PREM 19/1369

PART 1

CONFIDENTIAL FILING

Maintaining the Strength of the Science Base.

Science Budget

SCIENCE AND TECHNOLOGY

SEPTEMBER 1983

Referred to	Date	Referred to	Date	Referred to	Date	Referred to	Date
~~0.9.83~~		~~2.7.84~~					
~~4/10/83~~		~~7.8.84~~					
~~8.10.83~~		30.7.84					
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1984 Annual Review of Government
Funded Research and Development.
(– See Folder at back of ~~this~~ file).

PART 1 ends:-

DB to MOD 30.7.84

PART 2 begins:-

DB to PM 2.8.84

TO BE RETAINED AS TOP ENCLOSURE

Cabinet / Cabinet Committee Documents

Reference	Date
MISC 99(83) 7	25/10/1983

The documents listed above, which were enclosed on this file, have been removed and destroyed. Such documents are the responsibility of the Cabinet Office. When released they are available in the appropriate **CAB** (CABINET OFFICE) CLASSES

Signed J. Gray Date 3/10/2013

PREM Records Team

Published Papers

The following published paper(s) enclosed on this file have been removed and destroyed. Copies may be found elsewhere in The National Archives.

Department of Education and Science: Press Notice 44/84 – More Money Needed for New Science Research, Says Report.

Scientific Opportunities and The Science Budget: a report to the Secretary of State for Education and Science from the Advisory Board for the Research Councils.

Signed J. Gray Date 3/10/2013

PREM Records Team

file KG

10 DOWNING STREET

From the Private Secretary

30 July 1984

MAINTAINING THE STRENGTH OF THE SCIENCE BASE

The Prime Minister was grateful for the notes from your Secretary of State and the Secretary of State for Education and Science in response to my letter to you of 23 May.

The Prime Minister has noted your Secretary of State's view that the expenditure of an additional £20 million per annum in universities and Research Councils would mean that no "basic" research was carried out within research establishments and acknowledges that establishments, if they are to maintain high scientific standards, need to include some work of a longer-term nature in their programmes. She would, however, expect there to be a spectrum of work in the establishments ranging from the "basic" and long-term to the highly applied and short-term. While accepting that most research potentially suitable for university and Research Council laboratories will be found at the "basic" end, she conisders that other work, some of which may in turn stimulate a need for more fundamental studies, will be found elsewhere in that spectrum.

The Prime Minister has further noted that there is reasonable overlap between the list put forward by your Secretary of State of subject areas where MOD could in principle make greater use of external expertise and the subjects that the Secretary of State for Education and Science considers would most interest the Research Councils.

The Prime Minister takes the view that the response from the Secretary of State for Education and Science has demonstrated that there could be some advantages in transferring £20 million per annum to the Science Vote. But she recognises that there could also be disadvantages. Accordingly, the Prime Minister has asked that Dr. Nicholson, with the aid of the Chief Scientific Adviser, MOD and the Chairman of the ABRC, should examine the proposal more closely with a view to clarifying the way in which such a transfer of responsibility for research could be carried out, the methods which could be used to maximise the advantages

/and minimise

MK

and minimise the disadvantages, and the likely outcome in terms of the strength of the scientific base of the country as a whole and the MOD'S ability to use this base to fulfil its responsibilities for the defence of the country.

I am sending copies of this letter to Elizabeth Hodkinson (Department of Education and Science), and to Richard Hatfield and Robin Nicholson (Cabinet Office).

(DAVID BARCLAY)

Richard Mottram Esq.,
Ministry of Defence.

CDL

Please type this

Dub 30/7

CONFIDENTIAL

Prime Minister (4)

Agree attached letter?

Dub 25/7

W.0487

25 July 1984

MR BARCLAY, NO 10

Yes mb

MAINTAINING THE STRENGTH OF THE SCIENCE BASE

You asked for advice on the responses of Mr Heseltine and Sir Keith Joseph to the questions posed in your letter of 23 May on a hypothetical transfer of £20 million pa from MoD intra-mural establishments to universities and Research Councils.

2. An analysis of certain aspects of the responses is given in the Annex. My own conclusions, which are inevitably coloured as much by my general views of the relative performance of MoD laboratories and University/Research Council laboratories as by the responses themselves, are as follows:

(a) Mr Heseltine has propounded a case based on minimal overlap between MoD and DES funded work using the definitional and organisational peculiarities of MoD to substantiate this. The argument is fallacious and Sir Keith Joseph's proposition that there is a substantial slice of MoD work which could be done in universities and Research Council laboratories is persuasive. I would estimate the size of the slice at £100 m pa so a £20 m pa transfer seems a sensible level to look at.

(b) Mr Heseltine has ignored the deteriorating situation in MoD laboratories and the very real possibility that without an injection of vigour and scientific competition from universities and Research Councils they are likely to be unable to deliver the scientific goods to the Services in the future.

(c) Sir Keith Joseph has made clear that if MoD funds were to be transferred to the Science Vote, he has ideas on how to ensure that a closer relationship between MoD and University and Research Council scientists would follow.

(d) The hypothesis that a transfer of funds would lead to an improved quality of research is supported by the comments in Sir Keith Joseph's response and by the absence of effective counter-arguments in Mr Heseltine's. The same can be said for the hypothesis that a transfer would also lead to broader application of research results.

3. Thus the correspondence has supported the view that a transfer of funds would be beneficial on a national basis. But MoD clearly do not yet accept this.

4. The way forward could be through a meeting between the Prime Minister and the two Secretaries of State but I am not satisfied that we yet have enough effective ammunition to offer the Prime Minister for such a meeting. Sir Keith Joseph proposes a meeting of officials with my 'help and oversight'. The danger here is that MoD would simply stonewall. My preference would be that the official group should meet with a strong steer from the Prime Minister to flesh out the method of transfer and its consequences, leaving open whether or not the transfer will be made.

5. In case this way forward appeals, I enclose a draft Private Secretary's letter.

6. I am copying this minute to Sir Robert Armstrong.

RBN

ROBIN B NICHOLSON
Chief Scientific Adviser

DRAFT LETTER FROM THE PRIVATE SECRETARY TO THE PRIME MINISTER TO THE PRIVATE SECRETARY, SECRETARY OF STATE FOR DEFENCE.

MAINTAINING THE STRENGTH OF THE SCIENCE BASE

The Prime Minister was grateful for the notes from your Secretary of State and the Secretary of State for Education and Science in response to my letter to Richard Mottram of 23 May.

The Prime Minister has noted your Secretary of State's view that the expenditure of an additional £20 million pa in universities and Research Councils would mean that no "basic" research was carried out within research establishments and acknowledges that establishments, if they are to maintain high scientific standards, need to include some work of a longer-term nature in their programmes. She would, however, expect there to be a spectrum of work in the establishments ranging from the "basic" and long-term to the highly applied and short-term. While accepting that most research potentially suitable for university and Research Council laboratories will be found at the "basic" end, she considers that other work, some of which/may ~~in~~ turn stimulate a need for more fundamental studies, will be found elsewhere in that spectrum.

The Prime Minister has further noted that there is reasonable overlap between the list put forward by your Secretary of State of subject areas where MoD could in principle make greater use of external expertise and the subjects that the Secretary of State for Education and Science considers would most interest the Research Councils.

