Priorities for the science base : report / Select Committee on Science and Technology.

HOUSE OF LORDS

SESSION 1993—94
2nd REPORT

SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY

PRIORITIES FOR THE SCIENCE BASE

REPORT

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(Q) refers to a Question in oral evidence. QQ 1-796 are in HL Paper 82-I, Session 1992-93; subsequent QQ are in HL Paper 12-II of this Session. References relating to the meeting with Mr Waldegrave and Professor Stewart on 13 July 1993 are to HL Paper 106, Session 1992-93
(p) refers to a page in HL Paper 82-I, Session 1992-93
(P) refers to a page in HL Paper 12-II of this Session

SECOND REPORT

15 December 1993

By the Select Committee appointed to consider Science and Technology.

ORDERED TO REPORT

PRIORITIES FOR THE SCIENCE BASE

SUMMARY

This report examines the ways in which, within given resources, choices are made about scientific research conducted in universities and Research Council institutes. The Committee have considered particularly the changes introduced by the Government's recent White Paper on science, "Realising our potential". (The report does not examine in detail either medical research or the EEC Framework Programme.)

Chapter 2 concerns the objectives of such research. The White Paper proclaims a new partnership, with the Science Base working with industry and Government to improve national prosperity and the quality of life. We welcome this in principle; but we find that the Science Base is already substantially aligned towards these objectives, and that the onus rests on the other "partners" to play their part. In the case of industry, more encouragement is required from the Department of Trade and Industry, the Treasury and the City than is at present forthcoming. We report evidence that what industry wants from the Science Base is a pool of fundamental expertise based on long-term research, and a source of trained researchers; nor is industry blind to other, less tangible benefits of a strong Science Base. We make recommendations concerning monitoring the progress of the partnership with industry, the role of the Government Chief Scientific Adviser in developing the partnership across Government, and Government plans for postgraduate research training.

Chapter 3 concerns the processes whereby priorities are arrived at by the Research Councils. We consider the consequences of the appointment of a Director-General of Research Councils, the reorganisation of the Councils themselves, and the creation of a Technology Foresight Programme. We welcome the appointment of the DGRC, but make recommendations intended to ensure that he will have the authority necessary to fulfil his important role. We also make recommendations on the future development of research in particle physics. We welcome Technology Foresight, provided that it is operated with an eye to the process and the long term, rather than implementation of short-term outcomes.

Chapter 4 deals with the institutions and individuals who make up the Science Base. We consider current developments in the higher education sector and the system of "dual support" for academic research, involving the Research Councils and the Higher Education Funding Councils. We accept the case for selectivity in funding university research by block grant in the context of limited resources. However we make recommendations intended to preserve flexibility and local discretion, and to prevent the policies of the Research Councils and the HEFCs from producing a vicious circle of concentration. We recommend that the capacity of the Research Councils to conduct long-term research in their own institutes be preserved. We consider the possibility that the field for receipt of Research Council support might be extended, and recommend against it.

In Chapter 5, we bring our recommendations together to address the Government's concept — proclaimed in the sub-title of the White Paper — of a "strategy" for the Science Base. If the Science Base is to serve the purposes intended by the Government and set out in the White Paper, then:

— the strategy must leave room for new people and new ideas;

— it must be focused on long-term user needs, by means of the recommendations in Chapter 3;

— industry and Government must be made to play their parts in the new partnership, by the means set out in Chapter 2;

— inflexible concentration of university research must be prevented, management of the human resources of academic science must be improved, and the Research Councils' capacity for long-term basic research must be preserved, as recommended in Chapter 4.

ACKNOWLEDGEMENTS

This report was prepared by Sub-Committee I, whose members are listed in Appendix 1.

The Committee are grateful to all those who gave evidence (see Appendix 2), during what has been a busy year for science policy-makers and commentators. We are particularly grateful to the Royal Society for allowing us the services of Dr Peter Collins as Specialist Adviser to the inquiry; to the Royal Society of Edinburgh for their hospitality when Sub-Committee I visited Scotland in November; and to both Royal Societies for putting us in touch with some talented researchers currently at work in the Science Base.

CHAPTER 1 INTRODUCTION

Definitions

1.1 By "the Science Base", we mean *scientific research conducted at United Kingdom universities and Research Council institutes*. We use the word "science" to include technology, engineering and related aspects of the social sciences.

1.2 By "priorities", we mean the choices which fall to be made as to what the Science Base does and where it does it. *We have not set out to make these choices*, but to examine the mechanisms by which they come to be made and the influences on those who make them. We have done so in the light of the Government's White Paper "Realising our potential: a strategy for science, engineering and technology" (Cm 2250) published on 26 May 1993.

1.3 *Medical research* is an important part of the Science Base, but distinct in certain crucial respects. Most significantly, clinical research (i.e. research involving patients) relies on NHS hospitals, and particularly the teaching hospitals. A further special factor is the substantial support for medical research from charities: some large and many small, some disease-specific and some not, all independent of each other and of Government. This Committee reported on priorities for medical research in 1988 (3rd Report 1987-88, HL Paper 54). The major changes currently taking place in the NHS raise special issues for medical research to which this somewhat panoramic report cannot do justice. These are under examination by a Task Force recently set up by the Department of Health, which is intended to report in April 1994; we intend to keep them under review in the light of that report.

1.4 Nor does this report consider in detail the *European Community Framework Programme*, though this is of importance as a source of funds and an influence on priorities. Instead, we refer the reader to our 1st Report of this Session (HL Paper 5), on the 4th Framework which was scheduled to be agreed in December 1993.

1.5 It has been put to us (eg ABPI p157) that the national science base also includes work done in Government research establishments and industrial laboratories. In a sense this is true. But these categories of research are not of direct interest to this inquiry, because their priorities are not in dispute: Government departments commission research from their own establishments to inform policy-making and regulation; industrial laboratories serve the needs of the industry, for new products, increased efficiency, greater safety etc.

1.6 It has also been put to us that it is misleading to see the Science Base in purely national terms; this too is true up to a point. In Sir Mark Richmond's words (Q171), "The international fraternity of science is sometimes a great deal more strong than the national one." British universities employ and train scientists from overseas, and supply learning and personnel to foreign companies (whether by means of inward investment or the "brain drain"); companies owned or based in the United Kingdom may acquire research results and research staff from abroad (Q716); and all of these things are facilitated by the international use of the English language (Q1114).

1.7 The Science Base is largely supported by the taxpayer. Following a period of expansion (by between 3% and 19% in real terms between 1977-78 and 1990-91, depending on the deflator applied), public funding of the Science Base (i.e. the core budgets of the Research Councils and the Higher Education Funding Councils) is expected to be roughly static in "real" (GDP deflator) terms between 1990-91 and 1995-96. Total Government expenditure on civil R&D is expected to fall during this 5-year period by about 10% in real terms; as a proportion of either total Government spending or gross domestic product, it is low compared with competitor countries, and the position is getting worse.

1.8 Several of our witnesses deplore this situation, and so do we: see our contribution to the consultation which preceded the White Paper (*Proposed Science & Technology White Paper*, HL Paper 34 Session 1992-93, paragraphs 8-13 and 19-22). But *it is not the purpose of this report to*

make a case for new money. Rather, taking given public resources as a starting-point, we have examined the processes whereby choices are made about the use of those resources.

Excellence and utility

> *"The decision for Government, when it funds science, as it must, is to judge where to place the balance between the freedom of researchers to follow their own instincts and curiosity, and the guidance of large sums of public money towards achieving wider benefits, above all the generation of national prosperity and the improvement of the quality of life. Finding this balance is not a simple task..." (Realising our potential, paragraphs 1.7-8)*

1.9 To purists, our title "Priorities for the Science Base" is a contradiction. The whole point of the Science Base, they will say, is that its sole priority is excellence; it simply assembles the best scientists, gives them what money there is, and lets them do the best they can. Examples will be produced of basic research with far-reaching applications which could not have been foreseen when the work began (e.g. number theory and stimulated emission of radiation), and of discoveries of great practical value made serendipitously, in the course of excellent research directed towards some other application or no particular application at all (the best current example being DNA fingerprinting — see a most interesting letter from Professor Alec Jeffreys of Leicester University, p222; a good example from an earlier scientific generation is polythene). Among our witnesses, this view is most nearly represented by the pressure group Save British Science (p26).

1.10 Pragmatists will take an opposite view. To the extent that the Science Base is funded by the taxpayer, they will argue, it should serve the taxpayer. Priority should go to research which will create or preserve wealth or improve the quality of life. "Blue skies" research is a luxury which the nation cannot at present afford.

1.11 The truth lies between these two positions. The purists will admit, if pressed, that choices have to be made, and that it is possible to identify those areas of even the purest research which are *more likely* to yield some practical dividend, and therefore perhaps more deserving of public funding when money is short. The pragmatists will concede that no-one has an interest in funding second-rate research, however desirable the end in view; they may admit that what is basic science today may give rise to applications tomorrow; and they may be willing to acknowledge that "pointless" science, such as cosmology, astronomy (which used to underpin marine navigation, but does so no longer) and archaeology, may have important technological spin-offs (e.g. satellites), may have a strong hold on the public imagination and may be the first or even the only science to interest young people.

1.12 The process whereby the tensions between excellence and utility, and between the short and the long term, are resolved to produce a set of priorities and funding decisions for the Science Base is a complex one, involving many players and many complex interactions. Most members of this Committee have played a part in it at some time in our lives. The process was already in flux when we began this inquiry a year ago, and the Government's Science White Paper announced a further set of changes. Our inquiry is therefore timely.

1.13 The importance of the topic should go without saying. Whatever other national institutions may be in decline, the best British science is still indisputably of world class. This is to some extent a legacy of the past; but, as life becomes ever more dependent on knowledge and technology, it becomes ever more important as an investment in our future.

1.14 Priority-setting for the Science Base involves a large number of organisations, each with its acronym; and the position is currently further complicated by the White Paper initiatives, under which some familiar institutions are being wound up and new ones brought into being. A list of acronyms and significant dates will be found in Appendix 3.

CHAPTER 2 OBJECTIVES: WHAT IS THE SCIENCE BASE FOR?

A NEW PARTNERSHIP: THE SCIENCE WHITE PAPER

2.1 The Science White Paper "Realising our potential" (Cm 2250) sets out to clarify what the Government wants from the Science Base, and announces a series of initiatives intended to deliver it. The aim is to contribute to "the crucial effort to improve our national competitiveness and quality of life"; the means are "a closer partnership and better diffusion of ideas between the science and engineering communities, industry, the financial sector and Government" (paragraph 1.21). The White Paper expresses these ideas in a variety of ways: for example, "national competitiveness" is also expressed as "the generation of national prosperity" (paragraph 1.7) and "national wealth creation" (paragraph 1.14).

2.2 The principal means by which the new "partnership" is to be achieved may be summarised as follows. "WP" refers to the White Paper.

(i) The Office of Science and Technology, the industry departments, the education departments and every other government department receive a "Science and Technology Mission Statement" (WP pages 9-10; see below, paragraph 2.35).

(ii) A "Technology Foresight Programme" has been established (WP paragraphs 2.23-33; see below, paragraph 3.28).

(iii) Government science spending is to be the subject of an annual "Forward Look" (WP paragraphs 2.34-38; see below, paragraph 2.45).

(iv) The Advisory Council on Science and Technology (ACOST) has been replaced with a new "Council for Science and Technology" (CST) (WP paragraphs 2.39-40; see below, paragraph 2.54).

(v) The Research Councils are to be reorganised. The five Councils which have existed since 1965 are to become six: the Science and Engineering Research Council (SERC) is to be dissolved, and its responsibilities divided among a new Engineering and Physical Sciences Research Council (EPSRC), a new Particle Physics and Astronomy Research Council (PPARC) and the new Biotechnology and Biological Sciences Research Council (BBSRC) which will be formed from the existing Agricultural and Food Research Council (AFRC) (WP paragraphs 3.19-22).

(vi) Each Research Council will receive "a mission statement which recognises the importance of research undertaken to meet the needs of users and to support wealth creation" (WP pages 29-31; see below, paragraph 3.24).

(vii) A Director-General of Research Councils (DGRC) has been appointed (WP paragraphs 3.26-29; see below, paragraph 3.15). His duties will include the functions of the Advisory Board for the Research Councils (ABRC), which is wound up.

(viii) Those Councils which do not already have one are to receive a part-time lay chairman (WP paragraph 3.31; see below, paragraph 2.76), "selected with a view to securing representation for the users of research and in order to bring in relevant experience from the industrial and commercial sectors most closely related to the Councils' missions".

(ix) Each Council is to draw up Concordats with cognate Government departments (WP paragraph 3.40; see below, paragraph 2.43).

(x) A Science and Engineering Base Co-ordinating Committee has been established, bringing together the Research Councils and the DGRC with the education departments and the Higher Education Funding Councils, with the Chief Scientific Adviser in the chair (WP paragraph 3.48).

2.3 The White Paper also announces initiatives in respect of postgraduate training (see below, paragraph 2.61) and academic careers (see below, paragraph 4.59), and public awareness of science.

THE SCIENCE BASE AS A RESOURCE FOR INDUSTRY

The White Paper

2.4 On 13 July 1993 we met the Minister responsible for the Science White Paper, Mr William Waldegrave, Chancellor of the Duchy of Lancaster and Minister for Science (see our 8th Report of the last Session, *Science and Technology White Paper*, HL Paper 106, QQ 19-26). He agreed with us that basic science cannot be justified by pretending that it can all be applied; but, he insisted, when times are hard the taxpayer cannot be expected to fund basic science "unless the wealth creators in society see the value of it".

2.5 The White Paper initiatives therefore have a dual purpose: to open the eyes of the wealth creators to the value of basic science as such; and to steer basic scientists towards work which is "interesting" or "appropriable" (Q21) to the wealth creators, though still basic (Mr Waldegrave said, "I do not at all think that the fulfilment of the Research Council missions means that every piece of research has to show a use") and of top quality ("There is no point at all in funding second-rate basic science...whether it is of interest to industry or not"). The new places for industry in the priority-setting processes are intended to achieve both these things.

2.6 Mr Waldegrave's Office of Science and Technology (OST) controls half of public core funding for the Science Base, and to that extent has power to direct the efforts of the Science Base towards the needs of the wealth creators, or in any other way it chooses. It is less certain that the wealth creators can be induced to align their own efforts with what the Science Base can offer. Mr Waldegrave told us that, during the year of consultation which led up to the White Paper, he found no need to convince "the best of the industrialists" of the importance of basic science (Q19). These are the people exemplified by the members of the new Council for Science and Technology: "those businesses who are likely to be with us still in ten years' time, that is those businesses who are spending enough on R&D" (Q46).

2.7 Mr Waldegrave intends the new part-time chairmen of the Research Councils to be partly "explainers...of what is going on in the Science Base to the wider industrial world" (Q22). He concluded:

> "There is only so much that Government can do to bring the horse of British industry to water. If the horse refuses to drink, the horse will die. It is essential to get across the message that industry must take its own responsibilities. We are trying to build a proper networking with them...but ultimately the industrial side must, I hope, respond." (Q50)

2.8 If the OST is science's champion in Whitehall, then the voice for industry is the Department of Trade and Industry (DTI); and those who see the White Paper as an industrial conspiracy mostly cast the DTI as the chief plotter. We discussed the White Paper in June 1993 with Dr Geoffrey Robinson, Chief Adviser on Science and Technology to the DTI (formerly R&D Director for IBM UK); his account of this aspect of the White Paper tallies with Mr Waldegrave's.

2.9 Dr Robinson (Q558) considers that the purpose of the White Paper initiatives is to improve academic-industry dialogue "at very early stages in people's thinking about research opportunities". He gives the same reasons for doing so as the Minister: "not necessarily to bias them in any way, and certainly not necessarily to turn them into short-term activities," but "so that research work, even when it is basic research, is more likely to be in areas where wealth creation potential might be foreseen," and "so that, when research is at the stage of being exploitable, it is likely that people will be ready to exploit it." He agrees with Mr Waldegrave that research can be both basic and mission- or market-oriented (cp ABPI Q734), and that "None of us has an interest in funding second-rate science". He acknowledged the training function of the Science Base (see below, paragraph 2.56) as a legitimate priority in itself; and he saw less difficulty than Mr Waldegrave

(Q23) in "making a convincing story" to justify public funding of particle physics and astronomy (QQ 563-5).

2.10 Where Mr Waldegrave's and Dr Robinson's accounts to us of the thinking behind the White Paper diverged was at the level of the ultimate objective. According to the Minister, the aim of the exercise was to justify public funding of basic research at a time of financial stringency (Q19 — cp Sir Eric Ash, Q10). Dr Robinson explained it more as an attempt to solve the intractable problem of under-exploitation of science by British industry (QQ 558, 574). Both these objectives are legitimate, both are expressed in the White Paper (eg paragraphs 1.19 and 21), and both are implied by its ambiguous title.

Before the White Paper

2.11 It should not be imagined that the Science Base was wholly cut off from industry until the publication of the White Paper. According to Mr Ian Harvey of the British Technology Group (BTG), which manages intellectual property in academic inventions, since 5-10 years ago "many more researchers are very much attuned to what the market-place wants in the short, medium and long term" (Q802, cp Q1074).

2.12 The ABRC, whose evidence launched our inquiry back in March 1993 and whose functions will be absorbed into the OST on 1 January 1994, included two industrial scientists among its non-executive members. As one of them, Dr Ashok Ganguly, Research Director of Unilever, told us (Q5), "What somebody like me can bring to the debate is the priorities in wealth creation." Commercial exploitability is one of the six criteria developed by the ABRC to guide the Research Councils as they make plans and grants.

