in touch with developments. Enhancing the professional status of research management within government could help motivate the scientists involved to build a career in the science area of the department's activities.

Recommendation C9: Chief Scientific Advisers across Whitehall should act to ensure that professional staff engaged in research management undertake continuing professional development and are exposed to the latest science in their area of work.⁶²

⁶¹ Within the Department of Health this function is provided by the Chief Medical Officer, on the advice of the Department's Chief Scientist.

⁶² This recommendation will extend to physical and life scientists good practice already in place for social scientists, without seeking to recreate a centrally managed 'scientific civil service'.

258. Many specialist groups within departments could benefit from wider career horizons if they were able to move more freely into related scientific areas in other departments, rather than relying solely on moves within their home departments.

Recommendation C10: Departmental Chief Scientific Advisers should work together, and with the Government's Chief Scientific Adviser, to ensure that opportunities and resources for career progression for scientists are available across the civil service wherever appropriate.

Knowledge transfer⁶³

259. In recent years there has been a drive, prompted by the recommendations of the Baker Report⁶⁴ on commercialisation of the research outputs of Public Sector Research Establishments (PSREs), to promote more effective exploitation of publicly funded research, including that commissioned by government departments. Departments are also involved in knowledge transfer from the research they fund to the public services they support, for example the NHS. The rest of this section relates more to the commercialisation agenda.

260. Departments and agencies involved in delivering the knowledge transfer agenda have been hampered by the lack of appropriate incentives, and the required skills and expertise for this area. There have been a number of welcome changes in policy, as well as the creation of schemes to assist and encourage knowledge and technology transfer. An element of this part of the cross-cutting review was therefore to assess the effectiveness of these efforts, and what more might need to be done.

261. The main initiatives have focused on delivering the agenda set out in the Government's response to the Baker Report. These include the Patent Office guidelines on Intellectual Property in Government Research Contracts, the OST's guidance on good practice for PSREs on staff incentives and the management of conflicts of interest, and the establishment of a Science and Technology Commercialisation Unit within Partnerships UK. The Small Business Research Initiative (SBRI), which applies to those departments with a research spend over £50 million, has also been launched, but it is too early to assess its impact. Treasury and OST officials have been monitoring implementation of the Baker Report. Implementation of knowledge transfer agenda by government departments has so far been patchy. Despite the higher profile given by Baker and the follow-up initiatives, there is little evidence that, at departmental level, knowledge transfer is treated as an appropriately strategic goal. It often does not have a sufficiently central or senior focus in many departments. Further measures are desirable to improve progress.

⁶³These paragraphs on knowledge transfer should be read in conjunction with Section B of this report on knowledge transfer from the science base.

⁶⁴http://www.hm-treasury.gov.uk/Documents/Enterprise_and_Productivity/Research_and_Enterprise/ent_sme_baker.cfm

Recommendation C11: Departments should ensure that knowledge transfer objectives are included in their science and innovation strategies and in their research programmes. A senior official should be responsible for delivery, by the department and the PSREs for which it is responsible, of the action points listed in the Government Response to the Baker Report, Small Business Research Initiative targets and other relevant guidance. Treasury and OST should continue to monitor implementation of the Baker Report.

262. The establishment of a Science and Technology Commercialisation Unit within Partnerships UK was one of the outcomes of the Baker Report. The Unit provides general and specific advice to PSREs on their exploitation activities. It is also preparing guidance on behalf of the Treasury, and has published detailed guidance on establishing joint ventures with the private sector. During the course of its work, the Unit has found that the tone and letter of many of the Baker Report recommendations have not been cascaded by departments to their PSREs. This is particularly true of financial freedoms, including the ability of PSREs to retain the receipts from exploitation activities, and to allow greater carry over of these receipts at the end of the year (within limits).

Recommendation C12: Departments should ensure that the PSREs for which they are responsible have a framework in place for commercial exploitation. As far as possible, they should ensure that their PSREs are given the financial and other freedoms recommended by the Baker Report. Where a department does not consider such freedoms to be appropriate, it should justify its decision by writing to the Treasury, copied to OST, to explain its reasons.

263. SR2000 resulted in the £10 million PSRE Fund, which had dual aims. It provided £6 million for PSREs to develop knowledge transfer capacity, and created a £4 million seed corn fund to invest in early stage ideas emerging from the PSREs. The number of applications was extremely encouraging, though demand far exceeded the available funds. The momentum generated by the PSRE fund must not be lost.