The Prime Minister takes the view that the response from the Secretary of State for Education and Science has demonstrated that there ~~would~~ could be some advantages in transferring £20 m pa to the Science Vote. ~~but~~ But she recognises that there ~~are~~ could also be disadvantages. Accordingly ~~she~~ the Prime Minister has asked that Dr Nicholson, with the aid of the Chief Scientific Adviser, MoD and the Chairman of the ABRC, should examine the proposal more closely with a view to clarifying the way in which such a transfer of responsibility for research could be carried out, the methods which could be used to maximise the advantages and minimise the disadvantages, and the likely outcome in terms of the strength of the scientific base of the country as a whole and the MoD's ability to use this base to fulfil its responsibilities for the defence of the country.

I am sending copies of this letter to Elizabeth Hodkinson (DES) and to Richard Hatfield and Robin Nicholson (Cabinet Office).

D J Wood [signature]

ANNEX

1. The first point to make is that the need for the Annual Review of R&D, with its common definitions of different types of research, is amply demonstrated by the inconsistent and selective use of expenditure data in both minutes. Mr Heseltine's minute is particularly loosely worded, since he refers to MoD spending £20 m on "basic" research, split 50:50 between the establishments and universities, whereas the MoD's own submission to the Annual Review showed MoD spending nothing on basic research. I imagine that Mr Heseltine is actually referring to work with a long time to application, but not undertaken purely with the aim of adding to knowledge - eg, strategic research. Such work is extensively supported in the university and Research Council system; further, it blurs imperceptibly with the more applied research carried out in the establishments.

2. Mr Heseltine sets out in his third paragraph sound criteria for deciding where work should be carried out. In particular, the closer the foreseen application, the more need there will be for close contact with Service staff and, probably, the greater the security constraints. However, for the reason set out above, I cannot believe that the pool of available work for universities is confined only to the £10 million that he claims is at present spent on long-term work. I am convinced that there is a considerable segment of the £200 million spectrum of intra-mural expenditure which parallels university and Research Council work. Thus the transfer of the £20 million pa would not therefore mean the end of all the long-term, intellectually stimulating work which Mr Heseltine sees, correctly, as an important factor in maintaining the vigour of research establishments.

3. Moreover, I think he glosses over some of the problems that are currently affecting the establishments and which impair their ability both to maintain high scientific standards and to assist the translation of their work into civil fields. They have been considerably affected by the constraints on Civil Service recruitment and as a result have found it difficult to deploy staff in new fields. Universities are also affected by the same problems but through the use of short-term

contracts, the natural flow of post-graduate students and the "new blood" posts, they can more easily inject some flexibility into their research efforts. MoD establishments, furthermore, are not competitive in pay when seeking to attract high quality recruits in high technology areas for the few posts that are on offer. Again, universities have problems of a similar nature but their high quality staff can supplement academic salaries by industrial consultancies. All this suggests to me that, unless policies on the staffing of MoD research establishments are to change markedly in the near future, which seems unlikely, MoD will have great difficulty in maintaining the quality of their science and would be well advised to seek to strengthen outside centres of expertise.

4. The same difficulties affect the translation of MoD scientific work to civil fields. The establishments are only now taking tentative steps towards taking their developments forward in non-military directions; a university unit would have more flexibility. MoD have been very slow in announcing further measures to improve civil take-up of ideas originating in the research establishments following the Maddock report and the Lancaster House statement by Mr Heseltine. ACARD have commented on this delay in the context of the Annual Review.

5. Mr Heseltine, unlike Sir Keith Joseph, deals with the question of maintaining scientific standards. There is some first-class work in some defence establishments (notably RSRE), but the problems I have referred to will make it more difficult to sustain and inevitably open publication of research results in refereed journals, which is the main mechanism for maintaining standards elsewhere, is not as available to defence workers. The grant-awarding committees of Research Councils, coupled with refereed publication, are effective mechanisms for ensuring high scientific standards; the MoD procedures are probably the best that can be arranged in their circumstances, but must suffer from the need to retain permanent staff at the establishments even when expertise has become outdated.

Ref. A084/2104

PRIME MINISTER

Annual Review of Government Funded Research and Development

The second of the Annual Reviews of Government Research and Development expenditures instituted by Cmnd 8591 (Government observations on the report "Science and Government" from the House of Lords Select Committee on Science and Technology) has now been completed and I attach a copy. Responsibility for preparation of the Review lies with the Science and Technology Secretariat in the Cabinet Office, working under the guidance of the Sub-Committee of Chief Scientists chaired by Robin Nicholson.

2. As in 1983, the Review is in two parts. Part I contains a summary of past and projected Government R and D expenditures for the PES period 1981/2 to 1986/7 and a factual commentary on their distribution. This year, Departments and Research Councils were invited to state the primary aim of each of their programmes, whether to advance scientific understanding, to support purchasing decisions, to develop technology etc. This has enabled the Secretariat, in Chapter 2 of this part of the Review, to provide helpful analyses of the distribution by industrial sectors and product groups. Some international comparisons are made in Chapter 3. In general, this Review provides much more analysis than last year's, while also including projected expenditures, as envisaged in Cmnd 8591, for the first time.

3. Part II of the Review contains information on the expenditures and R and D objectives of individual Departments and Research Councils supplementing the summary information in Part I.

--- 4. I also attach a copy of a letter from Sir Henry Chilver and note by ACARD giving the Council's views on the distribution of expenditures revealed by the Review, as Cmnd 8591 invited them to do. The Council were able to see a first draft in April and established a small sub-group to give the matter detailed attention over the following two months. You will see from the summary of ACARD's main comments in Sir Henry's letter that they have drawn particular attention to the relatively high level of defence R and D expenditures in the United Kingdom, and have suggested that this could be impairing the country's economic performance. They have also questioned the balance between support for agricultural R and D and for manufacturing R and D and, within manufacturing, they have offered preliminary comments on the distribution of expenditures among different industrial sectors. ACARD will develop their views on this last aspect through a standing sub-committee that the Council have established to consider issues arising from the Review. It is clear from Sir Henry's letter that ACARD regard the Review as a very valuable piece of work.

5. As you know, the review of agricultural support policies whose report was recently submitted to Ministers included an examination of R and D support. The international comparisons of R and D expenditures provided in Section 3 of the Review also were an input to the official group. ACARD's views can be taken into account in further consideration of this subject.

6. ACARD's views on defence R and D, however, raise questions that are not under current interdepartmental discussion. Dr Nicholson considers them highly relevant to a number of current issues, notably the future demand for "high technology skills, and he will be minuting you separately. I too consider that ACARD's arguments should be thoroughly examined, but further thought needs to be given to the boundaries of any study for it to be manageable, and I would also suggest that it might be preferable to delay its start until after the current PES discussions. ACARD's general points may then be taken into account in these discussions in a way which might be difficult if the study were already in existence.

7. If you agree, I will consult with interested Departments (principally the Ministry of Defence, the Treasury and the Department of Trade and Industry) over the exact terms of reference for an interdepartmental examination of the issues raised by ACARD and report further to you. The main focus would be on the economic impact of current defence R and D expenditures, but the study would inevitably involve some aspects of procurement policies. It should be carried out under Cabinet Office chairmanship.

8. The various other comments made by ACARD can, I suggest, be considered by the sub-committee of Chief Scientists and, either individually or collectively, Departments can enter into a dialogue on them with the Council.

9. A declassified version of the 1983 Review was published and received a warm welcome from the House of Lords, from academics and from others interested in science and technology policy. I suggest that it would be appropriate for this Review also to be published, with suitable deletion of classified information relating to future defence expenditures. Dr Nicholson has agreed with the Ministry of Defence what might be said about these. If you agree, I will make arrangements for publication in the autumn. Sir Henry Chilver's letter makes it plain that ACARD have no intention of requesting permission to publish their advice, but Sir Henry and the Chairman of ABRC could, of course, choose to reflect some Council's vies in their next joint report.