2.13 The Councils and their grant-making Boards have always included representatives of firms with an interest in the relevant areas of research (QQ 8, 129, 444, p111); and they have generally treated it as "a very positive indicator" (Q12) if a grant application is backed by industrial support. Two of the Councils, the Medical Research Council (MRC) and the AFRC, are already used to having a part-time chairman from industry. The same two Councils have formal mechanisms for aligning their research programmes with those of interested parties: the MRC Technology Transfer Group (p111), and the Priorities Board for Research and Development in Agriculture and Food, which also involves the agriculture departments (p184).

2.14 In any case, the science community is not divided cleanly into academics and industrialists. Many scientists have one foot in the university and the other in the business world. Some of our witnesses pointed this out (Royal Academy of Engineering Q 724, CBI Q1024); several exemplify it. Several witnesses also reminded us that, as Dr Robinson of the DTI put it, "There is no such thing as industry out there; all there are is lots of individual companies" (Q574; cp CBI Q998).

2.15 Nor should it be imagined that the Councils' new, explicit mission statements, focused on industrial competitiveness and the quality of life, amount to an abrupt conversion of their priorities. On the contrary, our evidence and our experience suggest that *the White Paper makes explicit what was already substantially the case.*

2.16 In May 1993, when the White Paper was imminent and it was no secret that the wind was blowing towards wealth creation, the then Chairman of the Natural Environment Research Council (NERC) Professor John Knill told us, "NERC's sails are well set" (Q405). "The environmental sciences are entirely applicable" (Q371): they touch both wealth creation, through for example the finding of new natural resources, and wealth preservation, through avoidance of pollution and cost-effective regulation, as well as the quality of life.

2.17 On the same occasion, the Director General of the AFRC, Professor Tom Blundell, told us (Q427), "Our research underpins a broad area of industry involving not only food but also fibres, fuels, specialist chemicals and polymers." As well as underpinning these industries, he said, AFRC

research contributes to health and the environment, both of which contribute indirectly to wealth creation or preservation. The user communities already have input into AFRC planning through the Priorities Board (p182). The AFRC has recently taken initiatives to encourage technology transfer (Q444), and runs its own Collaboration With Industry Scheme, which complements its involvement in 10 of the 30 programmes of the LINK scheme (p181). "Market pull" has led to a widening of focus over the last 10 years to embrace food production as well as farming (Q431).

2.18 The remit of the Economic and Social Research Council (ESRC) stands to be equally unaffected by the White Paper initiatives. According to its Chairman, Professor Howard Newby (QQ 312-320), the social sciences stand, or ought to stand, "upstream" of applied science: looking at the management issues surrounding innovation, at the social factors which create markets, at techniques of evaluation and at "science's understanding of the public". The OST's work on Technology Foresight has in fact been informed by work done at the ESRC-funded Science Policy Research Unit at Sussex University by Mr Ben Martin, who is now advising the Steering Group. Professor Newby also described to us the efforts which the ESRC is already making to encourage the dissemination of research results to "users" outside the academic community (Q222).

2.19 The Council to be most radically altered is the SERC. On 1 April 1994 it will cease to exist: its biology and biotechnology activities will pass to the AFRC, renamed as the Biotechnology and Biological Sciences Research Council (BBSRC); most of the rest of its activities will be divided between the other two new Councils, the Engineering and Physical Sciences Research Council (EPSRC) and the Particle Physics and Astronomy Research Council (PPARC); and its Daresbury and Rutherford Appleton laboratories will eventually become a free-standing institution under the aegis of the OST.

2.20 The status of the SERC as "residuary legatee" (Q144), taking responsibility for any disciplines not embraced by the missions of the other Councils, will die with the SERC; all its successor Councils will be fully mission-oriented. The BBSRC and the EPSRC, like the other Councils, will be required to "enhance the United Kingdom's industrial competitiveness and quality of life"; the PPARC will be required only to "take account of the potential for contributing" to these things, while pursuing its main aim of improved understanding of physical phenomena.

2.21 Yet, according to Sir Mark Richmond, the SERC's outgoing Chairman, this amounts largely to a "clarification" of changes which were already taking place. The SERC had already been committed to underpinning wealth creation by a series of previous Government initiatives (e.g. Alvey, LINK) (QQ 89, 848-851). 43 of its committees included a representative of the DTI (p243). Over the last 10 years it had shifted the balance of its funding away from nuclear and particle physics towards engineering and technology (p238 — see Table 1), and it was already questioning its function as residuary legatee (Q145, p233).

Table 1: Net allocation of SERC funds among Boards

	1977-78	1984-85	1992-93
Astronomy, space, radio	20.8%	17.3%	16.3%
Nuclear physics	31.6%	21.8%	16.4%
Engineering & technology	15.7%	25.9%	26.2%
Science	23.2%	26.6%	31.8%

2.22 Finally, the MRC, writing to us after the publication of the White Paper, envisaged "some re-ordering" of its aims and objectives but no significant change (p110). It was already one of the MRC's objectives "To develop arrangements for the exploitation and application of research results". As Professor Michael Peckham, Director of Research for the NHS, reminded us (Q600),

medical research helps to preserve wealth as well as create it, e.g. by reducing lost working days. In the view of Sir Dai Rees, the Council's Secretary, "What the White Paper is doing is making all the Research Councils similar sorts of animals" to what the MRC and AFRC already are (Q631).

2.23 The White Paper itself acknowledges (paragraphs 3.10-11) that the Science Base has made "considerable progress" in its relations with industry in recent years. It refers particularly to collaborative and contract research undertaken in universities, and the growth in university income by these means (see Table 2); the proliferation of university science parks; the Research Councils' Interdisciplinary Research Centres, start-up companies and industrially-relevant research training schemes; and the LINK initiative.

Table 2: Income of UK universities from research grants and contracts

Cash terms, £m	1982-83	1987-88	1991-92
Research Councils	119.2 45.4%	187.9 34.9%	290.9 30.9%
Government Departments	51.5 19.6%	93.4 17.4%	131.6 14.0%
Industry	27.0 10.3%	78.6 14.6%	121.9 13.0%
Charities	Included in "Other"	110.0 20.4%	222.0 23.6%
Overseas including EC	Included in "Other"	43.4 8.1%	112.4 12.0%
Other	65.1 24.8%	25.1 4.7%	61.7 6.6%
TOTAL	262.8 100%	538.3 100%	940.5 100%

University spending on research out of core funds

Cash terms, £m	1982-83	1987-88	1991-92
TOTAL	535	760	920

The view from industry

2.24 The Technology Group of the Confederation of British Industry (CBI) (P214, Q1024) considers that the primary aim of the publicly-funded Science Base should be "generating wealth for the nation as a whole". However it gives this expression a broad meaning, to embrace not only the generation of exploitable results, but also training, the attraction of inward investment, and the unquantifiable social and cultural benefits of a healthy Science Base.

2.25 The Group's spokesman, Professor Brian Mellitt, London Underground's Director of Engineering, sees innovation as a state of mind (Q998), which the Group is trying to inculcate in "Government and the user community". He admitted that industry as a whole has not put enough into research in the past (Q1002). He and his colleagues representing the CBI all agreed that some

firms, both large and small, and some trade associations, are a great deal more aware of the Science Base than others (QQ 1002-4, 1008). They imply, as did Mr Waldegrave (see above, paragraph 2.6), that they are having more success in preaching to the converted than in reaching the unchurched.

2.26 Our CBI witnesses see giving the Research Councils part-time industrial chairmen as another way to convey the "message" (Q1018). But they did not insist that every Council should have one; they acknowledged that being the right person for the job mattered more than being an industrialist; and they reported "differing views" as to how much time off work a company should be expected to allow to a senior executive appointed to such a post (Q1022).

2.27 Among those of our witnesses who represent an industrial point of view, we have heard differing views as to how far, and why, the priorities of the Science Base should be dictated by the needs of industry. On the whole, they give the White Paper a cautious welcome. Most, however, insist that they look to the Science Base to do the long-term, speculative, fundamental research which their own laboratories cannot provide, or which their shareholders will not pay for:

— Dr David Giachardi of Courtaulds plc (Q743): "Most industrialists can identify that which is better done by industry and that which is better done in the academic sector because they are different".

— Celltech Research Ltd (p199): "We rely upon a well-funded and varied academic research base to complement our own efforts. We particularly look for skills and approaches that we do not already possess".

— Dr Michael Edwards, Principal Engineer, Unilever Research (Q712): "My aim is to see something different in the universities. Particularly in the work the Research Councils sponsor, I would like to think this is not a pale imitation of what we in industry do, but is something different and novel. The technological universities...should still be doing background, pure, basic science and engineering research that will give one new insight, new opportunities that I would not think of, and that is the sort of research that I think the Research Councils should pay for".

— British Aerospace (p196): "Much of the Science Base makes an important contribution to the long-term technology investment which is needed by industry...In the current UK climate and culture, it is very difficult for industry to justify the use of shareholders' funds for such speculative, long-term investment".

— The Association of the British Pharmaceutical Industry (ABPI) (p157): "It is not the function of universities and Research Council Institutes to undertake research which has as its sole aim the production of marketable products and commercial inventions, but rather to provide the intellectual and knowledge infrastructure on which UK industries can build. Nor is the Science Base there to serve merely as a contract house for UK industry, and should not be carrying out routine screening or providing services which are most appropriate for industry itself. The main function of the academic Science Base is to engage in *fundamental* research within defined national priorities".

— Sharp Laboratories of Europe Ltd (p240): "As an industrial company we do not expect a simple and exact correlation between our needs and university research. However, we look for an area of expertise which has developed to an advanced level to see if we can identify a new direction or application for the research which does match our needs. The university research base must not be fettered by over-dependence on contracts with industry".

2.28 Several of these witnesses mentioned the relatively long time-scale of much basic research. The Royal Society of Chemistry observe that this is often longer than the time-scales used by City investors and analysts, and even by Governments (P248; see also Dr John Lackie, Q1045).

The wrong target?

2.29 Sir David Phillips, Chairman of the ABRC, acknowledged the apparent causal link between a successful industrial sector and close interactions with the Science Base (Q15). His examples were the familiar ones, chemicals and pharmaceuticals, in both of which United Kingdom companies are world leaders. But he suggested that, in trying to apply the same remedy to other less thriving sectors, the Government have chosen the wrong *point d'appui*: "If one wanted to reform the state of UK industry, it is at least arguable that one would not start by worrying about the Science Base". Dr Michael Edwards, speaking for the Royal Academy of Engineering from his experience in the chemistry-based business of Unilever, saw the main responsibility for innovation resting on industrial research and the financial sector; "the role the Research Councils have to play in this is a rather small one" (Q700). Dr John Lackie, of the Yamanouchi Research Institute, suggested that the Government have focused on the Science Base, rather than industry, simply because it is "the bit that can be manipulated easily" (Q1036).

2.30 A range of other witnesses, all well qualified to pronounce on the process of innovation, share the view that it is industry which needs to be made more aware of science, rather than *vice versa*: Sir Geoffrey Allen (Head of Research at Unilever 1981-90, chairman of the SERC 1977-81) Q526, the Royal Society Q674, ABPI p165, BTG Q802, Professor Howard Newby (Chairman of the ESRC) Q885, the Wellcome Trust p200. This was also the conclusion of this Committee's report, *Innovation in Manufacturing Industry*, of January 1991 (1st Report 1990-91, HL Paper 18, paragraphs 4.15, 9.36). Sir Mark Richmond put it thus:

> "The piece that is missing, I think, is...the White Paper sponsored by the DTI on how the Science Base is pulled through into industry" (Q858).

2.31 The DTI responded positively to our report of 1991; and the Secretary of State of the day, Mr Peter Lilley, set up the Innovation Unit, which is currently being expanded (Q569). However the proper role of the DTI in respect of research and innovation has been the subject of constant oscillation, as Dr Geoffrey Robinson admitted (Q558). The current President of the Board of Trade, Mr Michael Heseltine, has gone further than any of his recent predecessors in committing his department to an active industrial policy, and has initiated a review of its role in this area.

2.32 The DTI issued a statement to coincide with the publication of the White Paper (House of Commons Hansard 26 May 1993, col. 583). This announced various changes of balance within the DTI Innovation Budget of £125m:

— concentration on "helping smaller firms gain access to technology";

— less support for collaborations between firms;

— support for products under research restricted from 1 April 1994 to firms with 250 employees or fewer.

The intention is to place less emphasis on funding R&D and more on assisting technology transfer.

2.33 As part of this change of balance, the DTI intend to wind up the Advanced Technology Programmes (ATPs), which support mainly collaborations between firms. Dr Robinson (QQ 574-5) presented this action as a response by the DTI to the very concern noted above: "the significant weakness that we see at the moment is the exploitation and dissemination of what research has already been done". In any case, the ATPs were worth only £20-25m per year, and were not making "a fundamental difference".

2.34 However most commentators see this action as a sign that the DTI is not in fact committed to Mr Waldegrave's new partnership (eg MTD Q1031). Sir Mark Richmond sees it as an attempt by the DTI to unload their responsibility to encourage industrial research onto the OST, the Science Budget and the Research Councils (P247); others see it as a case of bad timing and

presentation. Dr Robinson himself admitted that technology transfer activity may appear "rather wimpish compared with doing yet more research" (Q569).

THE SCIENCE BASE AS A RESOURCE FOR GOVERNMENT

Strategy

2.35 As well as proclaiming a new partnership with industry, the Science White Paper offers "a clearer sense of strategy" (paragraph 1.16) for the whole of Government spending on science — about £5,700m in 1993-94, of which less than 20% goes through the OST to the Research Councils ("the Science Budget"). This is to be achieved by means of:

— a Science & Technology Mission Statement for each Government department, giving every department a duty to have regard to "the general objective...to increase national prosperity and improve the quality of life" in planning its science spending;

— clarified relations between departments and the Research Councils;

— an annual Forward Look across the whole of Government science spending, covering strategic objectives 5-10 years ahead (not to be confused with the Research Councils' bids for the Science Budget, which have also been known as Forward Looks);

— the new Council for Science and Technology (replacing ACOST, the Advisory Council on Science and Technology), informed by the findings of the Foresight programme.

The Research Councils and departments

2.36 Any Government department in need of research to underpin its activities of policy-making or regulation may look to the appropriate Research Council to provide it. Each Council may receive commissions from a wide range of departments; but in the case of some of the Research Councils there is one Government department which has traditionally been the main source of government-commissioned work.

2.37 In 1972, in response to the Rothschild report on the Organisation and Management of Government Research and Development (Cmnd 4814), the Government placed the MRC, the NERC and the AFRC in a clearer contractor relationship with their "customer" departments. As part of this process, they made a one-off transfer of resources from the Research Councils to the departments. It was intended that the departments would act as "intelligent customers": they would return most of the money to the Councils to fund work in which they were interested, at a level of charge sufficient to support not only the projects in hand but also the fundamental research needed to underpin them.

2.38 The Rothschild reform was only a partial success. Notoriously, the fundamental research overhead, set by Rothschild at 10%, has hardly ever been paid; according to the Royal Society of Chemistry, departments have often failed to offer even conventional overheads (P251). More generally, the Research Councils have not on the whole found it easy to make "intelligent customer" relationships with the departments. Sir Mark Richmond, speaking from the point of view of the SERC, told us some of the problems (QQ 116-9): departments have generally revealed little of their science programmes; and the Public Expenditure Survey (PES) process has been until recently "covered by extremely low cloud".

2.39 The NERC was the Council most affected by the Rothschild transfer. Professor John Knill, their former Chairman, told us (QQ396-406, p225) that his Council tries to stay "ahead of the game", informing Government priorities rather than being forced to react to them: his example was the conversion of the Government to the potential importance of global climate change in 1988. He commends the NERC's biggest customer in Government, the Overseas Development Administration, for operating a "long time horizon". But he criticises other departments, and clients outside Government, for failing to provide for their own long-term strategic needs and leaving the NERC too dependent on small, short-term contracts. "We should far rather see from Government

departments a wider portfolio of activity where we have greater guarantee of funding over a longer period, and this would certainly introduce much more stability within our institutes".

2.40 The AFRC reports similar difficulties (QQ 443-451). Professor Blundell believes that departments could learn a lot about customer-contractor relationships from industry. "It is no good saying that this year we want this expertise and expect to close down another area and to pick it up in five years' time; it is not there"; meanwhile, retraining or releasing a scientist, if an expected contract is not awarded, usually costs the Science Budget a year's salary. What is more, the relationship between the AFRC and the Ministry of Agriculture, Fisheries and Food (MAFF) is changing as the MAFF seeks to "broaden its contractor base" (p181). The MAFF themselves acknowledge (p184) that they have "an obvious interest in the maintenance of a skills base and facilities which are attuned to their needs...This is therefore a factor which purchasing departments such as MAFF need to take into account in their commissioning decisions even in the context of a policy of competition in an open market".

2.41 The history is different in respect of the MRC. In 1981, the money allocated to the DHSS (Department of Health and Social Security, now the Department of Health) under the Rothschild transfer was returned to the MRC, for use in accordance with an agreement or "Concordat" between the MRC and the health departments. The Concordat was renewed in 1991.