Recommendation C13: The PSRE fund, which was worth £10 million in SR2000, should be continued in SR2002 at least at that level to support the aim of developing knowledge transfer capacity. Consideration should be given to the creation of a separate seed corn fund.

264. There is a need to ensure that, when departments undertake major policy reviews, they consider the scope for enhanced knowledge transfer and the role which might be played by research. Departmental Chief Scientific Advisers could have a useful input to major policy reviews undertaken by their departments. So far, they have not been sufficiently involved. Consulting them at an early stage is

likely to add value and help identify the scope for research and/or knowledge transfer.

Recommendation C14: When departments undertake a major review of policy or launch public consultations on policy development, they should consult their Chief Scientific Adviser at an early stage and report on the scope for enhancing the evidence base and on how they will deliver and evaluate improvements in knowledge and technology transfer.

Cross-cutting issues

265. Research needs often cut across departmental – and disciplinary – boundaries. Arrangements for co-operation and communication vary according to need; departments agree that one size does not fit all. Generally the arrangements are informal. Although there are some examples of cross-cutting research areas where stronger co-ordinating arrangements are used, procedures for allocating and accounting for budgets have not always facilitated such an approach.

266. The review examined alternative approaches to cross-cutting issues, including:

- central science budget;
- merged budgets; and
- co-ordinated steering arrangements.

Central science budget

267. Officials have explored the case for a centrally managed budget for Government science, possibly allocated by the Prime Minister's Chief Scientific Adviser. This included looking at arrangements internationally. A more centralised science budget management system would bring a stronger weight of expertise to bear on a budget which, overall for civil departments, runs at over £1 billion but which, as explained earlier, does not at present get the level of scrutiny given to some other areas of departmental spending because it represents such a small part of the overall departmental spend. It would also provide a stronger mechanism for dealing with the many issues, such as energy research, drugs research, health and the environment, which cross departmental boundaries.

268. The main argument against a central science budget is that it would take decisions on science spending away from decisions on overall spending priorities in a way that cuts across decision-making by both departments and the Treasury. Centrally held budgets are often less efficiently run than local budgets and can result in delays in spending money, slippage and spending not properly focused on priorities. In short, in the view of the Treasury, a central science budget is unlikely to offer value for money, and it is not certain that it would represent an improvement on the current arrangements whereby departmental Chief Scientific Advisers work with their departmental priorities to allocate and manage a science budget. Furthermore, a ring-fenced budget may restrict science spending if upward pressures are exerted; and the benefits of a single overview (above and

beyond the role played by Treasury spending teams and departmental Chief Scientific Advisers) are not clear.

269. In conclusion, there does not appear at present to be widespread support for a central science budget. Nevertheless, the idea should not be lost altogether. It should be borne in mind as an alternative to the package of measures proposed in this report, and the Government should revisit it at the next Spending Review if the success criteria cannot be achieved through current budget structures.

Merged budgets and co-ordinated steering arrangements

270. Merged budgets, with departments contributing to a single pot under the leadership of a single department and with shared steering arrangements, are already in use. Research co-ordination of this type generally follows policy and programme co-ordination. A good example is the interdepartmental Research and Information Working Group in the drugs research area, chaired by the Home Office, which monitors the progress of the research programmes and manages a ring-fenced budget. Other examples of programmes with merged budgets include the Sure Start initiative and the work on mobile phones and health; there are also examples of single pots at the level of individual research projects. Co-ordinated steering arrangements are a step back from merged budgets. Under such arrangements, departments involved hold their own budgets for a particular research area, but programmes are co-ordinated by an interdepartmental group. One example is research on transmissible spongiform encephalopathies (TSEs) which is co-ordinated by a funders group led by DoH, under the oversight of a High Level Group chaired by the Government's Chief Scientific Adviser.
271. While co-ordinating arrangements might provide an overview of research in a particular area and a means for identifying gaps and overlaps, merged budgets provide a stronger basis for strategic direction. The case for and against pooled budgets was set out in the Performance and Innovation Unit report 'Wiring It Up' (January 2000). The general conclusion was that flexible use of budgets should be encouraged in dealing with issues that cross departmental boundaries. Four case studies to explore options for allocating and managing the budgets of cross-cutting initiatives, including pooling resources, were reviewed in SR 2000.