10. The contents of the Review and ACARD's comments should now be brought to the attention of the Cabinet as an input to current PES discussions. I attach a draft Private Secretary's letter.

RTA

ROBERT ARMSTRONG

23 July 1984

DRAFT LETTER FROM PRIME MINISTER's PRIVATE SECRETARY TO THE PRIVATE SECRETARY TO THE CHIEF SECRETARY

Annual Review of Government Funded Research and Development

The Prime Minister has received the report from the second of the Annual Reviews of R and D announced in Cmnd 8591 (Government observations on the report "Science and Government" from the House of Lords Select Committee on Science and Technology) together with the views of the Advisory Council for Applied Research and Development (ACARD) on the expenditures covered in the Review.

2. The PM ~~She~~ has asked that the Review and ACARD's views (copies attached) should be drawn to the attention of members of the Cabinet, and she has agreed to publication of the Review with the deletion of classified information relating to defence expenditures.

3. The Prime Minister has noted that ACARD's major comments relate first to expenditures on defence R and D, secondly tothe balance between the Government's support for R and D for agriculture, fisheries and food and for manufacturing and thirdly, within manufacturing, to the distribution of support among different industrial sectors. She further notes that ACARD will themselves be considering the last aspect in more detail over coming months.

4. The Prime Minister has asked Sir Robert Armstrong to advise her on how the issues raised by ACARD in respect of defence R and D expenditures might best be examined interdepartmentally and to invite the Sub-Committee of Chief Scientists to consider the other comments made by ACARD.

5. I am sending a copy of this letter and the attachments to the Private Secretaries of members of the Cabinet and (without attachments) to Richard Hatfield.

ANNUAL REVIEW OF GOVERNMENT FUNDED

RESEARCH AND DEVELOPMENT

1984

Cabinet Office
July 1984

LIST OF ABBREVIATIONS

AFRC	Agricultural and Food Research Council
DAFS	Department of Agriculture and Fisheries for Scotland
DANI	Department of Agriculture for Northern Ireland
DEmp	Department of Employment
DEn	Department of Energy
DES	Department of Education and Science
DHSS	Department of Health and Social Security
DOE	Department of the Environment
DTI	Department of Trade and Industry
DTp	Department of Transport
ESRC	Economic and Social Research Council
FCO	Foreign and Commonwealth Office
HSC	Health and Safety Commission
IDS	Industry Department for Scotland
MAFF	Ministry of Agriculture, Fisheries and Food
Met. Off.	Meteorological Office
MOD	Ministry of Defence
MRC	Medical Research Council
NERC	Natural Environment Research Council
NI	Northern Ireland
ODA	Overseas Development Administration
OPCS	Office of Population Censuses and Surveys
OS	Ordnance Survey
SDD	Scottish Development Department
SED	Scottish Education Department
SERC	Science and Engineering Research Council
SHHD	Scottish Home and Health Department
UGC	University Grants Committee
UKAEA	United Kingdom Atomic Energy Authority

ANNUAL REVIEW OF GOVERNMENT FUNDED RESEARCH AND DEVELOPMENT 1984

PART I

1. INTRODUCTION

1.1 The 1984 Annual Review of Government funded R & D is the second in the series established by Cmnd 8591, the Government's response to the report "Science in Government" by the House of Lords Select Committee on Science and Technology (see Annex A). It thus builds upon the experience gained in assembling the information in the 1983 Review (1), which was published in January 1984 as a contribution to the public discussion of science and technology policy.

1.2 The 1983 Review concentrated on assembling a consistent database of Government R & D expenditures for the period 1977/8 to 1982/3, and on establishing procedures for the collection of such information regularly in the future. The balance of these expenditures was analysed, and compared with the balance in 1973/4. It was possible to see from the 1983 Review the overall effect of individual Departments' decisions on R & D expenditures over that period, thus fulfilling one of the Government's objectives in establishing the Annual Review process. Because of the decentralised nature of decisions on Government R & D funding in the United Kingdom, the relevant figures had not previously been brought together in one place on a consistent basis. It should be noted, however, that there is in the UK no "Government R & D Budget" as such; decisions on R & D expenditures are made independently by Departments in the light of their other programmes and priorities. Shifts in the balance do not imply that one area has necessarily gained at the expense of another, but all programmes compete for funding from a set total of public expenditure and for the national resources (skilled staff etc) involved in R & D.

1.3 The 1983 Review did not set Government R & D expenditures in any national or international framework in the manner, for example, of the publication "Science Indicators" (2) produced by the National Science Foundation in the USA. This present Review aims to provide such a framework. Decisions on levels of R & D funding must, though, remain a matter for informed judgement based on knowledge of the prospective subject of study, and taking into account other expenditure priorities. They cannot be determined solely from formal analyses, particularly when the expected output is intangible, eg knowledge to provide an informed basis for policy decisions. However, when the purpose of the R & D is to advance technological development, there is in principle a linkage between R & D expenditures and final products - manufactures, foodstuffs, energy supplies, etc - and analyses that explore these relationships can inform funding decisions. Some data relevant to such analyses are included in Section 4 of this Review.

1.4 R & D expenditures by nationalised industries and other public bodies are not formally included in the Review. Some are substantial and Government, directly or indirectly, has some responsibility for them. Some bodies receive Ministerial approval of corporate plans ; others require Government to approve charges which finance their R & D programmes and other activities; others receive deficit funding from Government and a few have a specific statutory obligation to bring their R & D programmes to Ministers for approval. The size of some of the major nationalised industry R & D programmes is indicated in Section 5 of the Review; it is intended that more detailed information should be included in future Reviews.

1.5 The 1984 Review therefore contains:

in Part I,

i. a summary of past and projected Departmental and Research Council expenditures (1981/2 to 1986/7)

ii. an analysis of these expenditures by primary objectives

iii. some broad international comparisons of government funding of R & D

iv. data relevant to an examination of the relationship between expenditures related to technological development and aspects of the UK economy;

and in Part II,

iv. a comprehensive and consistent database of Government R & D expenditures for the years 1981/2 to 1986/7 and statements by Departments and Research Councils of their objectives in funding R & D.

1.6 The following general comments may be made about the expenditure statistics in the Review:

i. as in 1983, the "Frascati" definition of R & D activities has been employed in order to provide a consistent interpretation of R & D across Departments and to facilitate international comparisons. This covers research in both the social and natural sciences. Further details of this definition may be found in Annex B;

ii. a principal aim of the Review is to provide information on the volume and distribution of R & D supported by Government that enables valid comparisons to be made with R & D programmes in the private sector and in public corporations. The expenditure figures therefore include costs arising from R & D but falling on other public expenditure votes. For example, they include estimates of the superannuation liability incurred by employing Departments in respect of their staff, and accommodation costs when these are not explicitly included in R & D votes.

iii. consequently, other tables of Government R & D expenditures, provided for other purposes, may differ from those in the Review. For example, public expenditure estimates use figures aligned to public accounting needs, which do not necessarily include all relevant costs under the "R & D" heading. Statements in Departments' annual R & D reports may include expenditures related to R & D but falling outside the Frascati definition (eg connected with technology transfer) and may not be on the basis of full economic costs. It is hoped that such discrepancies will be progressively reduced;

iv. the data presented in this Review cover the financial years

1981/2 to 1986/7, reflecting the Government's intention that the Annual Review should consider and influence future expenditure plans. 1981/2 and 1982/3 data are outturn figures, those for 1983/4 are estimated outturn figures based on expenditures up to early 1984 and those for 1984/5, 1985/6 and 1986/87 are based on expenditures consistent with the figures in "The Government's Expenditure Plans 1984-85 to 1986-87" (Cmnd 9143) with the adjustments indicated in (ii) above. Information on expenditures in previous years may be found in the 1983 Annual Review, although because of the emphasis in this year's Review on including all relevant costs, figures for the years prior to 1981/2 may not be completely consistent with those presented here.