2.42 The Concordat defines the roles, in respect of medical research, of the Council and the departments. In brief, basic research is the business of the MRC; operational research and health-related surveillance are the business of the departments; and responsibilities overlap in respect of applied research. Each party is given a voice in the other's planning processes: the departments are represented on the Council, its Strategy Committee and its Boards, and have the right to comment on research proposals and field reviews; in return, the MRC is entitled to representation on relevant departmental committees and on the Research Committees of health authorities/boards. The working of the Concordat is monitored at regular "stocktaking" meetings (QQ 583, 621).

2.43 The White Paper commends the MRC Concordat. It says (paragraph 3.40):

> "The Government wants to build on this sensible good practice so that Departments and Councils are fully informed of each other's current programmes and future plans, and in order to make transparent the relationship between universities, Research Council institutes and establishments and Government research establishments. It proposes that each of the new Research Councils should work with the Government Departments with which they have a significant policy connection to draw up and publish Concordats."

2.44 The NERC, in particular, welcome this proposal (p225). One thing they hope to see in any new Concordats is equivalent representation for the Research Councils on departmental research advisory bodies to that which the departments already enjoy within the Councils.

Forward Look

2.45 Concordats will clarify bilateral relations between departments and the Research Councils; but the Government also intends to engender multilateral science planning across Whitehall, by means of the Forward Look. According to the White Paper (paragraphs 2.34-38), the Forward Look will be a development of the Annual Review of Government-Funded R&D, which the Cabinet Office has published every year since 1983 (see their response to this Committee's report on Science and Government: Cmnd 8591, July 1982, paragraph 20). Whereas the Annual Review gives spending plans for the following two years, the Forward Look will look forward 5-10 years. It will also build on the work of ACOST in reviewing departmental strategies as part of its "Priorities Advice".

2.46 According to a note circulated by the OST in November 1993, the Forward Look is to consist of:

— an overview by the OST, "outlining changes in the perspective and balance in publicly-funded research and education and training in response to the needs of the country";

— submissions from Government departments and the Research Councils;

— performance indicators showing "the health of the UK's science and technology" and "the degree of success achieved in implementation of the White Paper";

— the statistics which currently appear in the Annual Review.

2.47 The preparation of the Forward Look will involve several stages. As Mr Waldegrave put it (Q36), "Each department will have to produce its chapter and be subject to cross-examination by us [OST] as to whether it makes sense and how it fits in with the others". A consolidated draft will then be prepared by the Chief Scientific Adviser (CSA) and the OST, and presented to the Cabinet Committee on Science & Technology (EDS). The final version, approved by the Ministers, will be published each April starting in 1994.

2.48 As to how much influence the CSA will have over what each department puts in its chapter, the White Paper is cautious: the Forward Look will set out "the portfolio of publicly-funded work best suited to the broader scientific and technological needs of the country" and "the extent to which current individual departmental science and technology programmes are matched to that portfolio, and the prospects of bringing about a closer alignment between the two". The CSA himself, Professor William Stewart, was even more cautious (Q36): he put it in terms of simply "publishing what departments intend to do in each of their sectors", in the interests of openness and scrutiny.

2.49 There is no caution in the approach of the DTI to Government science strategy. DTI has "particular interest in ensuring that future Government S&T policies are more effectively geared to increasing industrial wealth creation" (p244). Dr Geoffrey Robinson sees no "ambiguity" or "conflict of interests" between this and the support of departmental objectives (Q558).

2.50 Mr Waldegrave explained to us that the Chief Scientific Adviser will now be involved in two "cycles": the long-term strategic Forward Look cycle, and the annual PES cycle.

2.51 Other departments with significant spending on science have told us how they envisage participating in the Forward Look cycle (PP 258-9). The MAFF (£138m of science spending in 1993-94) already has its own scientific strategy, drawn up after consultation with other departments and outside interests. It regards the Forward Look as "a logical progression from and a natural complement to" what it is doing already. The Ministry of Defence (£2,461m) "welcomes the idea of the Forward Look"; the Scottish Office (£75m) offers no opinion at all, but is willing to participate.

2.52 Two departments go so far as to say that the Forward Look might make a difference to decision-making. The Department of Health (£57m) expects it to "form the basis for better informed decisions between competing priorities, which can in turn inform decisions taken during annual public expenditure surveys". The Department of the Environment (£95m) goes furthest of all, by allowing that the Forward Look might reveal a need "to adjust the Department's research plans".

2.53 The Government's plans for the Forward Look correspond closely with our suggestion, made in the course of the consultation which preceded the White Paper, that departments should produce annual R&D programmes for endorsement by the OST (HL Paper 34 Session 1992-93, paragraph 25). But the Government stops short of our recommendation that "The Treasury should not approve any PES bid for spending which had not been included in the forward programme, unless otherwise advised by the CSA". As it is, the Chief Scientific Adviser will be able to advise on the annual R&D bids of other departments, but he will have no right of veto. Dr John Mulvey

of Save British Science provocatively suggested to us that, in this situation, it is something of an exaggeration to refer to Mr Waldegrave as the Minister for Science (Q221).

Council for Science and Technology

2.54 The Council for Science and Technology (White Paper paragraphs 2.39-40) was appointed in October 1993. It replaced the Advisory Council on Science and Technology (ACOST), which itself succeeded the Advisory Council for Applied R&D (ACARD) in 1987 on a recommendation from this Committee (*Civil Research and Development*, HL Paper 20 Session 1986-87, paragraph 76). Its ten members are drawn from industry (6), the universities (3) and the medical charities. The CSA is deputy chairman; the Chairman is Mr Waldegrave, "on behalf of the Prime Minister". (ACOST had an independent chairman, and the Prime Minister occasionally attended its meetings.) The Council is intended to receive reports from the Foresight programme, and to advise the Ministers in EDS on "the balance and direction of Government-funded science and technology".

2.55 Mr Waldegrave explained to us some of the thinking behind the new Council (QQ 39-45). It is modelled on the President's Council of Advisors on Science and Technology in the USA (cp Sir David Phillips, Q52). It has an unfettered right to publish (Q41), which ACOST did not. It will be "the top level place where the science and engineering community can...ring an alarm bell"; the Minister is in the chair because from that position he cannot fail to hear it. "I do not regard it as being my committee; I regard myself as being there to meet the science and engineering grandees of the nation".

The Science Base as a source of trained researchers

Science and employment

2.56 The Science White Paper (paragraph 7.5) puts the number of workers in science and engineering at over one million and rising. The skills and knowledge of this large section of the workforce rest on the Science Base. The number of people employed in teaching, learning or conducting research in the Science Base is not easy to determine, but appears to be around 80,000: 35,000 university teaching and research staff, 39,000 research students and 6,000 researchers directly employed by Research Councils.

2.57 When we began our inquiry, we decided explicitly to exclude from our terms of reference "academic careers and the structure of the PhD". However witness after witness has told us that we were wrong to do so, and we accept the correction. Our witnesses from industry were unanimous in declaring that it was a primary function of the Science Base to produce world-class research scientists — "ideas on the hoof" — to fill industrial posts (ABPI p157; British Gas p197; Glaxo p204; Sharp p240; Thorn EMI p240; Yamanouchi p245). Some declared this a more important function than the generation of new knowledge and ideas (Dr A Ganguly, Unilever, Q17; Sir Geoffrey Allen, Kobe Steel, formerly Unilever, Q513; CIA p156; Dr P Doyle, Zeneca, Q747; Ian Harvey, BTG, Q804).

2.58 Some of these witnesses went out of their way to make it clear that what they want in a recruit from the Science Base is not so much a matter of competence in the specifics of a particular technology; that can be learned on the job. What they want is "scientists and engineers of world class training with a capacity to solve fundamental science and technology problems" (CBI, P213), or, as Sir Geoffrey Allen pithily put it, "international people" (Q513). "The value of training is much more in general skills of approaching problems and much less in the factual content of a particular field" (Dr John Lackie, Q1053).

2.59 Evidence from Government departments confirms the importance of the training function of the Science Base. The Department of the Environment endorsed it from the point of view of a purchaser of research services (p203). Dr Geoffrey Robinson of the DTI confessed to us his concern that "we do not concentrate enough" on this aspect of the Science Base (Q564).

Postgraduate students

2.60 Graduates studying for a postgraduate qualification (PhD etc.) receive individual grants, usually limited to three years. About one PhD student in two is supported by the Research Councils (Q32); the rest are self-supporting or supported by other sources including industry, charities (mostly medical), the universities themselves, and overseas sources. Sir David Phillips told us in March 1993 that postgraduate student funding is "a rather complicated picture which is very little understood on the ground" (Q42), and which was at that time receiving urgent attention from a joint committee of the ABRC, the HEFCs and the universities with a view to establishing "how the responsibility for seeing that they are properly funded would be best apportioned among the responsible agencies".

2.61 The White Paper announces three initiatives in respect of PhD students:

(i) Most PhDs funded by the Research Councils should be preceded by a one-year taught Master's (MSc) course. This is to be achieved "within planned resource levels", which, the Paper admits, will mean fewer PhDs.

(ii) Postgraduate training must become "more closely related to the needs of potential employers": research students are to "work in industrial and commercial settings", and be prepared for "the budgetary, time-limited, interdisciplinary and team-based manner in which research and development is conducted and constrained within firms".

(iii) The Research Councils must consider ways of paying their postgraduate students more, including the option of supporting even fewer of them.

2.62 An MSc course can serve various purposes. For some students it provides professional training, more specialised than the content of an undergraduate course, to fit them for a job. Others take a one-year course to prepare for research in a field not covered by their first degree. Others use an MSc as a conversion course, to enable them to work or do research in a different field altogether from what they have studied previously.

2.63 Sir David Smith, Principal of Edinburgh University, called proposals for MScs across the board "a little naive" (Q650), on the ground that only half of postgraduate students are supported by the Research Councils: overseas students, in particular, are unlikely to be turned away by universities just because they decline to enrol for an MSc. Professor J H Horlock, Treasurer of the Royal Society, acknowledged the value of a fourth year of teaching before starting research; but he pointed out that some undergraduate courses already include a fourth year (Q655). The President, Sir Michael Atiyah, called for flexibility, in view of the "large diversity of institutions, courses and people" (Q656). Dr David Giachardi of Courtaulds also called for flexibility, on the ground that different industrial situations call for different kinds of training (Q748).

2.64 The Royal Society of Chemistry are firmly opposed to the plan (P256). More MSc students, and no more money, will mean fewer PhD students; but PhD students are the lifeblood of research, particularly in sciences such as chemistry where much work can be delegated. It will also mean more teaching responsibilities for the academic staff, and therefore less time for research.

2.65 Paying postgraduate students a higher stipend would also have the effect of reducing their number, in the context of given resources. The Wellcome Trust, the largest of the medical research charities, has led the way in this respect (P199).

2.66 As for making the experience of working for a PhD more closely related to the needs of potential employers, Dr Geoffrey Robinson of the DTI told us, "The science that goes on in industry sometimes is like academic research, but more often it is not" (Q580). But, according to Dr Shohet of the CBI;

> "Most companies...would recognise that in any form it is unlikely a research student is going to have all the right skills which the company may want when it comes to doing research within that company...If...companies all expect perfectly trained scientists who can walk into their companies knowing precisely how to do that research, they are probably asking for too much" (Q1026).

He added (Q1028) that many companies value "the products of our great universities" for their general capacity to solve problems, as much as for any particular special knowledge.

Training base under threat?

2.67 Training for research can only take place in an institution where research is being conducted. This need not be a university department: many people study for a PhD in Research Council institutes or industrial laboratories. The evidence suggests that the number of university departments capable of offering research training is set to fall, with consequences for the capacity of the Science Base to fulfil its training function: see Chapter 4 below.

OTHER IMPORTANT OBJECTIVES

2.68 As our inquiry was beginning, Sir David Phillips, Chairman of the ABRC, urged us not to forget, "We are still a relatively rich country, and in my view ought to be prepared to contribute our part to the advancement of human knowledge for its own sake" (Q20).

2.69 We asked all our witnesses what public funding of science was for, and most of those who addressed this question included a cultural, altruistic or otherwise non-balance-sheet objective in their answer. For example:

> "The general enrichment of the quality of life and culture that science provides" (Royal Society, p131)

> "To maintain and strengthen the excellent contribution of UK scientists and engineers to the overall knowledge and cultural base of the world community" (ABPI, p157)

> "The education of informed people who can operate effectively in the modern context...a means to ensure national power or prestige" (AEA Technology, p179)

> "Contributing to national cultural heritage and world standing of the UK" (SERC, p236)

> "Enhancing future options for mankind...Improving our understanding of nature and natural phenomena and our place in the scheme of things" (Thorn EMI, p240)

> "An immense, largely unquantifiable contribution to Britain's literary, artistic and cultural fabric" (CBI, P213)

2.70 The ABPI observe that, although the benefits of making a national contribution to world knowledge are not reducible to pounds and pennies, they are nonetheless important in terms of national prosperity. They include national influence on international science programmes, and an ability to retain the best British scientists and to attract talent from abroad. We would add the ability to attract inward investment in science: two of our witnesses wrote from research institutes established in Oxford by Japanese firms (pp 239, 244). As for the cultural contribution of a healthy Science Base, AEA Technology are prepared to refer to this as a "social overhead" (p179).

CONCLUSIONS

Partner of industry

2.71 **We warmly welcome the White Paper "Realising our potential".** It acknowledges real problems, and proposes measures which if implemented in the right way could bring benefits to science and industry alike.

2.72 Partnership between industry and science is nothing new, but it has in the past been somewhat one-sided. The evidence suggests that the Science Base was already fully alive to exploitability as one of the criteria to be used in justifying its use of public funds, and already had a variety of ways of relating its priorities to those of associated industries, well before the new Science White Paper was drafted (see above, paragraph 2.11). Yet whereas many industrial scientists hold visiting Professorships or seats on Research Council boards, few professors are to be found on the boards of companies; and, with exceptions including several of our witnesses, investment in R&D by British firms is modest by the best international standards (see *Annual Review of Government-Funded R&D* 1993, table 2.6.1).

2.73 As Mr Waldegrave himself acknowledged, the OST may take steps to make industry more aware of the resources available within the Science Base, but it cannot force industry to take action. The DTI might offer inducements from its Innovation Budget, but the closure of the Advanced Technology Programmes suggests that it will not. Our Innovation report of 1991 also recommended a range of fiscal and company law measures to remove disincentives to innovation arising from the tax and accounting regimes (paragraphs 9.41-45); they are in the gift of the DTI and the Treasury, who show no signs of adopting them. And the financial sector is still wedded to the short term (Q1076), despite Government initiatives such as the new Enterprise Investment Scheme announced in November 1993.

2.74 In this situation, the institutions of the Science Base might feel forced to offer more inducements from their own resources, by placing top priority on work of obvious and immediate industrial relevance. In the short term this might be presented by the OST as success. But in the long term it would be bad for science, and bad for industry too. *Most of the firms who gave evidence to us know where their responsibilities lie* (see above, paragraph 2.27). They expect the Science Base to continue to do the things which industry needs but cannot provide for itself: fundamental research, training, and the maintenance of a national pool of expertise which firms may consult from time to time.

2.75 If the new partnership only operates in one direction, it will do more harm than good; it must be even-handed. **We recommend that the response of industry to the White Paper initiatives be monitored carefully by the OST.** Performance indicators must be established, which might include the level of civil industrial R&D spending, the number of science and engineering graduates taking employment in industry, the number of scientists and engineers on company boards, the number and scope of industry-university collaborations, the quality of industrial input to the Foresight Programme and the level of interest in the outcome, and the availability of venture capital to companies making medium- and long-term investments in R&D. These indicators may conveniently be published and analysed in the Forward Look. If in 5-10 years (the time-horizon of the Forward Look) the indicators show little improvement, the White Paper initiatives should be reviewed.

2.76 An important factor in inducing industry to respond will be the installation of part-time lay chairmen for all the Research Councils. Some witnesses see this as a case of "scientists on tap and not on top" (P200). However the experience of the MRC and the AFRC shows that a non-executive chairman with authority derived from industrial experience, an interest in the scientific method, and sufficient vision to look to the long term, can be a most effective ambassador for science into the user communities (which, in the case of the MRC and the AFRC, are clearly defined). **On these terms, we welcome this move.** We trust that the new lay chairmen will have sufficient time and commitment to give real guidance to the Councils.

Partner of Government

2.77 Similarly, we have received no evidence that the Science Base has been slack in responding to the needs of Government departments for research, including urgent short-term research, to underpin policy and regulation; but departments have not always acted as intelligent customers in the spirit of the Rothschild Report. **The Forward Look is warmly to be welcomed**

as an attempt to improve this situation, by obliging departments to plan their science programmes with an eye on the consequences for the wider Science Base.

2.78 **In our view, the best way to achieve this will be to give the Chief Scientific Adviser an effective voice, taken seriously by the Treasury, on departmental science spending bids and on their congruence with the Forward Look. The CSA should be empowered to expose inconsistencies in the science plans of departments to public scrutiny,** perhaps by publishing reports of his own without being obliged to pass them through a ministerial committee. Departments should be obliged to publish responses to such reports.

2.79 For these arrangements to work, **it will be necessary for the CSA to be clearly dissociated from the bid for the Science Budget presented by the OST,** of which he is formally the Executive Head. This raises the question of the CSA's relationship with the Director-General of Research Councils; we discuss this below (paragraph 3.18).

2.80 **We welcome the making of Concordats between each Research Council and its customer departments.** Such agreements must however be even-handed; in particular, **Research Councils must be given a seat and a voice in the planning process for departmental science programmes.** Involving the Research Councils at an early stage will greatly increase the coherence of the Forward Look.