Recommendation C15: The Government's Chief Scientific Adviser should explore the scope for increased use of merged research budgets in cross-cutting areas of research.

272. Government departments are frequently important buyers of applied research in specific scientific areas. They are reliant on a supply of suitable scientific manpower. The funding of basic or 'blue skies' research by the Research Councils helps to develop and train the necessary manpower. Government departments which rely on particular scientific capabilities at the applied end of the spectrum have an interest in ensuring that the research funding at the basic end of the spectrum is sufficient to ensure an adequate supply of trained manpower over the longer term.

Recommendation C16: Departments, with OST, should ensure that, within those areas of science on which they rely, arrangements for government funded research across the spectrum from basic to applied are sufficiently co-ordinated to ensure that their future research needs will continue to be met, and that they take action if this does not appear to be the case.

273. In some areas, several departments will need to tap into the same pool of research expertise. In these areas, departments will need to work with one another as well as with the relevant Research Councils. The Government's Chief Scientific Adviser has recently conducted a review of energy research, including renewables, which covered the interests of several departments and research programmes from the basic to the applied end of the spectrum. The Chief Scientific Adviser is putting together a co-ordinating group, involving government departments and Research Councils and other funders, to ensure that the recommendations are taken into account by those funding programmes.
274. DEFRA and BBSRC with inputs from the Food Standards Agency (FSA), DoH and OST are preparing to respond to the Royal Society Inquiry on infectious diseases, following last year's foot and mouth epidemic. A group involving the relevant departments, agencies and Research Councils is being set up to consider in a strategic way the Inquiry's emerging conclusions on the need for a more co-ordinated animal health research programme.

External scrutiny

275. The Government's Chief Scientific Adviser is responsible for advising the Prime Minister and the Cabinet on the overall health of science and scientific research. He needs to be in a position to provide assurance on the quality and rigour of the systems which departments have in place for using science and managing research. Departments have their own individual arrangements for quality assurance and audit of their research programmes. These have been reviewed to see if additional measures are needed for the Chief Scientific Adviser to fulfil his wider role.

Present arrangements

276. Departments generally have formalised procedures for identifying their research needs and for building a research strategy and programme. The top-down research strategy may be determined by the department's overall policy priorities, but it may also be informed by 'bottom up' ideas for research work. These may come from various sources. Contractors are involved to varying degrees in generating ideas, either by contributing formally to the design of the overall strategy or programme or by proposing projects on their own initiative. Some departments have formal consultation processes to facilitate the reception of ideas and to help determine the overall shape of the strategy.

277. Most departments have an intermediary or interface, usually a research division or designated research manager, between policy customers and contractors, responsible for commissioning and managing the research programmes. Projects are usually let by competitive tender. Research funded by departments normally has to pass two hurdles. First, it has to be tested for scientific relevance against the department's overall research strategy or 'fitness for purpose'. Second, it has to pass a threshold of scientific quality involving peer review. The decisions on which projects to fund are usually made by a committee, and the committees frequently include external experts.
278. Longer contracts generally have milestones and break points which give opportunities for reviews of progress. These can be of an 'administrative' character only, concentrating on whether the work is within budget and will be delivered on time. Alternatively, they may extend to an assessment of the quality of the science. In such cases, departments can bring along external experts to help them reach a view. Departments generally encourage their contractors to publish whenever possible, which involves a peer review stage. Irrespective of publication, departments for the most part have their own peer review procedures for evaluating completed research.
279. Additionally, many departments have some form of regular technical assessment of contractors who carry out significant volumes of work for them. These are often part of a rolling programme that might aim to visit every relevant part of the contractor's activities every, say, 3-5 years. The composition of the assessment team depends on the balance between a process audit and a review of scientific quality. Insofar as the visits are intended to assess scientific quality, outside experts generally have to be engaged.
280. The cyclical process described above for identifying research requirements, determining the research programme and commissioning the work generally lasts some 12-18 months. In some cases, this is too long for the results to be able to inform the policy issue which the research was originally intended to investigate. Where answers are needed urgently, most departments also have a 'fast track' procedure to commission the relevant research, which avoids some of the stages of the formalised procedure. The fast track process generally involves less consultation, and often only a single contractor is approached. Research initiated in this way often has a more direct and immediate effect on policy.