1.7 Some caution is required in interpreting data on government expenditures through the general funds of universities. These expenditures are referred to under the heading "UGC etc" in the tables, since by far the greater part of this non-specific funding is received by universities in the form of grants from the University Grants Committee (UGC). However, central Government also contributes through fees for home students, and through Department of Education of Northern Ireland grants to the universities in Northern Ireland. The sum involved is large (£555 million in 1983/84 if research into the humanities is excluded) but it is derived from an estimate of the distribution of universities' resources among different functions which may have changed substantially since it was last assessed. The data may therefore be subject to some considerable error, either up or down. The Department of Education and Science and the UGC have set in hand a study which it is hoped will eventually provide better information on the volume and distribution of university research, but as the same resources support both teaching and research functions, it is inevitable, even following this study, that some uncertainty will remain in estimates of research expenditure in universities. The split of this expenditure by primary purpose is also impossible to determine explicity; this document uses a split based on the breakdown of research effort between different disciplines. (See also Table 4a in Part II and the footnotes to that table.)

1.8 A broad-brush exercise such as that set out here cannot fulfill all the objectives set out in Cmnd 8591 for the Review. It can indicate areas where expenditures appear out of line, either with international figures or by comparison with their expected economic significance; these may require further study leading perhaps to changes in policy. It cannot, however, show in detail the possible overlap in individual research programmes funded by different Departments, or the gaps in knowledge that need to be filled. These must be investigated by studies of specific areas. Annex C summarises information gained from the first of these specific studies, on marine science and technology.

1.9 Finally, this Review deals mainly with inputs to the R & D process. The publication "Science Indicators" refered to above attempts to measure trends in outputs through analyses of scientific publications, patents and trade in high technology goods. The conclusions to be drawn from such analyses are not clear-cut, but they potentially provide a useful complement to the presentation of inputs, and may be included in future Reviews.

(1) "Annual Review of Government Funded R & D 1983", HMSO, 1984, ISBN 011 630825 7

(2) "Science Indicators 1982", National Science Board, National Science Foundation, Washington DC, USA, 1983

2. GOVERNMENT R AND D EXPENDITURES

2.1 Table 2.1 shows actual and planned R & D expenditures for the years 1981/2 to 1986/7, expressed in cash terms on the bases set out in paragraph 1.6. Tables 2.2 and 2.3 are derived from Table 2.1. The former shows individual Departmental and Research Council totals as a proportion of the overall total; the latter shows the expenditures in cost terms, ie constant (1983/4) prices, the relevant deflators being those used in "The Government's Expenditure Plans 1984-85 to 1986-87" (Cmnd 9143) and the Financial Statement and Budget Report 1984-85. Table 2.4 shows the expenditures in index form (1983/4 = 100) using the same deflators. Figures 2.1 to 2.3 illustrate some of the main features of the tables.

2.2 The tables show that the broad distribution of Government R & D expenditures will change little in the next few years. Defence R & D, some 80% of which is associated with the development of specific military equipments, accounts for half the total and will rise slightly in relation to civil expenditures. University and Research Council expenditures account for a further 25-26% (falling slightly) and other Departments the remainder. The increase in the proportion accounted for by defence needs continues the trend since 1973/4 noted in the 1983 Review. Total expenditures will rise a little in real terms from 1983/4 levels but changes in individual Departments and Research Councils will be more marked, the greatest relative changes between 1981/2 and 1986/7 (apart from "other Departments" which is a statistical anomaly arising from the change in vote procedures for the Property Services Agency) being the rises in HSC, DTI and MOD (Research) programmes and the decline by 1986/7 in ESRC, DHSS, and UKAEA programmes (but see paragraph 2.9). In cost terms, the largest changes will take place in the MOD (Research) and DTI programmes.

2.3 Table 2.5 and Figure 2.4 provide information on the overall distribution of expenditures among different classes of recipient. Each Department's distribution may be found in Part II. Because of the difficulty of estimating the distribution of future expenditures, Departments were not asked to provide these in the same level of detail as past expenditures, although Research Councils have, for their own planning purposes, made estimates of their expected receipts from Departments and elsewhere

(Table 2.6). Table 2.7 expresses the main elements of the distribution of Departmental expenditures, ie excluding the UGC and Research Councils, as a proportion of total Departmental expenditures.

R & D Objectives

2.4 The Government fund R & D for a number of reasons. Part II of the Review contains detailed statements of the objectives of funding Departments; these may be classified under six broad headings:

Advancement of science

Work funded primarily in order to increase human knowledge, ie to advance scientific understanding of natural phenomena. This research contributes to the scientific base of the nation and, although originally funded with no specific application in view, much results in long-term benefit through the eventual application of the knowledge gained.

Support for policy formation and implementation

Applied research carried out in order to meet Departments' own needs for knowledge, for example:

to identify and assess policy options (eg on choice of renewable energy resources, to identify measures to deal with difficult-to-let housing estates, etc);

to facilitate forward planning (eg on the efficient use of the radio spectrum);

to make their operations more efficient.

Improvement of technology

Applied R & D, funded by Government but often carried out within the private sector, to advance the technology of different sectors of the UK economy - manufacturing, agriculture, construction etc.

Support for purchasing decisions

Applied R & D which contributes to the specification and development of goods and services required by Government (mainly related to defence needs).

Support for statutory duties

Work which assists Departments to carry out statutory responsibilities or other obligations (eg in connection with the Health and Safety at Work Act or Building Regulations).

Support for other activities

R & D which cannot be classified under the previous headings (eg research to support overseas development). Superannunation contributions which appear in Departments´ tables and which cannot be otherwise allocated are included in this category.

In the Frascati framework (Annex B), which is also related to objectives, advancement of science would equate to "basic" research while work under the other objectives would be classified as applied research and experimental development.

2.5 Table 2.8 shows the Government´s total expenditures analysed into these categories in current cost terms, while Tables 2.9 and 2.10 present the same information as a proportion of total expenditures and in index form at constant prices and Figure 2.5 shows the distribution in 1983/4. Many research programmes contribute to more than one objective; in such cases the expenditure has been ascribed to the primary purpose served by the programme. The changes between 1981/2 and 1986/7 are illustrated in Figures 2.6 and 2.7. The main trends in the balance of expenditures are a shift towards the "technological development" and "purchasing" categories (the second of which is dominated by MOD expenditures) and a corresponding shift away from "advancement of science" and policy orientated research. Principal causes of the latter are the declines in UGC funding and in Government support for UKAEA, as the electricity supply industry assumes responsibility for a larger share of the Authority´s work on thermal reactors.

Advancement of science

2.6 Table 2.11 shows expenditures in this category in current cost terms while Table 2.12 provides the same information in index form at constant prices. As expected, the main contributors to this table are the UGC and the Research Councils, with funding being maintained approximately level in real terms.