2.81 **Likewise we welcome the creation of the Council for Science and Technology as a successor to ACOST,** a body whose true value was perhaps never fully appreciated by Government. But we note with some surprise that two of the members nominated to the CST have also been appointed chairmen of two of the new Research Councils (EPSRC and PPARC). This seems to us to set up undesirable and unnecessary conflicts of interest, both perceived and real.

Training

2.82 We endorse the concerns of our witnesses (see above, paragraph 2.63) regarding the intention that a PhD funded by the Research Councils should normally be preceded by an MSc. The result will be a weaker Science Base. **We recommend that the plan for MScs for all be reconsidered.** We note that the issue is currently being examined by the Royal Society.

2.83 As for applying industrial/commercial constraints to research training, with a view to relating it to the needs of potential employers, the message from our industrial witnesses is clear. **What industry wants from the Science Base is world-class researchers with firm understanding of the fundamentals of their science.**

Other important objectives

2.84 **We affirm that the Science Base serves the national interest in many ways which appear on no balance sheet, and cannot be expressed by crude performance indicators.** We are greatly encouraged that so many of our witnesses acknowledged this (paragraph 2.69), even in these hard times, including many voices from the front line of wealth creation. If nothing is to be done that does not create wealth directly, then not only is science largely deprived of its creative potential, but questions arise about other areas of Government spending, such as social security, arts funding and overseas aid.

CHAPTER 3 PROCESSES: DECIDING WHAT THE SCIENCE BASE SHOULD DO

The work of the ABRC

3.1 The top level of conscious and explicit priority-setting for the Science Base is the distribution of the Science Budget, currently about £1,000m, among the Research Councils and the other funding bodies (see below, paragraph 3.14). In April 1992 this function passed from the Secretary of State for Education to the Minister of Public Service and Science. On 1 January 1994, the function of advising the Minister on the distribution of the Science Budget will pass from the Advisory Board for the Research Councils (ABRC), a semi-independent body, to the new Director-General of Research Councils, Sir John Cadogan.

3.2 Following reconstitution in 1990, the ABRC consisted of an executive Chairman, the five executive Heads of the Research Councils (HoRCs), and six non-executive or independent members chosen from industry and the universities, plus the Government Chief Scientific Adviser acting as an "assessor".

3.3 Sir David Phillips, Chairman of the ABRC since 1983, gave us an insight into how the ABRC did its work when we met him on 17 March 1993. As he described it, it involved a "rather complex iterative process" (Q4). This process leaned more towards the bottom-up than the top-down (Q9): rather than forming its own view of priorities from scratch and advising the Minister accordingly, the ABRC received annual bids ("Forward Looks") from the Research Councils, over which it proceeded to argue and negotiate. The aim was to reach consensus (Q4), and the Board's function was to shorten the list of priorities, rather than to add to it (Q6). Its eventual advice to the Minister took the form of a composite bid, based on work programmes of comparable priority.

3.4 The ABRC adopted seven criteria by which to judge the priority of scientific research:

Criteria internal to the work

(a) Timeliness, i.e. expectation of rapid scientific advance

(b) Pervasiveness, i.e. links with other research

(c) Scientific excellence

Criteria external to the work

(d) Commercial exploitability

(e) Applicability to government policy or the public good

(f) Significance for education and training

And above all

(g) Affordability, weighing benefits against costs

(The criteria were promulgated in this form in 1987, but they may be traced back to 1972 and the chairmanship of Lord Dainton — Q26.)

3.5 The one unambiguously top-down factor in the ABRC's calculations is the political imperative: on some aspects of the Science Budget, the Minister's mind is made up before any advice is drafted. This applies most obviously to the United Kingdom's subscriptions to the European Particle Physics Laboratory (CERN) in Geneva and the European Space Agency (Q128), and provision for the British Antarctic and Geological Surveys.

3.6 Subscription to CERN and ESA cost the United Kingdom £60m and £36m respectively in 1992-93 amounting to 18 per cent of the budget of the SERC. Such international subscriptions

are especially difficult to build into a national system of priority-setting, since the amounts are fixed by international agreement and are vulnerable to changes in exchange rates; what is more, if subscription to an international facility is to be worthwhile, it must be backed by funding for British scientists to use the facility. Sir Mark Richmond told us in this connexion that "there is a strong feeling in the Council...that some areas of physics are over-represented", but that it was out of their hands (Q97).

3.7 The British Antarctic Survey (BAS) receives a ring-fenced allocation within the Science Budget, amounting in 1991-92 to £26m, or 21 per cent of the NERC's share of the Science Budget (p228). The BAS received an extraordinary boost for obvious political reasons after the war over the Falkland Islands in 1982-83 (Q67). What the BAS does with the money is up to the NERC. The British Geological Survey, which currently consumes a further 9 per cent of the NERC's Science Budget allocation (£11.3m in 1991-92), does not receive a ring-fenced allocation, but its mission is set by Government (Q372).

3.8 Sir Mark Richmond was the only one of all our witnesses to comment in any detail on the ABRC as a means of setting priorities. Writing to us just before the publication of the White Paper (p234), he observed first that the SERC was at a disadvantage simply because its share of the Science Budget (about a half) was so big: the ABRC tended to prefer the smaller Councils, or at least to consider their bids in more detail. This problem will be mitigated when the SERC is dissolved on 1 April 1994: the new Engineering and Physical Sciences Research Council will be the biggest of the six new Councils, but it is expected to collect only about a third of the Science Budget. Sir Mark went on, "As in all situations where advocacy is the essence of decision-making, eloquence and presentation can win the day; and some cases are inherently easier to present than others."

3.9 Writing to us again after the White Paper was published (p238), Sir Mark added, "The activities of the major Councils have now become so diverse and complex that independent members of the Board, with limited time available for detailed analysis, must find assessing competing claims nearly impossible" (cp Q153). Other witnesses expressed similar concern about the constraints on non-executive members (NERC p228). Professor Sir Geoffrey Allen, speaking from his experience as Chairman of the SERC 1977-81, added two further concerns: each independent member was liable to be "seen to have an affiliation to one of the Research Councils"; and the independents were never able to give "real advice", because they never met apart from the HoRCs (Q520).

3.10 Mr Waldegrave explained to us on 13 July why the ABRC is to be wound up. "My starting point in all of this was a piece of work that was done for me which showed that within the boundaries of the Research Councils over the last 20 odd years there have been quite marked shifts in priorities. Between the Research Councils, over that similar period, there has been very little overall shift. That seemed to me to strain credibility, and seemed to me to be showing that the boundaries were having a greater influence *prima facie* than was plausible on where the money fell. That is why I believe that the Minister, who after all has the only effective power to make these shifts, should take a greater direct responsibility for it...I did not think that the old system...of the arm's-length ABRC giving the Minister the let-out, that it was all at arm's length and nothing to do with him, was really right. If there were shifts in the national priorities he should answer for them..." (Q5).

3.11 A look at the figures confirms Mr Waldegrave's impression. Over the last 10 years, the distribution of the Science Budget among the five Research Councils has varied little from the following pattern:

Science & Engineering - 51%
Medical - 23%
Natural Environment - 12%
Agricultural & Food - 10%
Economic & Social - 4%

3.12 The Minister went on, "This structure, I believe, will deliver more steerage for the Research Councils" (Q6). He concluded, "It does mean over time some changes, I think, and therefore some trouble probably; but I think by implication you are saying that perhaps we have not had enough trouble in the past, there has not been enough shifting of things across boundaries" (Q7).

3.13 On the face of it, this concern to bring down barriers is at odds with the decision to create five new interfaces by transferring the "big science" activities of the SERC to a new Particle Physics and Astronomy Research Council (PPARC), leaving the Engineering and Physical Sciences Research Council (EPSRC) responsible for the rest. As Mr Waldegrave explained it to us, the common thread is the desire to put the top level of priority-setting in the hands of the Minister. "It just seemed to me that the thing was too big now and we were asking a devolved chairman and chief executive to make such spectacular chalk-and-cheese judgments between whether we should go on with a subscription to CERN or whether we should be doing more small science in a different area. It was unfair to devolve and somebody else had to be responsible for that, namely the Minister ultimately, and therefore we should have these judgments rather more out in the open" (Q25).

Other funding bodies supported by the Science Budget

3.14 The Royal Society and the Royal Academy of Engineering (RAEng) also receive money from the Science Budget, but the amounts are relatively small: in 1993-94, £18.5m and £1.7m respectively out of a Science Budget of £1,073m (the ESRC, the poorest of the Research Councils, received £50m). In terms of priorities, the grant to the RAEng represents a commitment to engineering in all its forms (p144); the Royal Society uses its grant to support excellent scientists (including engineers) as individuals, irrespective of discipline or mission (Q660).

Director-General of Research Councils

3.15 We have been concerned for a long time that the autonomy of the individual Research Councils, five and soon to be six of them, invites territorial disputes and works against any strategy for the science base as a whole (see *Proposed Science & Technology White Paper*, HL Paper 34 Session 1992-93, paragraphs 29-31). On the face of it, the appointment of Sir John Cadogan as Director-General of Research Councils (DGRC), to start work on 1 January 1994, goes some way towards meeting these concerns. The DGRC will be an official within the OST, and is expected to be advised by "a small standing group of independent experts", which will not (as the ABRC did) include the HoRCs (White Paper paragraphs 3.23-29).

3.16 To those who wish to see the mutual independence of the Research Councils moderated, Mr Waldegrave's evidence to the Select Committee on 13 July was less than reassuring. The DGRC will not be Accounting Officer for the Science Budget; that role will continue to be divided between the HoRCs and the Permanent Secretary to the Office of Public Service and Science (OPSS), of which the OST forms a part. The DGRC will give the Minister the advice on distributing the Science Budget which formerly came from the ABRC, and this advice will be "more intimate and continuous" (Q3); but it will still be only advice. The DGRC will be "the person to whom it would be very wise for the Heads of Research Councils to pay sufficient attention" (Q4), but he will not be their line manager. Neither, on the other hand, will he be "a sort of lobbyist" to the Minister on the HoRCs' behalf, as the Chairman of the ABRC sometimes seemed to be (though Sir David Phillips strongly denied it — Q59): Mr Waldegrave said, "He is my man, he is inside" (QQ 6,7).

3.17 When we met representatives of four of the five Research Councils in Swindon in October 1993, we received similarly uncertain signals as to the real authority of the DGRC. Sir Mark Richmond believed that each Research Council would be required by its Financial Memorandum and Resource Management Agreement to consult the DGRC and follow his advice, putting him in a *de facto* line management position (Q867). Dr Eileen Buttle, acting Chief Executive of the NERC, considered that his position as adviser to the Minister on allocating the Science Budget would give the DGRC "power enough" (Q870). On the other hand, Professor Newby of the ESRC saw the post as "a brokerage position, not one that has any power" (Q873).

3.18 If the relationship between the DGRC and the HoRCs is not yet clear, neither is his relationship with the Chief Scientific Adviser (CSA). The CSA became the "head" of the OST when it was set up in April 1992, so he will be in some sense in authority over the DGRC. The CSA is a Grade 1A; the DGRC will be a Grade 2. But the DGRC will be paid on the 1A scale, and will have "direct access" to the Minister (Q5), rather than having to pass his advice on the Science Budget through the CSA. Professor Newby told us that the position was confusing (Q875); Sir Mark Richmond called it "a complete muddle" (Q877).

3.19 The functional relationship between the DGRC and the CSA is superficially more straightforward than their formal relationship. In Mr Waldegrave's words, the CSA will advise the Minister on "lateral issues", i.e. trans-Whitehall issues, while the DGRC advises him on "the shape and direction and strategy of the science and engineering base" (Q7). Professor Stewart put it in similar terms, though he made the DGRC sound less advisory and more executive: "I [as CSA] look more across government departments as a whole...with the DGRC very closely involved in ensuring that the Research Councils for their part are able to deliver their sector of overall Government policy" (Q11).

3.20 But, according to the Minister, the DGRC will also have a trans-Whitehall role: "He or she will want to be in very close touch with departments in so far as they are user communities" (Q11). Departmental Chief Scientists were members of the ABRC until 1990, but since then they have met the Board only once a year (Q8).

3.21 Mr Waldegrave invited us to imagine a "triangle" or "troika", comprising the Minister, the CSA and the DGRC, with the Permanent Secretary holding "formal accountability for the big blocks of money" (Q7). Professor Stewart offered a slightly different vision of a "tripartite arrangement", with the Permanent Secretary yoked alongside the CSA and the DGRC and the three officials advising the Minister "collectively" (Q11). Mr Waldegrave brought his mental model into line with Professor Stewart's a little later, when he compared what is intended for the OST with the "troika" at the top of the Department of Health: the Permanent Secretary, the Chief Medical Officer and the Chief Executive of the NHS (Q17).

3.22 Two limitations of this parallel are apparent. First, the Minister and Permanent Secretary in question belong not to the OST as such, but to the OPSS of which the OST forms a part. Whether the OPSS is in Whitehall to stay, or whether its parts may go separate ways at the next Cabinet shuffle (a possibility contemplated by Sir Mark Richmond, Q874), and what in that case would become of the OST, are open questions. The second weakness points up an aspect of the new arrangements which seriously concerns us and many of our witnesses: whereas the Chief Executive of the NHS is executive head of the largest organisation in Europe, the DGRC may turn out to be only an adviser-cum-broker in respect of six semi-autonomous chartered bodies.

3.23 Mr Waldegrave laid considerable stress on the DGRC's personal, as opposed to official, authority. The DGRC was to be "a big man or woman", a "professional" who will "carry weight" both in the science base and among the "user communities" (QQ 5,10). Such emphasis on pulling personal weight suggests that the DGRC will not be able to pull much rank or formal authority.

Research Council boundaries and missions; the position of basic science

3.24 The SERC, writing to us after the publication of the White Paper (pp 235, 238), made the important observation that there will now be more boundaries than there were before: 15 interfaces between Research Councils instead of only 10. Some fields which had an obvious home in the old system may find themselves homeless in the new: eg biological chemistry (Q631). Several witnesses expressed concern for chemistry as a whole (Q654, p166, P254). Others are concerned to see what will become of biotechnology in fields other than agriculture (Q790), including fields as yet unknown.

3.25 The position of basic science, i.e. science not oriented towards any identifiable application, is more complicated in the new situation than it was before the White Paper. Under the

old dispensation, the SERC combined its own mission with a function as "residuary legatee", ready to support anything which none of the other Councils regarded as relevant to its more specific mission. Under the new, all the Councils' specific missions include the support of basic science. According to the White Paper, paragraph 3.17, "All five natural science Councils will, where it is appropriate to the pursuit of their specific missions, support the full range of underpinning disciplines."

3.26 The Research Councils themselves hope that basic science will not be squeezed out by their new missions to support the creation of wealth through applied research. Sir Mark Richmond, speaking before the White Paper was produced (Q115), told us, "Without an effective pure and fundamental research base, there is nothing to apply. One has to cherish that." The SERC's letter written later, in the light of the White Paper, acknowledges that this may not be easy (p236): "It remains to be seen whether the new bodies experience difficulties in determining the right balance of basic, strategic and applied research."

3.27 The NERC (Q378) drew our attention to the particular importance, in underpinning environmental science, of survey and monitoring. They hope (p225) that applied research will continue to be at least part-funded by those who stand to benefit, rather than falling wholly on the Science Budget.

Technology Foresight

3.28 By the end of 1994, those involved in setting priorities for science will have the benefit of the first report of the OST's new Technology Foresight Programme, launched by the Science White Paper (paragraphs 2.23-33). Technology Foresight is an attempt to inform the priority-setting process by means of a "systematic, well-informed assessment of the match between potential research outputs and the likelihood that they can be appropriated by firms and organisations".

3.29 The United Kingdom is far from being the first in this field. Exercises of this general character are already part of the science and industry policy process in Japan, the USA, Germany and France, and have recently been set up in the Netherlands, Sweden, Norway, Canada and Australia. Each of these nations has its own way of conducting Foresight, and its own set of objectives. These are well described and analysed in two recent reports: *Research Foresight and the exploitation of the Science Base* (OST, March 1993) and *UK Technology Foresight* (POST, January 1994).

3.30 The process of Technology Foresight for the United Kingdom is currently being developed by a Steering Group. According to the White Paper (p19), it was to be conducted on the basis of "an agreed list of technology sectors", under the oversight of a panel of experts for each sector. Wide consultation was to produce for each panel "information on scientific opportunities and potential market applications" in their sector. Each panel was then to match "science-push" against "demand-pull", and thereby "identify those technologies within their sectors which they judge of most importance to the country's economy". The results were to be disseminated widely, and the whole exercise developed into a "rolling programme".

3.31 The Steering Group has already decided to depart from the approach sketched in the White Paper in one fundamental way. Following discussions described to us by one participant as "acrimonious" (Q881) between the Steering Group and the OST, the list of technology sectors (such as sensors, biotechnology, information technology, materials) is to be replaced with a list of "quasi-industrial sectors" (QQ 882, 890-5) such as energy, transport, retail services, financial services, domestic, security, environmental monitoring, health, business processes and leisure.