The way forward

281. In the university sector, the introduction of the Research Assessment Exercise (RAE), an external system of scrutiny whereby universities were benchmarked against world performance, as a basis for deciding funding, has succeeded in creating a leaner and better focused research culture in the universities. An analogous process of central review, drawing on the relevant RAE principles of benchmarking and regular external scrutiny, would help introduce an external dynamic for improvement, and so strengthen public confidence in the Government's handling of science. Departments generally have comprehensive

procedures for procuring and reviewing research, and for assuring quality and value for money. Although the underlying objectives of such systems are broadly the same, there are differences in the ways departments go about the task, and opportunities for departments to learn from one another are being lost. There is merit in having a more central review of the extent to which the different systems are delivering the broad underlying objectives, and for disseminating best practice.

282. The Chief Scientific Adviser has proposed a rolling programme of review of government funded science. His officials are working with departments to flesh out the details. The review programme will need to be able to cover:

- how departments identify their research requirements;
- how they commission the research;
- how they assure the quality of the work done by contractors;
- how they use the results of research; and
- how they harness and synthesise existing research.

283. One output from the review programme will be a developing corpus of information about best practice across Whitehall. The reviews will need to be able to look not only ‘vertically’, i.e. at the way in which departments are using research in specific areas, but also ‘horizontally’, at specific aspects of departmental research management functions, and how they match up to best standards both in Whitehall, in the private sector, and internationally. International benchmarking will require gathering information about practice in other individual countries. The FCO, through its science attaché network, may have a role to play in this exercise. In some areas departmentally-funded research is already part of an international body of work. For example, the concerted action of editors of major academic journals, major research review groups such as the Cochrane and Campbell Collaborations, the NHS Centre for Reviews and Dissemination and the American Council of Physicians have established international standards of sound research evidence in health and social sciences. The involvement of senior scientists from other departments in the review teams would ensure exchange of good practice, and a shared drive for improvement.

284. The review programme will need to work with the grain of departments’ own arrangements, including external scrutiny and peer review. It will also need to take account of other relevant work, such as the National Audit Office (NAO)’s value for money programme. Discussions have already taken place with the NAO to determine the role they might play in helping to define best practice and the most fruitful areas which a review programme might focus on.

Recommendation C17: The Government’s Chief Scientific Adviser should be responsible for a rolling programme of review in order that he can deliver on his responsibility for the quality of departments’ research. The programme and content of the reviews should incorporate regular external scrutiny, independent external assessment and benchmarking, and should focus on the management of research and use of science, including scientific advice. It should incorporate international benchmarking of good procurement and research commissioning practice.

Recommendation C18: The review process should be assessed in 4-5 years time, to see whether measurable improvements have been introduced. If not, other mechanisms for improvement should be considered, including the question of a central science budget.

Costs

285. The Government's Chief Scientific Adviser is proposing a new small central team to take forward the rolling programme of review of Government funded science, with departments contributing to the costs of the audit programme. The team will need to work closely with the Cabinet Office and Treasury who have cross-cutting responsibilities for social science research. There will also be additional running costs for departments associated with improvements in research management and career management for scientists. There will, however, be major benefits to Government in terms of reduced risk and more focused research, leading to higher quality advice and better decision-making.

Recommendation C19: Resources should be made available to support the Chief Scientific Adviser's new central team to implement the recommendations of the review relating to science standards in government departments

Glossary

HEFCE	Higher Education Funding Council for England
HEI	Higher Education Institution
HEIF	Higher Education Innovation Fund
HESA	Higher Education Statistics Agency
ITS	International Technology Service
JIF	Joint Infrastructure Fund
OST	Office of Science and Technology
PIU	Performance and Innovation Unit
PSRE	Public Sector Research Establishment
QR	Quality Related research (Funding Council stream)
RAE	Research Assessment Exercise
RCUK	Research Councils UK
RDA	Regional Development Agency
SEB	Science and Engineering Base
SR	Spending Review
SR2000	Spending Review 2000
SR2002	Spending Review 2002
SRIF	Science Research Investment Fund
TRAC	Transparent Approach to Costing
UoA	Unit of Assessment