Support for policy

2.7 Tables 2.13 and 2.14 show expenditures against this objective in the same way as in the previous tables. The MRC's expenditure does not, of course, relate directly to National Health Service policy but, by contributing to knowledge of new medical procedures, it enables new forms of treatment to be offered and therefore widens treatment options and contributes to the effectiveness of health service provision. The UGC expenditures shown also support medical research. The largest component of UKAEA funding in this category concerns the fast reactor programme which aims to inform future reactor options.

Improvement of technology

2.8 Tables 2.15 and 2.16 provide details of expenditures on R & D whose primary purpose to advance the technology of different economic sectors. Section 4 sets these expenditures, and those in the next category, in a broad economic context. The main elements of expenditure are directed towards industrial technology (DTI/SERC/UGC) and agricultural technology (MAFF/AFRC). Overall, a substantial rise in real terms is expected in the next few years.

Support for purchasing

2.9 Tables 2.17 and 2.18 show R & D expenditures which support purchasing decisions. This category is, of course, dominated by MOD expenditures which will rise slightly in real terms. As indicated above, the electricity supply industry is to take a larger share in the funding of UKAEA work on thermal reactors and so the cost to Government will reduce.

Support for statutory duties

2.10 Tables 2.19 and 2.20 show expenditures incurred in order to improve Departments' discharge of their legal or regulatory obligations. The Department of the Environment, because of its responsibilities for monitoring and reducing pollution, has a major share of this category. DTI expenditure shows a substantial proportional rise because of the move of British Telecom to the private sector and the consequent need for the Department to support R & D related to the supervision of telecommunications services.

Other activities

2.11 Expenditures which do not fall into any of the above categories are shown in Tables 2.21 and 2.22.

Table 2.1

GOVERNMENT R & D EXPENDITURES IN CASH TERMS
£millions
Columns may not sum to totals shown owing to rounding

Department	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Civil Departments						
MAFF (1)	106.8	113.9	120.3	126.5	130.5	133.2
DES	8.3	8.8	8.8	11.4	11.7	11.3
DEn	35.6	32.1	27.8	36.9	39.4	40.7
UKAEA	203.2	212.4	199.0	197.0	196.2	195.3
DoE	38.3	35.9	36.5	41.5	43.0	44.2
ODA	16.3	18.6	20.7	21.6	22.8	24.1
DHSS	28.2	28.9	26.5	25.7	24.2	23.8
HSC	6.2	7.5	8.3	8.8	9.9	11.5
Home Office	11.2	12.2	12.6	13.8	15.0	15.3
DTI	284.9	284.0	343.3	449.9	468.2	462.3
Department of Transport	27.5	25.9	31.7	40.4	44.5	42.0
N I Departments	9.7	9.4	11.1	12.9	13.8	14.1
Scottish Departments	40.8	42.8	47.3	50.7	53.3	54.8
Other Departments (2)	39.4	42.9	31.4	32.8	33.4	33.8
TOTAL Civil Departments	856.4	875.4	925.2	1069.7	1105.9	1106.4
Research Councils						
AFRC	41.4	43.1	45.5	45.9	45.6	46.9
ESRC	15.3	16.4	17.3	16.8	16.5	16.6
MRC	100.6	106.4	112.8	116.2	118.5	120.9
NERC	52.1	55.2	60.0	63.3	65.4	67.4
SERC	212.1	230.0	246.4	269.2	280.2	287.2
TOTAL Research Councils (3)	421.4	451.1	482.0	511.4	526.2	539.0
UGC etc	484.0	535.0	555.0	570.0	588.0	600.0
TOTAL Civil	1761.8	1861.5	1962.2	2151.1	2220.1	2245.4
Ministry of Defence						
MOD (Research)	263.3	304.8	329.2	392.3	405.7	419.8
MOD (Development)	1424.2	1395.8	1575.6	1654.8	1766.0	1854.0
MOD (Staff & Superannuation)	57.1	64.2	67.9	70.1	72.8	74.6
TOTAL Defence	1744.6	1764.8	1972.7	2117.2	2244.6	2348.4
NET TOTAL (4)	3506.4	3626.4	3934.9	4268.3	4464.6	4593.7

Notes

(1) see list of abbreviations preceeding Page 1
(2) see Table 21a (Part II)
(3) excluding commissions from Departments, which are included in Departments' expenditure totals and which form the main component of the commissioned research earnings shown in Table 2.6
(4) net contribution to public expenditure, ie excluding receipts from the private sector, overseas etc

Table 2.2

DEPARTMENTAL SHARES OF TOTAL GOVERNMENT FUNDED R & D
figures may not total to 100% owing to rounding

Department	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Civil Departments						
MAFF	3.0	3.1	3.1	3.0	2.9	2.9
DES	0.2	0.2	0.2	0.3	0.3	0.2
DEn	1.0	0.9	0.7	0.9	0.9	0.9
UKAEA	5.8	5.9	5.1	4.6	4.4	4.3
DoE	1.1	1.0	0.9	1.0	1.0	1.0
ODA	0.5	0.5	0.5	0.5	0.5	0.5
DHSS	0.8	0.8	0.7	0.6	0.5	0.5
HSC	0.2	0.2	0.2	0.2	0.2	0.3
Home Office	0.3	0.3	0.3	0.3	0.3	0.3
DTI	8.1	7.8	8.7	10.5	10.5	10.1
Department of Transport	0.8	0.7	0.8	0.9	1.0	0.9
N I Departments	0.3	0.3	0.3	0.3	0.3	0.3
Scottish Departments	1.2	1.2	1.2	1.2	1.2	1.2
Other Departments	1.1	1.2	0.8	0.8	0.7	0.7
TOTAL Civil Departments	24.4	24.1	23.5	25.1	24.8	24.1
Research Councils						
AFRC	1.2	1.2	1.2	1.1	1.0	1.0
ESRC	0.4	0.5	0.4	0.4	0.4	0.4
MRC	2.9	2.9	2.9	2.7	2.7	2.6
NERC	1.5	1.5	1.5	1.5	1.5	1.5
SERC	6.0	6.3	6.3	6.3	6.3	6.3
TOTAL Research Councils	12.0	12.4	12.3	12.0	11.8	11.7
UGC etc	13.8	14.8	14.1	13.4	13.2	13.1
TOTAL Civil	50.2	51.3	49.9	50.4	49.7	48.9
Ministry of Defence						
MOD (Research)	7.5	8.4	8.4	9.2	9.1	9.1
MOD (Development)	40.6	38.5	40.0	38.8	39.6	40.4
MOD (Staff & Superannuation)	1.6	1.8	1.7	1.6	1.6	1.6
TOTAL Defence	49.8	48.7	50.1	49.6	50.3	51.1
NET TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