3.32 The arguments leading to this decision shed light on what Technology Foresight is for. The White Paper gives two answers to this question. First, it is *to inform the allocation of "scarce public funds"* (which appears to refer to the whole of Government spending on science, rather than just the Science Budget) among competing research programmes. But it is also intended *"as a process which will forge a new working partnership"* (paragraph 2.27) between Government,

industry and the Science Base. (The introduction to the White Paper calls this "a key cultural change" — paragraph 1.18.2.) The Science Base is to be made "even more aware of and responsive to" the needs of industry, and industry is to be encouraged to be "more aware of and receptive to" the work of the Science Base. Technology Foresight is intended to generate informal interaction, and the remit of the Steering Group includes the encouragement of "networks".

3.33 According to Professor Howard Newby, a member of the Steering Group, confusion between these two objectives lies behind the argument over the demarcation of the panels (QQ 881-7). If Foresight is mainly intended to inform the PES round and the allocation of the Science Budget, he argues, then all that is needed is a ranked list of technologies. This can be produced without a wide process of consultation, and is not likely to excite industry. Sir Geoffrey Allen, who imagined when we met him on the day of publication of the White Paper that Foresight would indeed be used to shape the Science Budget, agreed with Professor Newby that for this purpose nothing elaborate would be required, just "a very coarse map of the technologically important things" compiled with the help of "a few companies" and information from abroad collected by the DTI (Q520).

3.34 If on the other hand, as the Steering Group believes, the main intention is to raise awareness and generate informal interaction, then the consultation process is all-important. Since, in the view of Professor Newby (and others of our witnesses — see above, paragraph 2.30), the blocks to awareness and interaction are found more on the industry side than the science side, the consultation process must take place on "ground on which industry feels comfortable and can relate to", i.e. industrial sectors rather than technology areas.

3.35 Our witnesses generally support this change from starting with technologies to starting with a vision of needs and markets (NERC p227, CBI P214, Wellcome Trust Q956). Dr Michael Edwards of Unilever observed that this was much easier in the context of a company (e.g., in his own company's case, "How do we wash clothes without water?" — Q705) than with an eye on the wealth of a whole nation; but he agreed that it would be worth doing. Mr Don Lennard of MTD, speaking for the CBI, suggested rechristening the process "Market Foresight" (Q1007).

3.36 Another area of debate is who should be involved in the Foresight process. Dr Michael Elves of Glaxo is afraid that it might degenerate into "occupational therapy for certain groups" (Q749). Dr Geoffrey Robinson indicated that the DTI is offering itself to the OST as a conduit for industrial input to the Foresight process (Q562), though later in our discussion he stressed the importance of talking to "real companies" (Q574). Thorn EMI point out (p241, cp Q1072) that those involved will require time off work (involving opportunity cost to their employers), and adequate remuneration plus resources to travel overseas.

3.37 As to what the output of the process might be, many witnesses cautioned against any attempt to use the Foresight process to "pick winners", i.e. to select particular private sector projects for extra support from public funds in the expectation that they will create wealth for the nation: Professor Newby (ESRC) Q331, Dr Robinson (DTI) QQ 558, 574, Professor Horlock (Royal Society) Q674, Professor McCaughan (RAEng) Q709.

3.38 Several witnesses expect the process to identify a set of "generic technologies" (CBI Q1006). This term is used to denote a technology which underpins or enables a variety of specific activities. We recommended in our report of 1991 on Innovation in Manufacturing Industry (paragraph 9.73) that Government had a legitimate role in identifying and promoting generic technologies appropriate to national needs or the national industrial base, and this is now accepted wisdom (e.g. RAEng p141). In the view of the Chemical Industries Association (p155), aiming at generic technologies will leave room for "a degree of diversity to ensure that curiosity research is not stifled and cross-disciplinary research is not discouraged".

3.39 On the other hand, we find general agreement that merely producing a list of important technology areas is not in itself difficult, particularly since several industrial countries (Germany,

Japan, the USA) have already produced such lists; neither is it particularly helpful (ABRC Q49, DTI Q574).

3.40 Dr Michael Elves of Glaxo, speaking for the ABPI (Q749), cautioned against "stamp-collecting" of other countries' new technologies; technologies are only of interest to the extent that British industry can appropriate them. Glaxo itself (p205) similarly warns against "technological bandwagons".

3.41 Where ranking technology areas ends and identifying generic technologies begins, and at what point identifying a generic technology turns into stamp-collecting or picking a winner, are questions of definition to which none of our witnesses gives clear answers. These questions are no doubt engaging the Steering Group.

3.42 There remains the question of the use to which any output of the Foresight process will be put. The White Paper says only that "the results will be an important contribution to the deliberations of the Council for Science and Technology" (paragraph 2.32), and that they will provide a "background" for "strategic decisions" by the Research Councils (paragraph 3.33). Yet companies such as Thorn EMI (p241) are expecting vigorous implementation, by a DGRC and a Chief Scientific Adviser with enough "clout" to bring the Science Base into line with the outcome. Glaxo put it even more bluntly: "The Technology Foresight Programme must be backed up with an intention to provide money" (p205), by using the outcome to shape the national policies expressed in the Forward Look.

3.43 On the other hand the SERC (p237) see the outcome of Foresight as an important addition to "the information base which informs priority-setting", but not as something to use "prescriptively". The AFRC and the ESRC take the same line (QQ 899, 900); so do the CBI (Q1000). According to Professor Newby, elements within the OST support a "tablets of stone approach", whereby "Foresight produces an annual prioritised list of technologies which are then handed down through the Council for Science and Technology, to the DGRC, to the Research Councils to "implement""; but there is no support for this approach on the Steering Group (Q901).

3.44 Whatever form the outcome of the Foresight exercise might take, and however it might be used, most of our witnesses agree that the process of Foresight is at least as important (CIA Q753, BTG Q820, CBI Q1000). This line received support from Dr Robinson of the DTI (Q558): "We want to improve the dialogue, through research foresight...at very early stages in people's thinking about research opportunities — not necessarily to bias them in any way and certainly not necessarily to turn them into short-term activities."

3.45 Professor Newby, speaking to us before the publication of the White Paper, went a little further (Q331): "The value of technology foresight does not come from the particular recommendations on offer but from the actual understanding which is developed through the process of what each has to contribute."

3.46 Witnesses from the Royal Society went further still, and suggested that any outcome would in itself be of doubtful value. Professor J H Horlock, the Treasurer of the Society, pointed out that any forecast of future needs and markets is vulnerable to unpredictable developments; his example was the recent "dash for gas" in power generation (Q674). Sir Michael Atiyah, the President, added that, whatever the outcome of a Foresight exercise, no single party would be in a position to "implement" it (Q676).

3.47 The Royal Society of Chemistry observe that Foresight is equally vulnerable to unexpected developments in science (P252); their example is high temperature superconductivity. Dr John Lackie (Q1049) pointed out that one of the hardest things to predict is the new technique which, though not "sexy" in itself, may "open up a whole new area of science": his examples were restriction enzymes and electron microscopy.

3.48 We noted above (paragraph 2.11) that industrial involvement and concern for wealth creation were already developing in the Science Base before the publication of the White Paper; the same is true of Foresight. Before the White Paper brought Technology Foresight into the official vocabulary of science policy, Professor Blundell of the AFRC used this very expression to describe to us his Council's think tank, scientific opportunities meetings and open forums (Q428, p182); and the other Research Councils engaged in similar activities (ESRC Q307; MRC's field reviews, p112; NERC's Science Strategies, Q409, p227; SERC's initiatives, Q1082). Other funders of research also have foresight activities: e.g. the Department of Health's National Standing Group on Health Technology (Q587), and the Wellcome Trust's Policy Research In Science and Medicine Unit (Q954).

3.49 Professor Frederick Last, speaking for the Royal Society of Edinburgh (Q1080), brought all these thoughts together when he observed that people from industry may be unwilling to devote much effort to an exercise whose outcome will not necessarily be acted upon, and that it might therefore have been wiser to build on the Foresight activities already conducted by the Research Councils, where the outcomes are carried through into long-term planning. Whether he is right remains to be seen.

How will the White Paper affect peer review?

3.50 The sharp end of priority-setting within the Science Budget is at the level of the Research Council committees and boards which award grants to projects. This has traditionally been done by the process of "peer review": each project proposal is assessed by a number of scientists working in the relevant field, who then advise the grant-making body how it rates against the ABRC criteria (see above, paragraph 3.4), giving most weight to the expected excellence of the project's scientific content. The process of peer review is easy to criticise: as Professor Newby of the ESRC put it, it can be seen as "delivering yourself into the hands of your closest and deadliest rivals" (Q340); and, as we were politely told by the young researchers who met us in Edinburgh, it may tend to steer young creativity into channels known to be favoured by a generation of scientists whose creativity has begun to wane. However, as Professor Newby went on to say, it is generally agreed to be the "least worst" system available (cp Q943).

3.51 In the view of Sir Mark Richmond, this is going to have to change if the White Paper initiatives are to succeed. "A huge amount is going to depend on the extent to which the peer review system is adjusted...to reflect wealth creation" (Q858, cp ABPI p158).

3.52 The White Paper (paragraph 3.13) makes it clear that some adjustment is expected. "While the Research Councils should focus on the value of proposed research in terms of scientific excellence and timeliness, they should take more fully into account the extent to which outcomes could be taken up by potential users." As to precisely how this will be achieved, the White Paper gives no details, and our witnesses disagree.

3.53 In July Mr Waldegrave spoke to us (Q19) in terms of a "first cut" on the basis of excellence, followed by a "second cut" on various criteria including, "Are there serious science-based industries...who say that this stuff really must be done?" He went on to say, "I do not at all think that the fulfilment of the Research Council missions means that every piece of research has to show a use" (Q26). Similarly, in October, Dr Eileen Buttle of the NERC spoke in terms of "influencing our selections at the margins where we cannot discriminate quality, perhaps by the user requirements" (Q921). But on the same occasion Professor Newby told us (Q897) that the ESRC would not "use the outcome of the Foresight activity to alter the assessments of quality that we use for individual grant applications"; and Dr Brian Jamieson of the AFRC agreed that "At the individual project level scientific quality will still be the overriding criterion" (Q899, cp Q441).

3.54 Professor Mellitt of London Underground, speaking for the CBI, envisages some seats on Research Council boards going to people nominated by industry, "working to a somewhat different brief from the one they currently do", and applying "criteria for judging specific proposals more related to output measures than input assessment" (Q1009), in order to "credit industrial

linkages" (Q1011). This will not exclude academic considerations, but will provide "balance" and "creative tensions". Dr Simon Shohet, on the staff of the CBI, gave us a similar picture (Q1015): the Research Councils will receive "a liberal sprinkling" of industrialists, but not so as to dominate; "the criteria of excellence of quality and diversity" will remain paramount, and there will still be "funds available for undirected research which may not be obviously pointing in the direction of wealth creation". This is likewise the expectation of Sir Mark Richmond himself (P247).

3.55 The CBI also brought before us Mr Don Lennard, Chief Executive of the Marine Technology Directorate Ltd (MTD). MTD may be seen as a harbinger of the post-White Paper order: formerly a part of the SERC, it was privatised in 1986, with a view to taking it much closer to its "user community". MTD still disposes of some £5m of SERC funds each year, but the board which distributes it consists largely of people from industry rather than academics. Mr Lennard told us (Q1013) that one third of these funds are devoted to full support of fundamental research; the rest is used for part-funding of work with industrial relevance. Mr Lennard observed that the proportion of one third for fundamental science is high, but that it is what his industry-led board wants.

CONCLUSIONS

The Director-General of Research Councils and the new Research Council boundaries

3.56 We wish Sir John Cadogan well in his new post as Director-General of Research Councils; but we do not share Sir Geoffrey Allen's confidence that this will be "the most marvellous job in this country" (Q547). In particular, we fear that he will find it difficult to "generally direct" in the organisational framework described to us by the Minister (paragraphs 3.16-23).

3.57 Much will depend on relationships within the "troika", both formal and personal. We have already recommended, in the context of the Forward Look (paragraph 2.79), that the Chief Scientific Adviser must be seen to leave Research Council matters to the DGRC. It is equally important that the Minister should not only take the DGRC's advice but be seen to be doing so. **We recommend that the DGRC's advice on both quantum and allocation should be published in full, and that the Minister should either accept it or give to Parliament his reasons for not doing so.** Publication will also ensure that the activities of the DGRC are no less transparent than was the work of the ABRC.

3.58 One thing which would enhance the DGRC's authority out of all proportion to its cost would be **to give him personal control of an annual sum corresponding to the "flexibility margin" operated by the ABRC between 1984 and 1991**. Such a sum, perhaps 1% or 2% of the Science Budget, would allow the DGRC to touch the tiller of the science base in ways which could make an important difference over a period of years, without compromising the autonomy of the Councils and without involving the Minister. This might involve backing hunches not yet appreciated by the Councils, filling gaps, or increasing the discretionary funds available to outstanding institutes or university departments. The ABRC lost its margin in the stringent PES round of autumn 1992; Sir David Phillips told us that ABRC were "relatively content" with this, since the Councils had learned to build flexibility into their own budgets (Q64). This is to be commended and continued; but flexibility at the next level up must be restored if the DGRC is to be able to impart the desired steerage and direction.

3.59 As noted above, the DGRC is expected to have the advice of independent experts. **We welcome this**: willingness to consult identified and appropriate experts will enhance the DGRC's credibility, and militate against any impression of arbitrariness or favouritism. These people will carry on the important work of the non-executive members of the ABRC. We share the concerns expressed by several of our witnesses (see paragraph 3.9 above) that the effectiveness of the non-executive members of the ABRC was in fact limited by the time which they could give to the Board and the amount of material which they were expected to consider. **If the DGRC's expert group is to function properly, it must be properly resourced**.

3.60 The more the DGRC is in a position to direct, the less it should matter precisely how the boundaries are drawn among the Research Councils. If, however, the Councils were to remain substantially autonomous, then the new boundaries would cause us some concerns, if only because there will be more boundaries than before, and therefore more scope for good applications to fall between stools or to become the victim of policy differences between different Councils. We welcome the fact that the White Paper (paragraph 3.28) gives the DGRC express responsibility to keep the boundaries between the Research Councils under review. **It is important that he should continue the work of Sir David Phillips's "boundary study", and redefine the boundaries as the need arises.**

3.61 The separation of astronomy and particle physics from engineering and the other physical sciences will make for greater transparency and easier decision-making. Some forms of scientific research cost more than others, and require longer-term commitment, and in some areas the United Kingdom can only participate by way of subscription to an international programme (SERC, p238); nonetheless the new PPARC is likely to be seen as a soft target for savings in the Science Budget.

3.62 The Minister who takes responsibility for serious damage to the United Kingdom's capacity in these areas will not lightly be forgiven. On the other hand, an opportunity currently exists to enhance international high-energy particle physics while reducing its call on the UK Science Budget. We refer to the cancellation in October 1993 of the Superconducting Super-Collider project (budget $11,000m) in the USA. If research in this field by American, Russian and European scientists were now to be concentrated on the Large Hadron Collider being planned by CERN in Geneva (budget £800m), then British science would benefit immeasurably, while the cost of the UK subscription would be bound to come down. **We commend this possibility for consideration by the OST and the new PPARC.**

3.63 **Another matter to which we urge the new DGRC to pay close attention is the approach of the new Research Councils to the basic sciences which, while not directly linked to any one Council's mission, underpin the missions of them all to a greater or lesser extent.** We have in mind particularly general chemistry and general physics (about which Sir David Phillips expressed concern — Q70) and mathematics, but there will be many others. Now that none of the Councils is to see itself as the guardian of particular disciplines, beyond the extent to which they underpin its mission, it will be open to each Council to try to unload responsibility for these basic sciences onto the others; we look to the DGRC to ensure that this does not happen.

3.64 The Councils' new missions may meet the needs of the 1990s, but needs are bound to change. Therefore **the DGRC must also be ready to advise the Minister to amend the missions as new needs arise.**

3.65 Under the Science and Technology Act 1965 and the Royal Charters of the existing Councils, the Minister has power to give directions to the Councils. The new Charters will presumably preserve this power; the DGRC must stand ready to advise the Minister to use it.

Foresight and peer review

3.66 As we write, the Foresight programme is still at a very early stage. The OST has held a series of awareness-raising meetings, and is beginning the search for the right people to serve on the expert panels. It is therefore too early to form any judgment of the process, let alone the outcome.

3.67 **We welcome the Foresight programme.** Bringing together scientists and the users of science to share visions and ideas, and breaking down the endemic cultural divide between research and production, will have far-reaching benefits for the economy. Competitor nations consider that such a process has benefited them, and it may therefore be expected to benefit the United Kingdom too.

3.68 We qualify this welcome, however, with certain provisos. First, **Foresight must not become the preserve of civil servants and consultants**. Such a group might be able to produce a ranked list of technologies, but it would not generate the dialogues and contacts between real companies and real research teams, at the sharp end of science and its applications, which constitute a large part of the point of the exercise.

3.69 **Nor must participation in the Foresight programme be confined to firms and individuals who are already well networked with the Science Base, or to scientists who already have one foot in the industrial world**. If this were so, then Foresight would be an exercise in preaching to the converted, and would only waste the time of a great many people who could be more profitably employed. The value of the exercise will consist largely in its capacity to make new connections.

3.70 Most important, **any suggestion that the outcome of the Foresight exercise may be "implemented" by top-down means, or in response to short-term considerations, should be resisted.** Foresight if done properly will offer a vision over a 10-15 year time horizon, not a strategy for the short term. It will provide a useful input to Research Council planning and to the Forward Look, but it must not be allowed to dominate or supplant peer review, or to encourage short-termism. If it degenerates into a means for the DTI to shape the Science Budget, it may cause serious damage.

CHAPTER 4 INSTITUTIONS: WHERE SHOULD THE SCIENCE BASE BE?

UNIVERSITIES

Dual support

4.1 Most of the people who make up the Science Base are located in university departments. University scientific research is funded by a system of "dual support", of which the Science Budget is only one leg. The other leg, however, also affects priorities, and what gets funded or done and what does not.

4.2 The other leg of dual support is still provided (as the Science Budget was until 1992) by the education departments. It consists of money delegated to arm's-length bodies, currently the Higher Education Funding Councils (HEFCs) for England, Wales and Scotland and an analogous arrangement within the Northern Ireland Office. These bodies distribute this money to universities in the form of annual block grants. In theory, these grants are made to entire universities (rather than individuals or departments), to support both teaching and research in both sciences and arts; they are therefore entirely different from the project grants and individual fellowships given by the Research Councils and other funders such as the medical charities. In 1993-94, the HEFCs distributed £753m in respect of research, including £507m in respect of science.

4.3 The two legs of the dual support system are intended to complement one another: block grants support the infrastructure of buildings, administration, permanent staff and (in theory) "well-found laboratories", while the Research Councils pay the extra costs of the additional staff, equipment and materials needed to conduct particular scientific research projects.

All change

4.4 The block-grant leg of dual support is going through a series of major changes. First, in 1985 the University Grants Committee (which became the Universities Funding Council in 1989) put the funding of research through block grants on a more selective basis than before. A nationwide Research Assessment Exercise took place, resulting in a rating of every university department involved in research, both arts and sciences. This informed subsequent allocations to universities of the research element of block grants ("R", as opposed to the teaching element, "T"). A second Research Assessment Exercise took place in 1989, and a third in 1992.

4.5 It is generally acknowledged that the system of Research Assessment has not yet been perfected. The current method involves elements of rough justice, and invites departments to "play the system" in various ways (Q501). It bears a strong historical imprint, which may be felt to discourage innovative approaches.

4.6 Then, following the White Paper "Higher Education: a new framework" of May 1991 (Cm 1541), the funding structure of higher education was completely overhauled. The "binary divide" which formerly separated the universities and the polytechnics was abolished (leading most of the polytechnics to change their names), and block grant funding was divided among the new HEFCs for England, Scotland and Wales, and the Northern Ireland Office.

4.7 The White Paper of 1991 also announced that with effect from 1992-93 the Government would shift the weight between the two legs of dual support, by making the Research Councils responsible for more of the full costs of their projects than before, including overhead costs (calculated as 40% of direct staff costs) which were formerly expected to be met by the university from block grant. This involved a one-off transfer of resources from the UFC/HEFCs to the Science Budget. This "Dual Support Transfer" will amount to some £150m when complete in 1994-95.

4.8 Suspicion has been rife in the university world that the money transferred to the Research Councils has not returned to the universities in the form of enhanced project grants, but has been diverted to fund new grants or for other purposes. The finger of suspicion points most particularly at the SERC (e.g. Q267, p211).

Table 3: Current Distribution of Universities

England	"old" universities	37 (counting London as 1)
	"new" universities	34
Wales	"old" universities	1 (6 colleges)
	"new" universities	1
Scotland	"old" universities	8
	"new" universities	4
Northern Ireland	"old" universities	2
TOTAL		87 (of which 39 "new")

4.9 The Councils assured us that their consciences were clear in this matter (MRC p113, NERC p230, SERC p238, AFRC Q462, p183). Some referred to transitional problems as grant applicants, universities and the Councils themselves worked out how applications should be made and costed under the new rules. It is even suggested (Q644) that some grant applicants are deliberately underclaiming in the hope of improving their chances of funding. The situation is being monitored by the British Universities Finance Officers Group.

4.10 There has been much uncertainty as to whether the Government intended a further transfer of responsibilities and resources from the HEFCs to the Research Councils, and indeed whether they intended to make the Research Councils (and, for the arts, the British Academy in default of a Humanities Research Council) responsible for the whole of R (as envisaged by, for example, Sir David Phillips, Q34, Professor Howard Newby, Q342, and Professor Tom Blundell, Q460). The Science White Paper implies (paragraph 3.44), and Mr Waldegrave confirmed to us in July 1993 (Q12), that no further transfer is currently intended.

4.11 A further change has been taking place more gradually, but with major implications for the Science Base. Encouraged by the Government, universities are taking on more undergraduate students: between 1987 and 1992, the annual intake of full-time first-degree undergraduates grew by 43%. (The proportion enrolling for science courses has remained roughly constant at around 42%; the proportion enrolling for courses in the arts and social sciences has risen slightly, while that for medicine has dropped. Source: University Statistics volume 1 table 7.) Meanwhile the number of permanent staff in the universities has remained relatively static; staff therefore have a greater teaching load and less time for research.

4.12 The impact of all this on priorities for scientific research is indirect but substantial. The HEFCs have no scientific priorities: their priority is "to support excellence where it exists" (HEFCE Q234) with the funds available. The scientific priorities of the universities and their departments in these hard times are designed to maximise their share of those funds and any other resources they can find (CVCP p123, Sir David Smith Q638). But their decisions have considerable effects on what research actually gets funded or done.

Higher Education Funding Councils

4.13 Each HEFC has promulgated the formula by which it calculates each university's block grant. The funding formulas are broadly similar in respect of research, but with significant differences described in detail at QQ 466-8.

4.14 Every Council distributes most of R (95% in England and Scotland, 89% in Wales) as "QR", roughly speaking in proportion to the product of research rating, number of research-active staff and discipline-weighting (which is intended to reflect the fact that some disciplines are more

expensive to pursue than others). But for these purposes each Council treats the research rating in a different way.

4.15 The most recent ratings are taken from a scale of 1 (lowest) to 5 (highest). None of the Councils now awards any R in respect of a 1-rated department. For departments rated higher, the Councils modify the rating as follows:

Rating	England	Scotland	Wales
2	1	1	1
3	2	1.4	2.15
4	3	1.96	3
5	4	2.74	4

4.16 Professor Graeme Davies, Chief Executive of the HEFCE, observes that the effect of the Scottish and Welsh scales is to put "much less weight upon excellence" than the HEFCE. He believes that this may cause "some longer term difficulty" (Q292). On the other hand, in the English model, the differential between each weighting and the one below, i.e. the reward for improvement, decreases as a department ascends the scale; in the Scottish model, the differential is constant at 40% (Q466). Professor John Sizer, Chief Executive of the SHEFC, acknowledged that his Council's model is "slightly less selective" than the English one (Q471).

4.17 The Welsh HEFC explains its model as follows (Circular W93/10 HE, May 1993): "The uplift at the mid point of an otherwise linear scale acknowledges the Council's particular concern to secure a platform for development to help achieve the improvement in the quality of research in Wales sought by the Secretary of State".

4.18 Professor Davies expects the Funding Councils to "seek to develop their own individuality" (Q297). The AFRC believes that this is happening (p182). So does the SERC (p237), and it is not happy about it. "If expertise is too narrowly drawn, the risk of patchy coverage of international scientific developments is real." Neither is the Committee of Vice-Chancellors and Principals (CVCP): research "should be funded on the basis of quality, not location" (p123). The Councils are however committed to keeping Research Assessment on a national basis (Q296).

4.19 The Welsh HEFC is already developing its individuality in one particular respect. As part of a strategy to raise the quality of research in its universities, it has obtained an extra £2.25m through the good offices of the Secretary of State, and delegated it to a group, chaired by Sir John Cadogan. Sir John told us what his group has done (Q483): they called for proposals, received eight, and visited the institutions which made bids to examine the prospects of success. They have not considered the "research content" of the bids. Sir John considers that the exercise has been a success, not only in terms of distributing extra money, but also as a means of communicating "best practice", particularly in respect of technology transfer.

4.20 Sir Mark Richmond drew to our attention the statement in the Science White Paper (paragraph 3.13) that "The Government will...expect research relevant to industrial and other users to be taken into account by the Higher Education Funding Councils in their research assessment exercises". In other words, the mission of underpinning wealth creation is to apply to the HEFCs as it does to the Research Councils (QQ 858, 918-921). Sir Mark believes that the Department for Education is at present "much less seized of the importance" of this than the OST.

4.21 Here again, however, the White Paper appears to be endorsing and encouraging what is already happening, rather than saying something wholly new. The White Paper itself (paragraph 3.10) acknowledges the increase in university income from industry, from £27m in 1982-83 to

£122m in 1991-92 (see Table 2 on p 13 above). Sir David Smith, Principal of Edinburgh University, told us, "I think that universities contribute more to wealth creation than might be believed from the statements of certain politicians. That is certainly true at...the grass roots level. Quite a lot of my staff...become surprisingly entrepreneurial and look for applications" (Q650).

4.22 The last Research Assessment Exercise attempted to distinguish basic/strategic and applied research in some disciplines; but, for reasons explained to us by Professor Graeme Davies (Q248), this was not a success and is not intended to be repeated. However the operations of the Funding Councils already recognise the wealth-creation imperative in other ways, subject to the policy to limit public funding for anything "near-market" (i.e. expected to lead to commercial applications in the short term) which was Government policy until mid-1993. The HEFCs for England and Wales currently allocate 3% of R as "CR", in proportion to non-near market contract research; the Scottish formula takes account of all external research income (Q466).

4.23 The HEFCW has been charged by the Secretary of State for Wales to "have regard to his economic policies" (QQ 469, 483). In response, the Council is working with the Welsh Office, the Welsh Development Agency and other public services "to see how we can interface institutions with industry and with the public services". The SHEFC has no similar instruction; but it is cultivating relations with Scottish Enterprise (Q488, cp QQ 1070, 1102). The AFRC described assistance from the development agencies as an "interesting possibility" (p182).

4.24 There is no similar development agency for England; according to Professor Graeme Davies, "This will be to the disadvantage of the English universities" (Q293). But Dr Robinson of the DTI told us (Q560) that his department is working on ways to "improve the relationship between industry and universities in general", particularly through the Teaching Company Scheme and the activities of the new "one-stop shops". He emphasised that his department is interested in "universities as institutions", as well as in "specific research subjects, the sort of things that are bread and butter to the Research Councils".

4.25 The Chief Executives of the Welsh and Scottish Funding Councils, speaking to us just before the White Paper was published, acknowledged the value of applied research, and welcomed the fact that the limits on involving public funds in anything "near market" were to be relaxed. Professor Sizer of the SHEFC looked forward to reviewing his Council's methods in the light of the White Paper (Q480). For Wales, Professor John Andrews believed that the new policy would enable his Council to fulfil more effectively its brief to assist the Welsh economy (Q482). The Councils made it clear that by applied research they did not mean "doing some testing for some small company round the corner", let alone "actually trying to make the widgets".

4.26 Other witnesses are less enthusiastic about the rapid growth of university income from industrial contracts. The Association of Independent Research and Technology Organisations (AIRTO) (p186) regards contract research as "very much a tertiary task", which is diverting resources from the universities' main tasks of teaching and pure research; AIRTO would prefer industry to act as the universities' patron, rather than their customer. Glaxo (p207) detects a trend which would lead to "a compromising of the nature of academic science activities and the stifling of creativity". Sir Geoffrey Allen (Q515) considers that, for academic researchers, contract research "ought not to be a way of life".

Use of the block grant

4.27 In theory, the block grant is just that: an undifferentiated annual sum with which each university senate may, at the margin, do what it likes. However, the explicit funding formulas used by each HEFC now make it apparent how each block grant is split between R and T, and how much R has been "earned" by the performance of each department in the last Research Assessment Exercise (in combination with its size and discipline weightings).

4.28 Vice-chancellors and senates are under no legal obligation to take account of these figures in allocating their block grant, and some wisely retain a significant margin of discretion. The

Science White Paper itself affirms, "The universities will continue to play a vital part in sustaining basic research, at their discretion, through the resources made available to them by the funding councils" (paragraph 3.8). However, the evidence suggests (e.g. p202, Q1103) that many vice-chancellors behave as though their freedom to disregard the formula were in practice limited.

4.29 Pressure on senates to mimic the funding formulas in allocating R among departments comes from three directions. First, departments whose good performance in Research Assessment has earned the university a generous quantity of R expect to reap where they have sown. Secondly, the prospect of the next Assessment may encourage universities to foster their strongest departments, rather than resourcing the weaker ones in the uncertain hope of improving their ratings. Thirdly, the HEFCs expect universities to account to them for any significant deviation from the distribution indicated by the formula.

4.30 The HEFCs for England and Wales, in their evidence to us, stressed that, despite these pressures, their universities remain free to deploy R as they wish (HEFCE p38, Q235; HEFCW Q477). The Scottish HEFC chose to place more stress on the expectation that universities will "broadly" follow the formula, unless they can show a good reason for doing otherwise (Q472). But these are differences of emphasis; the intention of each HEFC seems to be as expressed in words from the HEFCE: "The important point is that institutions should have strategies for the use of their income which support their missions and that they should be able to account against those strategies" (p39). The HEFCs are demanding a corporate plan from each university, setting out its strategy and explaining how the proposed allocation of the block grant will support it.

4.31 One manner of exercising local discretion which the HEFCs explicitly permit is "top-slicing", i.e. distributing most of the block grant according to formula, but keeping back a "top slice" for some special purpose: HEFCE Q235, HEFCW Q477.

4.32 The use of R for T purposes (and *vice versa*) is discouraged by all the HEFCs. The HEFCE demands that any transfers from R to T should be "justifiable transfers, which reflect strategies" (Q252). Professor Graeme Davies gave us an example: the use of R to fund a taught postgraduate course (MSc) to prepare graduates for particular research. This would be "a very sound strategy, where R money was used in a T mode to sustain R" (Q253).

4.33 The HEFCs intend to enforce these directions by systems of "accountability". Professor Davies, speaking while the systems were still under development, assured us that the intention is not to create "a detailed audit process which is driven by the numerics of accountancy" (Q253). Professor Sizer, of the Scottish HEFC, similarly hopes to avoid "a detailed bureaucracy" and "a full absorption costing model for after-the-event accounting", relying instead on scrutiny through the corporate planning process of the ways research resources are managed; he intends this to involve less paperwork than was required by the UFC (QQ472-6, 500, 503). Professor Andrews, of the HEFCW, expressed horror at the thought of "people having to keep diaries to account for their time" (Q503); he intends to devise a "sensible and practical" system whereby universities will be required to account for allocation, but not for expenditure (P257)

Shortage of "seedcorn"

4.34 Departments are expected to use the R element of the block grant not only to provide well-found laboratories for Research Council-funded projects, but also as "seedcorn" to fill some of the gaps left by project-grant funding: by supporting researchers who are too young, or whose ideas are too unconventional, to attract project funding, or by tiding research assistants over between the end of one project grant and the arrival of the next.

4.35 The funding formula of the Scottish HEFC makes express provision for "seedcorn", as Professor Sizer explained (Q496): "5% [of R] is distributed on the basis of income generated by the departments in the 1 and 2 categories [of research rating]...This is a fund that is available to vice-chancellors and principals in order to support emerging areas of priority, the sort of green

shoots...that are not yet ready to be taken up by Research Councils and others." The English and Welsh formulas make no similar provision.

4.36 Sir David Smith told us how a large university like Edinburgh, strong in research, is able to "preserve good young people who have not yet got a permanent post...because you have various pots of money coming in and posts coming through. You can play the system to do that" (Q640).

4.37 But Edinburgh, as Sir David acknowledged, is in an exceptionally strong position. Witness after witness, including one of Sir David's own Professors (p213), has told us that, since the dual support transfer, seedcorn is in very short supply. According to Professor John Krebs (speaking for the Association for the Study of Animal Behaviour), dual support funding for anything not supported by a Research Council is "negligible" (p185). According to Sir Mark Richmond, dual support has "virtually broken down" (Q105, p237); according to Professor Richard Joyner of Liverpool University (speaking for Save British Science), it has "collapsed" (Q217, cp Q199). Sir Geoffrey Allen told us, "It is something that concerns many of my friends in industry" (Q523). The same concern was expressed to us by Professor Blundell of the AFRC (Q460), the ABPI (p157), Glaxo (p205) and the Royal Society (p132).

4.38 One consequence of weakness in the block grant leg of dual support is insecurity for research staff. As Professor Sizer of the SHEFC put it, "You are turning hard money into soft money" (Q502). Sir Eric Ash, Rector of Imperial College, spelled this out: "One year you may have a lot of your staff happily funded by research councils, and the next year you may have a lean year" (Q43). This contributes to the problem of the academic research career which we consider below.

4.39 Another consequence, graphically described to us by Dr Matthew Freeman, a young molecular biologist working at the MRC's Laboratory for Molecular Biology in Cambridge and brought before us by Save British Science, is the demise of the well-found laboratory, as more of the resources which would once have been the property of a whole department become tied to particular projects (Q199). Dr Freeman spoke from experience of much better-found laboratories in the USA.

4.40 Professor Davies of the HEFCE gave us further arguments for maintaining or restoring dual support (p41, QQ 233, 240). It is of particular importance to basic science which is less likely to attract project grant; and it provides the long-term stability which universities need if they are to plan, combined with flexibility to allow for local priorities and developments (cp Professor Knill Q424).