Table 2.3

GOVERNMENT R & D EXPENDITURES IN COST TERMS (1)
£millions, base year 1983/84

Department	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Civil Departments						
MAFF	120.1	120.1	120.3	120.8	119.5	117.3
DES	9.3	9.3	8.8	10.9	10.8	10.0
DEn	40.0	33.9	27.8	35.2	36.1	35.9
UKAEA	228.5	224.0	199.0	187.7	179.6	171.9
DoE	43.1	37.9	36.5	39.7	39.4	38.9
ODA	18.3	19.6	20.7	20.6	20.8	21.2
DHSS	31.7	30.5	26.5	24.5	22.2	21.0
HSC	7.0	7.9	8.3	8.4	9.1	10.1
Home Office	12.6	12.9	12.6	13.2	13.7	13.4
DTI	320.5	299.5	343.3	429.5	428.8	406.9
Department of Transport	31.0	27.3	31.7	38.5	40.8	37.0
N I Departments	10.9	9.9	11.1	12.3	12.6	12.4
Scottish Departments	45.9	45.1	47.3	48.4	48.8	48.2
Other Departments	44.3	45.3	31.4	31.4	30.6	29.8
TOTAL Civil Departments	963.3	923.4	925.2	1021.2	1012.7	973.9
Research Councils						
AFRC	46.6	45.5	45.5	43.9	41.8	41.3
ESRC	17.2	17.2	17.3	16.0	15.1	14.6
MRC	113.1	112.3	112.8	110.9	108.6	106.4
NERC	58.6	58.3	60.0	60.4	59.9	59.3
SERC	238.5	242.6	246.4	256.7	256.6	252.8
TOTAL Research Councils	474.0	475.9	482.0	488.2	482.0	474.4
UGC etc	544.4	564.3	555.0	544.2	538.5	528.2
TOTAL Civil	1981.7	1963.6	1962.2	2053.5	2033.0	1976.5
Ministry of Defence						
MOD (Research)	296.1	321.5	329.2	374.5	371.5	369.5
MOD (Development)	1602.1	1472.4	1575.6	1579.8	1617.3	1632.1
MOD (Staff & Superannuation)	64.2	67.7	67.9	66.9	66.7	65.6
TOTAL Defence	1962 4	1861.6	1972.7	2021.2	2055.5	2067.7
NET TOTAL	3944.2	3825.3	3934.9	4074.7	4088.5	4043.8

(1)Cash figures as in Table 2.1 adjusted for general inflation as measured by the GDP deflator at market prices. The figures used are consistent with those in Table 1.14 of Cmnd 9143 and Table 5.5 of the Financial Statement and Budget Report, 1984-85

Table 2.4

GOVERNMENT R & D EXPENDITURES IN COST TERMS
INDEX, 1983/84 = 100

Department	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Civil Departments						
MAFF	100	100	100	100	99	98
DES	106	106	100	124	123	114
DEn	144	122	100	127	130	129
UKAEA	115	113	100	94	90	86
DoE	118	104	100	109	108	107
ODA	88	95	100	99	100	102
DHSS	120	115	100	92	84	79
HSC	84	95	100	100	109	122
Home Office	100	102	100	105	109	107
DTI	93	87	100	125	125	119
Department of Transport	98	86	100	122	129	117
N I Departments	99	90	100	111	114	112
Scottish Departments	97	95	100	102	103	102
Other Departments	141	144	100	100	98	95
TOTAL Civil Departments	104	100	100	110	109	101
Research Councils						
AFRC	102	100	100	96	92	91
ESRC	99	100	100	93	87	84
MRC	100	100	100	98	96	94
NERC	98	97	100	101	100	99
SERC	97	98	100	104	104	103
TOTAL Research Councils	98	99	100	101	100	98
UGC etc	98	102	100	98	97	95
TOTAL Civil	101	100	100	105	104	101
Ministry of Defence						
MOD (Research)	90	98	100	114	113	112
MOD (Development)	102	93	100	100	103	104
MOD (Staff & Superannuation)	95	100	100	99	98	97
TOTAL Defence	99	94	100	103	104	105
NET TOTAL	100	97	100	104	104	103

Table 2.5

OVERALL DISTRIBUTION OF FUNDING

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural(1)	1350.0	1476.4	1469.3	1574.5	1624.5	1698.1
Research Councils(2)	60.1	62.3	63.9	67.4	69.0	70.7
Other Government Departments(3)	46.0	74.5	63.1	86.0	90.3	90.7
Universities	639.6	697.8	)			
Private industry	1395.3	1239.9	)			
Public Corporations	54.2	48.3	)			
Research Associations	14.4	23.1	)			
Overseas	186.0	212.4	)			
Non-industrial research institutes(4)	89.4	94.2	)2767.3	2985.2	3139.6	3212.7
Professional and learned societies	4.4	4.6	)			
Persons	40.2	42.7	)			
Others	27.3	31.9	)			
<u>less</u> Receipts(5)	400.0	383.4	429.1	447.3	460.8	479.0
TOTAL	3507.0	3624.8	3934.5	4265.8	4462.1	4593.3

(1) Expenditures within Departments' and Research Councils' own establishments and headquarters units carried on their own budgets.

(2) Departmental commissions with Research Councils.

(3) Departmental commissions with other Departments' establishments (which are offset against those Departments' votes and are included in the receipts line).

(4) Indcpendant research institutes receiving funds mainly from AFRC, Department of Agriculture and Fisheries for Scotland, NERC and MRC

(5) From other Government Departments, private industry, international subscriptions etc.

Table 2.6

COMMISSIONED RESEARCH WITH RESEARCH COUNCILS

£ millions

		81/82	82/83	83/84	84/85	85/86	86/87
AFRC	Central Government	44.6	49.1)	55.3	56.7	56.4	57.9
	Others	3.6	4.3)				
ESRC	Central Government	0.2	0.1)	0.3	0.4	0.3	0.3
	Others	0.1	0.1)				
MRC	Central Government	2.4	2.6)	6.8	6.7	6.3	6.5
	Others	2.7	2.9)				
NERC	Central Government	26.4	23.6)	26.3	24.6	25.4	26.2
	Others	5.1	5.7)				
SERC	Central Government	2.2	2.9)	9.7	9.3	9.2	9.9
	Others	5.7	6.4)				
TOTAL		93.0	97.8	98.4	97.7	97.6	100.8

Table 2.7

DISTRIBUTION OF DEPARTMENTAL R & D EXPENDITURES - PERCENTAGES(1)

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	32.1	37.6	31.8	31.9	31.3	31.9
Research Councils	2.3	2.3	2.2	2.1	2.1	2.0
Universities	1.7	1.6)				
Private Industry	53.6	46.9)				
Public Corporations	2.1	1.8)				
Research Associations	0.6	0.9)	66.0	66.0	66.6	66.1
Overseas	5.5	6.3)				
Non-industrial research institutes	1.1	1.2))				
Professional and learned societies	0.2	0.2))				
Persons	..	..)				
Others	0.9	1.1)				
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

(1) Excluding Research Councils and UGC etc

Table 2.8

PRIMARY PURPOSES FOR GOVERNMENT FUNDED R & D, IN CASH TERMS
£millions

PRIMARY PURPOSE	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Advancement of science	590.2	640.6	666.3	697.1	718.3	734.6
Support for policy	466.9	493.6	483.2	501.7	519.4	526.6
Improvement of technology	549.2	568.9	649.8	780.5	810.1	807.4
Support for purchasing decisions	1783.1	1802.0	2004.6	2151.3	2274.2	2378.3
Support for statutory duties	60.3	62.6	65.5	70.0	70.7	73.2
Support for other activities	56.6	58.7	65.5	67.7	72.0	73.5
TOTAL	3506.4	3626.4	3934.9	4268.3	4464.7	4593.7

Table 2.9

PRIMARY PURPOSES FOR GOVERNMENT-FUNDED R & D - PERCENTAGES
columns may not total to 100% owing to rounding

PRIMARY PURPOSE	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Advancement of science	16.8	17.7	16.9	16.3	16.1	16.0
Support for policy	13.3	13.6	12.3	11.8	11.6	11.5
Improvement of technology	15.7	15.7	16.5	18.3	18.1	17.6
Support for procurement decisions	50.9	49.7	50.9	50.4	50.9	51.8
Support for statutory duties	1.7	1.7	1.7	1.6	1.6	1.6
Support for other activities	1.6	1.6	1.7	1.6	1.6	1.6
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