4.41 Professor Andrews of the Welsh HEFC was also emphatic in defence of R (Q501):

> "It is important for the support of young scholars, but I think that it goes beyond that. It is the money that protects the research environment within the higher education institutions. It is the core provision...that enables the department to continue between one project and another when there may be a fallow period in the money that is coming in from the research councils; it is the money that enables the department to experiment, to go off, not on frolics of its own, but on research ideas of its own which at that point in time will not tempt the research councils; and it is the money that enables the department to build up research teams, to encourage young scholars, to take on post-doctoral research fellows, to nurture young lecturers. And it is absolutely vital that that continue."

He added that block grant funding has "a leverage, in that it provides a research base" for projects funded from other sources or conducted by researchers in their own time (Q505).

The new universities

4.42 The former polytechnics now face particularly challenging choices. Polytechnics have offered PhD programmes for some 15 years (Q53). Their departments are now eligible to attract R on the same basis as departments in the old universities. As a transitional measure, the UFC adapted the rules of the 1992 Research Assessment Exercise to allow polytechnics to bring forward for rating research groups smaller than the standard "Units of Assessment"; by this means, several polytechnic departments achieved 3s and 4s, and one (Centre for Communication and Information Studies, University of Westminster) a 5 (Q282). These ratings attract "QR", the large proportion of R which is tied to departmental research ratings; though, since it is awarded in proportion to the number of research-active staff, a rating based on fewer staff attracts less QR.

4.43 The HEFCs for England and Wales have made further special arrangements for the new universities within their funding methods (p37, Q468). Each has earmarked 2% of R as "DevR", for allocation to new universities in proportion to the number of researchers in departments rated 2 or more, subject to production of "strategic plans" for using the money. They expect to phase out DevR at the next Research Assessment Exercise in 1996. The Scottish HEFC has not made similar provision (p77).

4.44 Despite the offer of DevR to new universities in England and Wales, the message from the HEFCs to the former polytechnics is that they should avoid "mission drift" (pp 40, 77, Q510). Sir David Phillips of the ABRC takes the same line (Q53).

R-T-X

4.45 The traditional university combines teaching and research in every department. But there are other models of higher education institution, including the "graduate school", with no undergraduate teaching, and the polytechnic-type institution which concentrates on teaching and does relatively little research. In a controversial report of 1987, *A Strategy for the Science Base*, the ABRC coined the notation R-T-X to express a vision of a diversified higher education sector, with some universities doing world-class research in all or most departments (R), some universities with excellent research in some departments but not in others (X), and some institutions whose main mission and strength was teaching (T).

4.46 The Government has made no express commitment to move towards R-T-X. The abolition of the binary divide might be taken to imply a desire for R-X, or at any rate a desire not to have a formal category of T. But the increasing selectivity of research funding from the HEFCs encourages universities to "play to their strengths" (CVCP p123), and offers no incentive to sustain research in a weak department. This seems to point in the direction of R-T, with a diminishing group of R. Remarks by the Secretary of State for Education at the Conservative Party Conference in October 1993 have been taken by some commentators (e.g. *Sunday Telegraph*, 10 October) to imply the prospect of no more than a dozen R universities in the whole of England.

4.47 Professor Davies of the HEFCE hopes that every university will retain at least a little research. He envisages a "spectrum" or "continuum" between R and T, with each university exhibiting "degrees of R-ness and degrees of X-ness and degrees of T-ness", and a funding method sufficiently flexible to allow each university or department to move slowly either way along the line (p40, Q283).

4.48 Professor Andrews of the HEFCW supports selectivity, and the emergence of "centres of excellence" for university research, and he expects the balance to shift towards T (Q510). However, he warns (Q501), "There are dangers that we will take selectivity to a point beyond what is desirable for the system as a whole. I say that because the system of selectivity that we have now has effectively got a ratchet built into it. The departments who are rated 5 will grow in volume, and by growing in volume they will take more and more money from the system...There is a danger that we will not be looking to the day after tomorrow in the research world".

4.49 Professor Sizer of the SHEFC is similarly wary of "aggressive" selectivity, which in his opinion would lead to "ossification" (Q509). "Green shoots do not appear necessarily always in the best departments...We do not want simply to finish up with a system that supports only a limited number of departments".

R-T-X and the Research Councils

4.50 At present, despite the protestations of the Chief Executives noted above, the pressures towards R-T come mainly from the HEFCs, and from the block-grant leg of dual support. The funding formulas give only token recognition (CR — see above, paragraph 4.22) to a department's record of attracting Research Council funding; and Research Councils, in reviewing grant applications, do not explicitly take account of the research rating of the originating department (P260). The NERC observe that to do so would amount to "completing a circular argument" (P261) since a department's record of attracting Research Council grants is a major factor in determining its research rating.

4.51 We asked each Research Council how far their funding is currently concentrated in practice (P260). The AFRC is currently funding 841 grants in 71 institutions; but the top ten institutions account for half the awards. The MRC is funding 1,212 grants in over 70 institutions, but one third of these are concentrated in Oxford, Cambridge, London and Edinburgh (this partly reflects the concentration of medical students in those cities); during 1992-93, 55% of all NERC funding went to 11 universities (NERC Annual Report, Appendix 5); in March 1993, half of the SERC's grants by number, or 60% by value, were going to 16 institutions. The ESRC might be expected to be less prone to concentration than the other Councils, because it relies less on expensive infrastructure, with the exception of libraries; however during 1991-93, 49% of all ESRC funding for research went to 12 universities.

4.52 Sir Eric Ash, speaking in the context of the abolition of the binary divide, told us, "It is up to Research Councils to make sure that, whatever drift there is,...the main funding should continue to be concentrated on the relatively small number of universities that can make best use of the resources" (Q53). Our evidence from the Research Councils indicates that some at least are well aware of this issue. The SERC is aware of the danger of "spreading its limited resources too thinly amongst a greater number of universities" (p237); it has therefore produced proposals for making a limited number of block grants on its own account (p238). In similar vein, Professor Newby of the ESRC is discussing with the Vice-Chancellors of the 15-20 universities where most ESRC-funded work is done "how the social science base can be sustained in those places" (QQ 343, 925). He is beginning to worry about "market entry": "Where you are...will in the future make a much greater difference to...your life chances as a researcher" (Q329).

The view from the universities

4.53 In June 1993, through the good offices of the CVCP, we were able to meet a representative group of three Vice-Chancellors: Sir David Smith; Professor D E N Davies of Loughborough University of Technology (who has since been appointed Chief Science Adviser to the Ministry of Defence); and Dr Clive Booth of Oxford Brookes University.

4.54 We asked first whether they felt that the funding methods of the HEFCs were over-prescriptive. None of them did. But Professor D E N Davies expressed concern that accountability, though welcome up to a point, might if taken too far amount to constraint (Q636). Sir David and Dr Booth agreed that more direction from the HEFCs would be bad for research: "the judgments of some 100 universities collectively are likely to be better than the central judgment of a few bureaucrats" (Q636); "the science base is better managed on site, not at a distance" (Q637).

4.55 The Vice-Chancellors went on to tell us how each of their universities distributes its block grant (Q639). Their approaches turned out to cover the full range of the possible. Loughborough largely follows the formula. "We believe it is important that the individual subject areas understand the criteria used to fund them so they can develop their plans in a way that optimises their funding. This also means that departments are not really in competition with each

other in their own institutions; they are in competition with other departments of the same sort within the whole university sector."

4.56 Edinburgh, on the other hand, rejects formula funding, "because that will be an abrogation of management". Instead the university decides each year between costed plans from each department on the basis of a long-term university strategy. Oxford Brookes takes a middle way, allocating part of its grant according to the formula and the rest by means of an internal competition. The CVCP confirmed that all universities are now selective in their distribution of block grant, but that there is no consensus on the best way to do it (p123).

4.57 On the merits and consequences of selective research funding, the Vice-Chancellors offered us three different views (Q640). Edinburgh, as a large university with a tradition of excellent research in many fields, is doing well out of selectivity; but Sir David warned that "a function of all universities is to try to encourage and nurture very able young people regardless of their discipline. We cannot forecast at age 23 what will be the hot subject at age 43 when those people are reaching their peak." He also pointed out that the current funding methods discourage collaboration between departments of different universities, though such collaboration can be beneficial, particularly to a new university trying to develop a research tradition.

4.58 Like Sir David, Professor D E N Davies regards selectivity as a good thing; he also considers it inevitable given the end of the binary divide. But he warned of trouble in store when the rise in student numbers, and the extra money which comes with them, come to an end. Dr Booth sees the case for selectivity only in areas of research which are particularly expensive; he fears that selectivity across the board will nip in the bud research in the new universities like his own.

Research assistants and academic careers

4.59 Research assistants may have a postgraduate qualification, or be studying for one; but they are paid out of the grant funding the project on which they are working, rather than receiving individual support as postgraduate students. According to the Science White Paper (paragraph 7.26), the number of young researchers working in universities on short-term contracts as research assistants doubled over the 1980s.

4.60 The White Paper acknowledges widespread concern over the lack of secure long-term career prospects for most of these young scientists, and this concern is echoed by many of our witnesses. The SERC (p236) told us of "quite senior staff living hand to mouth from one short-term contract to another". Professor Malcolm Jeeves of St Andrew's University (Q1103) spoke to us of "a large amount of untapped talent which is now slipping out of the system". Similar concerns were expressed by Sir David Phillips (Q87), Sir Geoffrey Allen (Q523), Sir David Smith (Q645), the Royal Society (p131) and the Wellcome Trust (P200).

4.61 We received the same message when we met panels of young practising researchers at Westminster and in Edinburgh in the course of our inquiry. They told us of the struggle to build a reputation in a single field while constantly looking to new sources of support with new priorities and demands; of the time diverted from creative research into making applications; of the confidence-sapping insecurity of one- or two-year posts; and of the galling awareness that competitors overseas are better supported. They did not ask for old-fashioned tenure; only for the chance to spend four or five of their most creative years in reasonable security, so as to concentrate on work which might qualify them for a senior position in due course.

4.62 The White Paper says (paragraph 7.31):

(i) The Research Councils must monitor and take into account universities' systems of career development for research assistants.

(ii) The Research Councils must "help universities to increase career openings" for research assistants by giving longer-term grants, or larger grants which the university can top-slice.

(iii) The Research Councils must see that the "principal investigator" in a grant-supported project does not delegate too much of the project to research assistants.

(iv) The Research Councils must consider a shift in mode of funding away from funding specific projects and towards "fellowship" funding of individuals.

4.63 Items (i) and (iii) are uncontroversial matters of good practice, and several of our witnesses spoke in favour of item (iv) (NERC p230, Royal Society p131, ABPI p159, Glaxo p206). Several particularly commended the 200 university research fellowships distributed by the Royal Society (Sir David Phillips Q87; Sir Geoffrey Allen QQ 523, 541; Professor M A Jeeves Q1103): currently about 30 of these are awarded each year, for periods of up to 10 years. In July 1993, the ESRC launched a new scheme for 4-year half-funded junior fellowships, and one-year senior fellowships; other Research Councils have similar small schemes. The Wellcome Trust (P200) provides "career funding" for clinical scientists, and is currently working on a similar scheme for "key individual basic biomedical scientists".

4.64 Item (ii), however, has an ironic ring when read against the body of evidence we have received concerning the capacity of university departments to support researchers not working on a grant-funded project: see above, paragraph 4.37. It would not be necessary to contemplate "top-slicing" Research Council grants if the block grant had not been "bottom-sliced" by the Dual Support Transfer (Q645, p228).

RESEARCH COUNCIL INSTITUTES ETC.

4.65 The Research Councils do not put all their money into grants to university researchers. They also operate a range of funding modes at various distances from the universities: independent institutes of their own, institutes or units more or less closely connected with a university (e.g. the NERC's new Institute of Oceanographic Science in Southampton), "interdisciplinary research centres" (IRCs), and facilities (e.g. the SERC's Daresbury and Rutherford Appleton laboratories) or subscription to international facilities (e.g. CERN and ESA) for the use of researchers from universities or elsewhere (NERC p227).

4.66 The ESRC currently has no directly-employed research staff, and no plans to create institutes (Q925). Instead it funds Research Centres, currently 19 of them, within universities, and Research Programmes, currently 34, which involve researchers working in different places on related projects. By these means it acts as "a countervailing force" against the "discipline-bound" structure of universities, and can "create research communities which are not there because of the way in which the universities themselves are organised" (QQ312, 328).

4.67 Institute funding may be directed ("top-down") or responsive ("bottom-up"), or a bit of both. Some is clearly directed, as when a Council wishing to tackle a particular problem sets up a unit with that as its mission (Q14). An IRC may be set up to direct attention to a new scientific opportunity (e.g. warm superconductors), or to encourage response in an important area "perceived to have languished in this country and to need reviving" (e.g. polymer chemistry — Q83), or "in areas of science that were neglected in the university system, because they crossed traditional disciplinary boundaries or were...in fields where there was little emphasis on teaching" (MRC p111, Q607, cp NERC Q394). The NERC and the AFRC have devised the "community research programme", whereby a set of problems is defined, and bids for funding to work on them are invited from institute staff and university researchers on equal terms (QQ 84, 385, 455, 923-5).

4.68 Funding modes are a matter for each Research Council; but, according to Sir David Phillips, "Over the years the trend has been away from institute research towards more research in universities" or closely associated with them (Q83; see also SERC p238; AFRC Q433, p183; MRC

p111, Q611 and p113, Q605 on how they turned the Clinical Research Centre at Northwick Park into a new Clinical Research Initiative involving several universities). One practical reason for this trend is that pensions for retired institute staff are taking an increasing share of Council budgets: 5% for the NERC (p228), and in the case of the AFRC, the worst affected Council, more than 10%.

4.69 Professor Newby of the ESRC (QQ 342-359, 858) pointed to the increase in the number of undergraduate university students (in the social sciences more than the natural sciences), and the consequent increased teaching load for staff. In his opinion, there may come a time when "increasingly universities are not places where we can fund leading-edge research". Whether this happens will depend on the Research Councils' success in co-operating with the universities which matter most to them to sustain research in the relevant departments: see above, paragraph 4.52. If they fail, their next recourse might be a swing back towards institutes.

4.70 The institutes do not rely entirely on funds and commissions from their parent Councils; they are able to attract contracts from external customers, and are doing so to an increasing extent. The AFRC has more than doubled its external income since 1986-87 (p181).

4.71 The NERC's institutes receive over half their income in this way (QQ 396-404, p228), and the Council is not altogether content with this position. To the extent that contract work is "a bolt on to our science budget objectives", it can provide "value added" to the Science Budget. However contracts tend to be of short duration and for applied research; this produces insecurity for the institutes, and threatens to erode "the health of the basic underpinning science".

4.72 The Science White Paper (paragraphs 5.12-13) announces that all public sector research establishments are to be considered for privatisation. Mr Waldegrave told us (Q35) that "the bricks and mortar are not what I am interested in so much as the science output". The NERC (p229) hope that their institutes will be exempted from scrutiny; but the Government have given no indication that they intend to treat Research Council laboratories on a different footing from departmental laboratories in this context.

The wider Science Base

4.73 It is the firm view of Sir Mark Richmond that the Science Base is getting wider (QQ 88-94, 848-862). It was once the mission of the Research Councils to support research in universities or to do it themselves; even before the White Paper, the mission of the SERC had been shifted by a series of Government initiatives (eg Alvey, LINK) towards supporting "excellent research to underpin industry and commerce", wherever it might be found; the White Paper makes this shift explicit. The SERC was already funding work conducted in the institutes of other Councils; its successors are now obliged, in Sir Mark's view, to receive applications from Government research laboratories, and other laboratories of a public nature including privatised ones, though probably not from the out-and-out private sector. The DTI favours this development (p243). Sir Mark accepts the consequence that, overall, the universities are bound to get less.

4.74 According to Dr Brian Jamieson of the AFRC (QQ862-4), pressure to receive applications from laboratories in the "twilight zone" between the academic and private sectors comes from Government, and applies equally to all the Councils. He considers that, if this is to happen, a level playing field will have to be created to accommodate researchers who benefit from dual support and researchers who do not. Dr John Mulvey, Secretary of Save British Science, points out that though university researchers benefit from dual support, they have responsibilities for teaching and training which must also be taken into account (Q184).

4.75 The Royal Society makes the case against extending the Science Base in this way (p133, Q667). The Research Councils do not exist to "buy" specific pieces of knowledge; this idea arises from "a conceptual confusion between grants and contracts". Dr John Lackie directs the Yamanouchi Research Institute in Oxford, and might be expected to be first in the queue if Research Council money were made available to the private sector; but he made it clear that he

would not welcome any such move, which could only weaken the university sector and diminish the "pool of speculative exploratory work" which his Institute exists to dip into (Q1060).

CONCLUSIONS

Universities

4.76 The binary divide has in reality moved not out but up. Demand for R has increased with the involvement of the new universities, but the amount available has not. Spreading it too thinly would only create "equality of misery". In this situation, **we are wholly in favour of a degree of selectivity in research funding by means of block grant**. The resources currently available to science from Government will perhaps support no more than about 15 universities with a high reputation for research across the board, and another 15 or so with excellence in several departments.

4.77 However we are concerned that an R-T-X or R-T model should not be applied to university research in a formal or prescriptive way. Defining an exclusive group of R universities would have serious consequences.