Table 2.10

PRIMARY PURPOSES FOR GOVERNMENT FUNDED R & D IN COST TERMS
INDEX, 1983/84 = 100

PRIMARY PURPOSE	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Advancement of science	100	101	100	100	98	97
Support for policy	109	108	100	99	98	96
Improvement of technology	95	92	100	115	114	109
Support for procurement decisions	100	95	100	102	104	104
Support for statutory duties	104	101	100	102	99	98
Support for other activities	97	95	100	99	101	99
TOTAL	100	97	100	104	104	103

Table 2.11

EXPENDITURES FOR ADVANCEMENT OF SCIENCE
£millions

DEPARTMENT	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
MAFF	..	..	..	..	..	..
DES	8.3	8.8	8.7	11.4	11.7	11.3
DTI	0.0	0.0	0.2	2.0	2.2	2.3
N I Departments	0.1	0.2	0.2	0.2	0.2	0.2
Scottish Departments	1.7	1.8	2.4	2.5	2.7	2.7
Other Departments	11.8	12.7	13.4	14.2	14.4	14.6
AFRC	22.0	22.9	24.6	25.1	24.8	25.5
ESRC	15.3	16.4	17.3	16.8	16.5	16.6
MRC	22.8	23.9	25.6	26.3	26.7	27.2
NERC	46.8	48.9	51.4	53.7	55.5	57.2
SERC	153.5	168.0	173.4	186.0	193.6	199.9
UGC etc	308.0	337.0	349.0	359.0	370.0	377.0
TOTAL	590.2	640.6	666.3	697.1	718.3	734.6

Table 2.12

EXPENDITURES FOR ADVANCEMENT OF SCIENCE IN COST TERMS
INDEX, 1983/84 = 100

DEPARTMENT	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
MAFF	91	105	100	95	97	99
DES	106	106	100	124	123	114
DTI	0	0	100	955	1007	1012
N I Departments	53	88	100	100	103	108
Scottish Departments	80	81	100	98	102	101
Other Departments	99	100	100	101	98	96
AFRC	100	98	100	97	92	91
ESRC	99	100	100	93	87	84
MRC	100	98	100	98	96	94
NERC	102	100	100	100	99	98
SERC	100	102	100	102	102	101
UGC etc	99	102	100	98	97	95
TOTAL	100	101	100	100	98	97

Table 2.13

EXPENDITURES TO SUPPORT POLICY FORMULATION AND IMPLEMENTATION
£millions

DEPARTMENT	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
MAFF	8.1	8.6	9.2	10.2	10.5	10.1
DEn	21.4	19.4	13.8	20.3	21.9	22.5
UKAEA	170.0	179.8	171.6	169.8	173.5	172.0
DoE	15.5	13.7	13.4	15.4	16.1	16.4
DHSS	15.4	14.0	13.2	12.6	13.6	13.7
HSC	1.2	1.5	1.7	1.8	2.0	2.3
Home Office	9.2	9.9	10.5	11.2	12.1	12.4
DTI	16.5	18.5	22.4	24.0	26.2	28.8
Department of Transport	9.0	6.3	7.4	8.6	8.6	8.8
N I Departments	0.7	0.8	0.9	0.9	1.0	1.0
Scottish Departments	7.6	8.2	8.8	9.2	10.1	10.3
Other Departments	17.0	19.9	6.5	7.1	7.3	7.5
MRC	77.8	82.6	87.2	89.9	91.8	93.6
NERC	5.2	6.2	8.4	9.4	9.7	10.0
SERC	0.3	0.3	0.3	0.3	0.2	0.2
UGC etc	92.0	104.0	108.0	111.0	115.0	117.0
TOTAL	466.9	493.6	483.2	501.7	519.4	526.6

Table 2.14

EXPENDITURE TO SUPPORT POLICY FORMULATION AND IMPLEMENTATION IN COST TERMS
INDEX, 1983/84 = 100

DEPARTMENT	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
MAFF	99	99	100	106	105	97
DEn	175	148	100	140	145	143
UKAEA	111	111	100	94	93	88
DoE	131	108	100	110	110	108
DHSS	131	112	100	91	94	91
HSC	84	95	100	100	109	121
Home Office	99	100	100	102	106	104
DTI	83	87	100	102	107	113
Department of Transport	137	90	100	111	106	105
N I Departments	87	98	100	102	101	99
Scottish Departments	97	99	100	99	104	102
Other Departments	292	321	100	103	102	101
MRC	100	100	100	98	96	94
NERC	69	77	100	106	105	104
SERC	142	99	100	94	80	80
UGC etc	96	102	100	98	98	95
TOTAL	109	108	100	99	98	96

Table 2.15

EXPENDITURES TO IMPROVE TECHNOLOGY
£millions

DEPARTMENT	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
MAFF	85.3	91.0	96.0	100.1	103.2	106.3
DEn	5.8	6.4	7.4	10.6	10.5	10.7
UKAEA	3.9	4.4	4.1	4.3	4.2	4.5
DoE	2.5	3.3	3.0	4.0	3.7	3.8
DHSS	2.2	2.4	2.8	3.2	3.1	3.0
DTI	261.0	257.1	315.5	417.7	432.8	424.0
Department of Transport	5.0	6.1	6.6	10.1	14.4	10.8
N I Departments	8.9	8.4	10.0	11.7	12.5	12.8
Scottish Departments	28.2	29.4	31.6	34.0	35.2	36.2
Other Departments	3.6	3.9	4.0	4.2	4.2	4.2
AFRC	15.5	16.0	16.7	16.5	16.6	17.2
SERC	43.3	46.4	54.1	64.1	66.7	67.9
UGC etc	84.0	94.0	98.0	100.0	103.0	106.0
TOTAL	549.2	568.9	649.8	780.5	810.1	807.4

Table 2.16

EXPENDITURES TO IMPROVE TECHNOLOGY IN COST TERMS
INDEX, 1983/84 = 100

DEPARTMENT	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
MAFF	100	100	100	100	98	97
DEn	89	92	100	137	130	128
UKAEA	105	113	100	99	93	96
DoE	93	116	100	127	114	113
DHSS	89	93	100	108	101	96
DTI	93	86	100	126	126	118
Department of Transport	86	97	100	145	199	143
N I Departments	101	89	100	113	115	113
Scottish Departments	100	98	100	102	102	101
Other Departments	100	101	100	101	96	93
AFRC	104	101	100	95	91	91
SERC	90	91	100	113	113	111
UGC etc	96	101	100	97	96	95
TOTAL	95	92	100	115	114	109

Table 2.17

EXPENDITURES SUPPORTING PURCHASING DECISIONS
£millions

DEPARTMENT	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
MAFF	0.1	0.1	0.1	0.1	0.1	0.1
UKAEA	27.4	26.3	22.0	20.2	15.6	15.7
DoE	3.0	2.2	2.4	2.7	2.7	2.6
DHSS	0.1	0.1	0.1	0.1	..	..
Home Office	1.5	1.8	1.5	1.9	2.1	2.2
DTI	..	..	..	..	..	..
Department of Transport	6.5	6.7	5.8	9.1	9.0	9.3
MOD (Research)	263.3	304.8	329.2	392.3	405.7	419.8
MOD (Development)	1424.2	1395.9	1575.6	1654.8	1766.1	1854.0
MOD (Staff & Superannuation)	57.1	64.2	67.9	70.1	72.8	74.6
TOTAL	1783.1	1802.0	2004.6	2151.3	2274.2	2378.3