— It would amount to a charter for creeping mediocrity. As Dr John Lackie put it (Q1050), "If we go for a highly inbred and highly successful Science Base, then if the game changes we will be in serious difficulty"; we would only add that the game of science is changing all the time. Experience shows that even departments with long and distinguished traditions can run out of ideas, and they should not be protected from the consequences. Likewise, the history of the last 10 years shows that "hot spots" of excellent research can arise even in institutions whose research activities are marginal, and that such a university, under the right management, can if it chooses emerge fairly quickly as a major research centre. Defining a group of R universities would allow the best to rest on their laurels, without permitting the fostering of excellence which might emerge elsewhere.

— If standards were kept high, the size of the R group would be bound to diminish. As Professor Andrews of the Welsh HEFC put it, "The system of selectivity that we have now has effectively got a ratchet built into it" (Q501). Every now and then one of the R universities might drop out of the charmed circle; but it would be very hard for a T institution to break into it. We may compare the situation which would arise if only teams in the Premier League were allowed to play football, the others being permitted only to watch.

— Concentration in an exclusive group would run counter to the nature of much of the best British science. As Professor Alec Jeffreys reminded us (p222), this finds its strength in "the imagination and ingenuity of the lone scientist or small research group". The Chemical Industries Association told us (p155), "Much of the research which is conducted within the higher education sector, which is valuable to the chemical industry, is small scale research, performed by individuals or groups in large and small institutions which may or may not be highly rated"; they point for confirmation to the tendency for support by their members for university research to go to individuals rather than institutions. The principle is amply confirmed in respect of other disciplines by an examination of the roll of British Nobel laureates since the war.

4.78 **The university Science Base must not be allowed or encouraged to become inflexibly concentrated in this way**. To this end:

— **"Hot spots" of excellent research in institutions whose main activity is teaching must be identified and sustained.** This could be achieved by perpetuating the transitional measures introduced to encourage research in the new universities (see above, paragraph 4.42), but making them applicable to all universities.

— **The Research Assessment method must be adjusted so as to encourage collaboration between departments,** rather than penalizing it as at present (paragraph 4.57).

— **The Research Councils should not take concentration of their own funding any further than it has gone already** (paragraph 4.51), but should continue to support excellent projects at a broad range of institutions.

4.79 These are concerns for the medium to long term. In the short term, flexibility can be achieved at local level by imaginative use of discretionary or "seedcorn" resources to foster young research talent and new ideas whose worth is apparent to the department but not yet appreciated by the appropriate Research Council. We are concerned by evidence that seedcorn is in short supply (see above, paragraph 4.37), through the combination of formula funding and the Dual Support Transfer.

4.80 We have taken it as axiomatic for the purposes of this inquiry that new money is not an option; and, though the White Paper commits the Government to taking the Dual Support Transfer no further, it is unrealistic to expect them to put it altogether into reverse. Nonetheless, in our view the only possible source of seedcorn funding is the block grant.

4.81 **The HEFCs must see that their funding methods and accountability systems leave room for local discretion.** This provision should not be restricted, as in Scotland, to 5- and 4-rated departments; it is precisely in weaker departments that young talent is more likely to require extra help. But ultimate responsibility rests with management within the university, and particularly with the vice-chancellor. **Vice-chancellors must make full use of their discretion to top-slice the R element of the block grant** (paragraph 4.31), and use the funds thus released in imaginative ways focused on the encouragement of their best young researchers.

4.82 The White Paper's proposal that additional discretionary funds might be provided by inflating project grants from the Research Councils is bizarre (paragraph 4.64). **If the Dual Support Transfer has left the Research Councils with more money than they need to fund the full cost of their projects, then the surplus should be returned to the HEFCs for distribution as block grant.**

4.83 On the other hand, **we warmly welcome the White Paper's commitment to increased support for people as opposed to projects.** Too much time and talent is currently going to waste as the best young scientists waste their most creative years in chasing money, or simply give up.

Research Council institutes

4.84 We are concerned by evidence (paragraph 4.70) that the institutes maintained by the Research Councils may be becoming over-dependent on contract income, to the detriment of their basic research programmes. **We urge the Councils to monitor this tendency, and if necessary to include in their contract prices a modest surcharge to contribute to the cost of other longer-term work.**

4.85 We see nothing to fear in scrutiny of Research Council institutes for possible privatisation (paragraph 4.72), provided that the scrutiny is conducted with intelligence. **The scrutineers must appreciate the value of the institutes' basic research programmes, and must assess the level of support which these can expect from the commercial user community.**

The wider Science Base

4.86 In this climate, it would be the final straw if the Science Base were forced to share the Science Budget with the private or semi-private sector (paragraph 4.73). It might be possible to "buy" research more cheaply from institutions without the university overheads related to teaching and research training; but this would be an altogether false economy, and would further undermine the capacity of the Science Base to contribute to the health and wealth of the nation in the long term. **We recommend that the Research Councils set their faces firmly against any extension of their present funding field.**

CHAPTER 5 A NATIONAL STRATEGY FOR THE SCIENCE BASE?

5.1 The Government now has an opportunity to build a more comprehensive strategy for science, engineering and technology than ever before. The Research Councils are to some extent subject to a Director-General answerable to a Minister for Science; university departments are accountable to the Funding Councils as never before; the Forward Look may bring some order, or at least more transparency, to the science programmes of other Government departments; and private sector science may be brought into a degree of partnership by means of the Foresight exercise and the Council for Science and Technology.

A strategy or an overview?

5.2 Most of our witnesses agree that some degree of "overview" for the Science Base is desirable, particularly when resources are limited (e.g. CVCP p121, RAEng p143, Royal Society of Chemistry P249, AFRC p181). So many decision-makers contribute to the emergence of priorities that failure of communication may otherwise cause resources to be wasted or important opportunities to be missed.

5.3 But most of our witnesses are wary of the word "strategy" (e.g. Sir David Phillips Q9). Any suggestion of top-down direction is widely felt to run counter to the nature of scientific research, which relies so heavily on the enthusiasm and inspiration of the individual. Similarly, most people we have spoken to are content with the current plurality of sources of funding for the Science Base, subject to provision for an overview: it is generally felt that plurality reduces the chance that an important idea will go altogether unfunded (e.g. MRC p111, AFRC Q439, p181, MAFF p184, SERC p236, NERC p226, ABPI p161, Institute of Biology p212, Wellcome Trust Q943).

5.4 People are the primary asset of the Science Base, and, in the eyes of our witnesses from a range of industries, its most important output. Yet no-one is compelled to be an academic research scientist, and no-one does it for the money. So what is it that attracts bright young people to research careers in the Science Base?

5.5 We have met fairly representative groups of talented practising scientists on two occasions in the course of this inquiry, in March 1993 at Westminster and in November 1993 in Edinburgh. They gave us an answer to this question, which is summed up by Professor Miles Houslay of Glasgow University (p209):

> "Academics are geared to following research ideas that most excite them in essentially a 'blue skies' fashion; hence new ideas arise. Usually this is why people stay in academia rather than industry, i.e. they do not wish to be directed."

Sir David Phillips shares this perception:

> "It is a matter that the scientific population gets to be very concerned about if it thinks that there is too much drift away from purely responsive work into directed mode work, so we [ABRC] are very sensitive to that" (Q83).

5.6 Any strategy for the Science Base which is not sensitive to the human factor will fail, if the best young scientists are not attracted by it. They are not likely to be attracted by a research environment which is as directive as an industrial laboratory, or even more so.

5.7 **If the Government's new strategy for the Science Base is so directive that it leaves no space for a keen young scientist with a new idea, then it will defeat its own object, by starving the Science Base at its roots.** This would have serious consequences for British industry in the long term; and our evidence shows that industry is well aware of this (paragraph 2.57). Their remarks to us indicate that the main players in Government are aware of it too, in theory; they must translate this awareness into practice as the strategy unfolds.

A strategy to serve the needs of user communities?

5.8 The White Paper makes it clear that the Government wants a strategy which ties the priorities of the Science Base more closely to the needs of its "user communities", and in particular those that create national wealth, by which they mainly mean manufacturing industry, and improve the quality of life.

5.9 We are concerned that the needs of the user communities should be interpreted in a broad sense. The concept must not be confined to short-term needs for answers to specific questions; the users ought to find these for themselves from their own laboratories, or at least to pay for them if they must seek them from the Science Base. **The priorities for the Science Base ought to be longer-term needs, for a resource of fundamental knowledge and a source of researchers trained to international standards**. How far these needs will be met by work with immediate applications will vary from subject to subject.

5.10 Our recommendations in Chapter 3 above are intended to secure this focus on long-term, rather than short-term, user needs:

— **The new Director-General of Research Councils must be given real authority, by means which might include an unfettered right to publish his advice to the Minister, a slice of the Science Budget at his own disposal, adequate resources for any expert group and authority over Research Council boundaries and missions** (paragraphs 3.57-64).

— **In particular, the DGRC must be charged to see that the interests of basic science are not unduly subordinated to those of more obviously or immediately applicable or "appropriable" research** - though we have suggested a way in which the cost of UK participation in high-energy particle physics could be constructively reduced (paragraph 3.62).

— The Foresight exercise, if it reaches the parts of industry which have until now shown little interest in long-term research, may be of great value as a means of creative networking and as a source of information for priority-setters. But **the process of making contacts is all-important, and must not be allowed to dwindle as the exercise becomes more established**. Reports emanating from the exercise will be interesting and important; but **their conclusions must not be allowed to shape the Science Budget in a short-term or top-down way, or to dominate peer review at the expense of sheer scientific excellence** (paragraphs 3.67-70).

5.11 The White Paper calls for this new focus for the Science Base to be brought about by means of a partnership involving science, industry and Government; but only the first of these can be commanded by the OST. We are concerned by evidence that, while science has already moved a long way to meet the needs of the other two partners, the others show few signs of being willing to move at all. **A one-sided partnership would in the long run work against the interests of all concerned.**

5.12 Our recommendations in Chapter 2 above are intended to prevent this outcome:

— **The response of industry must be monitored closely by the OST** (paragraph 2.75).

— **The Chief Scientific Adviser must be given a degree of authority over the science spending plans of Government departments, by relating the new Forward Look process to the PES procedure, and by giving the CSA the right to comment both at the highest level of decision-making and in public** (paragraphs 2.78-79).

— **Research Councils must be allowed to participate reciprocally in departmental science planning** (paragraph 2.80).

5.13 The 1980s witnessed the continued decline of the British manufacturing base. It would be unfortunate if in the 1990s, partly in a belated attempt to revive manufacturing, the Government managed to send the United Kingdom's world-class Science Base into decline. This need not happen, if the Government take a long-term view of what the real needs of industry and their own departments are, and if they do not ask the Science Base to deliver more than lies within its power.

A strategy for university research

5.14 In our view, the aspect of the Science Base which calls most urgently for strategic thinking is the future of research in universities. Yet the Science White Paper here offers no strategy, but only a new and necessary forum for strategic thinking, the new Science and Engineering Base Co-ordinating Committee. **We welcome the creation of this Committee**; it has urgent work to do.

5.15 As explained in Part 4 above, the policies of the HEFCs (research rating, formula funding and accountability) may concentrate university research and research training in a defined, exclusive and diminishing group of "centres of excellence". **We recommend that the new Co-ordinating Committee address this situation as a matter of urgency, with a view to preventing inflexible concentration. We offer them our own proposals, as set out in Chapter 4** (paragraph 4.78):

— **"Hot spots" must be identified and rewarded.**

— **Collaboration between departments must be encouraged.**

— **Research Council funds must continue to be available to a wide range of Science Base institutions, to fund excellence wherever it continues to be found.**

5.16 Chapter 4 also sets out our concern that the human resources of the university Science Base are going to waste for lack of a proper academic career structure, and we welcome the White Paper's proposals in this respect. **We commend the new commitment to funding individual fellowships, and we look forward to seeing this carried forward on a large scale.** We note that the university sector is expecting a large number of retirements from senior posts in the next 10 years (QQ 645, 1105, P201); these measures will help to ensure that, when those posts fall free, the right people are still in the system and ready to fill them.

5.17 However, direct funding of individuals from the Science Budget is not all that is required. The university Science Base is best managed locally, by the universities themselves and their departments, who are in a better position to identify and encourage young talent than central funding bodies acting at one remove from the conduct of research. We recommend:

— **The HEFCs must modify their funding formulas to safeguard a discretionary or "seedcorn" element within the R part of the block grant, and vice-chancellors must make imaginative use of it** (paragraph 4.81).

— **Rather than providing discretionary funds as an increment on project grants, the Research Councils should return any surplus resources to the HEFCs** (paragraph 4.82).

A strategy for Research Council science

5.18 The Research Councils must continue to fulfil their over-riding mission to sustain the national resource which we have called the Science Base. To this end:

— **Research Council institutes must maintain their programmes of long-term basic research** (paragraph 4.84).

— **The Research Councils must not make their funds available to organisations in the private or semi-private sector** (paragraph 4.86).

A strategy for the Science Base

5.19 We have come a considerable distance from the starting point of our inquiry. But the issues of concentration of university research, careers for young researchers and the Research Councils' responsibilities for basic science call for urgent strategic thinking. If none is forthcoming, then the Science Base may go into decline; if that were to happen, then how priorities are chosen for its activities would become a matter of merely academic interest.

APPENDIX 1

Sub-Committee I - Priorities for the Science Base

The members of Sub-Committee I were:

L. Butterworth
L. Chorley
L. Dainton
L. Dean of Beswick
L. Flowers (Chairman)
B. Perry of Southwark
L. Porter of Luddenham
E. Selborne
L. Tombs

The Sub-Committee appointed as their Specialist Adviser: Dr Peter Collins, of the Royal Society.

APPENDIX 2

List of witnesses

The following gave evidence. Those marked * gave oral evidence.

* Advisory Board for the Research Councils
AEA Technology
* Agricultural and Food Research Council
Ministry of Agriculture, Fisheries and Food
* Professor Sir Geoffrey Allen FRS
Association for the Study of Animal Behaviour
* Association of the British Pharmaceutical Industry
Association of Independent Research and Technology Organisations (AIRTO)
Association of Medical Research Charities
Association of Researchers in Medicine and Science
British Aerospace
British Gas
* British Technology Group
British Telecom
Celltech Research Ltd
* Chemical Industries Association
* Committee of Vice-Chancellors and Principals
* Confederation of British Industry
Ministry of Defence
Professor Peter Dunnill
* Economic and Social Research Council
Edinburgh Centre for Rural Research
Department of the Environment
Glaxo Holdings plc
* Department of Health
* Higher Education Funding Council for England
* Scottish Higher Education Funding Council
* Higher Education Funding Council for Wales
Professor Miles Houslay
Institute of Biology
Institute of Ecology and Resource Management
Institution of Electrical Engineers
Institution of Professionals, Managers and Specialists (IPMS)
Professor Alec Jeffreys
* Dr John Lackie
Professor J B L Matthews
* Medical Research Council
National Office of Animal Health
* Natural Environment Research Council
* Sir Mark Richmond
* Royal Academy of Engineering
Royal College of Physicians
Royal College of Physicians of Edinburgh
* Royal Society
Royal Society of Chemistry
* Royal Society of Edinburgh
* Save British Science
* Science and Engineering Research Council
Scottish Office
Dr J B Searle
Sharp Laboratories of Europe Ltd
Thorn EMI plc
* Department of Trade and Industry
* Wellcome Trust

APPENDIX 3

Acronyms and Dates

Government bodies

OST	Office of Science and Technology
CSA	Chief Scientific Adviser
ACOST	Advisory Council on Science and Technology (*wound up October 1993*)
CST	Council for Science and Technology (*appointed October 1993*)
ABRC	Advisory Board for the Research Councils (*wound up 1 January 1994*)
DGRC	Director-General of Research Councils (*starts work 1 January 1994*)
EDS	Cabinet Committee on Science and Technology
DTI	Department of Trade and Industry
MAFF	Ministry of Agriculture, Fisheries and Food

Research Councils

Up to 1 April 1994

AFRC	Agricultural and Food Research Council
ESRC	Economic and Social Research Council
MRC	Medical Research Council
NERC	Natural Environment Research Council
SERC	Science and Engineering Research Council

From 1 April 1994

BBSRC	Biotechnology and Biological Sciences Research Council
ESRC	As before
EPSRC	Engineering and Physical Sciences Research Council
MRC	As before
NERC	As before
PPARC	Particle Physics and Astronomy Research Council

HoRCs Heads of Research Councils (ie executive heads, whether referred to as Chairman as in ESRC and SERC, Director-General as in AFRC, Chief Executive as in NERC and all the new Councils, or Secretary as in MRC)

Higher Education Funding Councils (HEFCs)

HEFCE	HEFC for England
HEFCW	HEFC for Wales
SHEFC	Scottish HEFC

R and T

These terms have two different uses in the context of higher education. First, they refer to the Research and Teaching elements of the block grants distributed to universities by the HEFCs. In this sense, R is composed of QR, CR, DevR etc: see paragraphs 4.14, 22, 43.

R and T also refer to the model of higher education described in paragraph 4.45, where R is a university strong in research and T is a mainly teaching university. X is a university with research strength in some departments.

"R&D" stands for research and development.

Other significant dates

April 1994	First Forward Look published.
December 1994	First Technology Foresight report published.

Other acronyms

ABPI	Association of the British Pharmaceutical Industry
BTG	British Technology Group
CBI	Confederation of British Industry
CERN	European Particle Physics Laboratory
CIA	Chemical Industries Association
CVCP	Committee of Vice-Chancellors and Principals
ESA	European Space Agency
MTD	Marine Technology Directorate Ltd
PES	Public Expenditure Survey
RAEng	Royal Academy of Engineering
UFC	Universities Funding Council

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