Table 2.18

EXPENDITURES SUPPORTING PURCHASING DECISIONS IN COST TERMS
INDEX, 1983/84 = 100

DEPARTMENT	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
MAFF	76	86	100	80	80	79
UKAEA	140	126	100	88	65	63
DoE	142	98	100	111	103	98
DHSS	157	214	100	80	54	53
Home Office	112	122	100	119	127	124
DTI	0	0	100	470	450	80
Department of Transport	125	121	100	150	143	142
MOD (Research)	90	98	100	114	113	112
MOD (Development)	102	93	100	100	103	104
MOD (Staff & Superannuation)	95	100	100	99	98	97
TOTAL	100	95	100	102	104	104

Table 2.19

EXPENDITURES SUPPORTING STATUTORY DUTIES
£millions

DEPARTMENT	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
MAFF	10.6	11.3	11.9	13.0	13.4	13.4
DEn	3.2	2.8	2.7	3.5	3.5	4.0
UKAEA	2.0	1.9	1.2	2.4	2.9	3.1
DoE	17.3	16.8	17.7	19.0	19.4	19.8
DHSS	10.4	12.2	10.4	9.8	7.6	7.0
HSC	5.0	6.0	6.7	7.0	7.9	9.2
DTI	2.4	3.1	0.8	1.1	1.9	1.9
Department of Transport	3.9	4.1	8.4	8.8	9.0	9.3
N I Departments	0.1	0.1	0.1	0.1	0.1	0.1
Scottish Departments	0.5	0.4	0.8	0.9	0.9	1.0
Other Departments	2.5	1.9	2.5	2.1	2.1	2.2
NERC	0.2	0.2	0.2	0.2	0.2	0.2
SERC	2.4	2.0	2.1	2.1	1.9	2.0
TOTAL	60.3	62.6	65.5	70.0	70.7	73.2

Table 2.20

EXPENDITURES SUPPORTING STATUTORY DUTIES IN COST TERMS
INDEX, 1983/84 = 100

DEPARTMENT	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
MAFF	100	100	100	104	103	99
DEn	133	106	100	123	118	129
UKAEA	184	163	100	188	215	224
DoE	110	100	100	102	100	98
DHSS	113	124	100	90	67	60
HSC	84	95	100	100	109	122
DTI	358	430	100	140	228	227
Department of Transport	52	51	100	101	98	98
N I Departments	100	102	100	99	100	97
Scottish Departments	64	52	100	101	101	101
Other Departments	112	81	100	95	81	82
NERC	100	100	100	99	98	97
SERC	129	99	100	95	81	82
TOTAL	104	101	100	102	99	98

Table 2.21

EXPENDITURES SUPPORTING OTHER ACTIVITES
£millions

DEPARTMENT	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
MAFF	2.8	2.8	3.0	3.1	3.2	3.3
DES	..	..	..	..	..	..
DEn	5.1	3.6	3.9	2.5	3.6	3.6
DoE	..	..	..	0.4	1.1	1.4
ODA	16.3	18.6	20.7	21.6	22.8	24.1
DHSS	0.1	0.1	0.1	0.1	0.0	0.0
Home Office	0.5	0.5	0.6	0.7	0.7	0.7
DTI	4.9	5.3	4.4	5.2	5.1	5.3
Department of Transport	3.1	2.8	3.4	3.7	3.6	3.7
Scottish Departments	2.9	2.9	3.6	4.2	4.4	4.6
Other Departments	4.5	4.6	4.9	5.3	5.4	5.3
AFRC	4.0	4.2	4.2	4.3	4.2	4.2
SERC	12.4	13.3	16.6	16.7	17.8	17.3
TOTAL	56.6	58.7	65.5	67.7	72.0	73.5

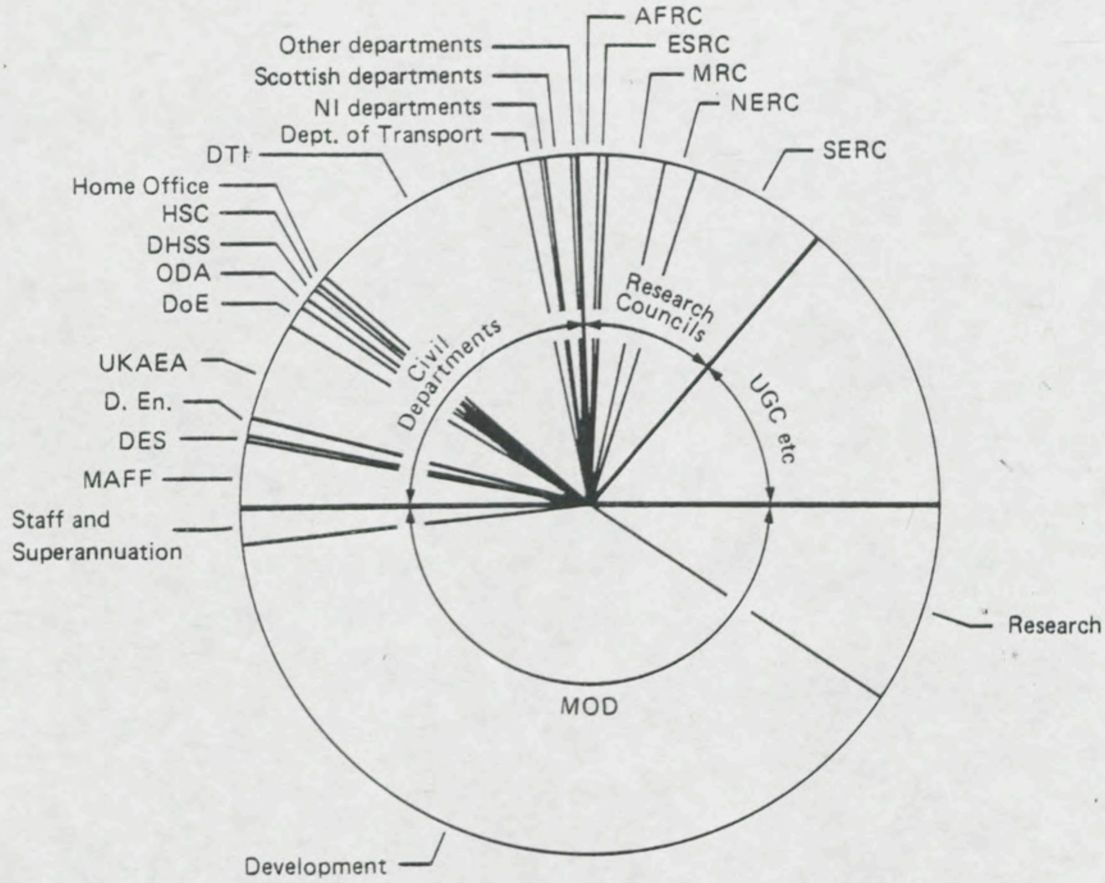
Table 2.22

EXPENDITURES SUPPORTING OTHER ACTIVITIES IN COST TERMS
INDEX, 1983/84 = 100

DEPARTMENT	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
MAFF	104	100	100	99	98	97
DES	76	86	100	100	100	100
DEn	148	97	100	62	84	81
DoE	80	87	100	966	2537	3057
ODA	88	95	100	100	100	102
DHSS	145	106	100	78	16	15
Home Office	92	100	100	109	110	110
DTI	125	125	100	112	106	105
Department of Transport	102	85	100	102	95	94
Scottish Departments	89	85	100	109	110	111
Other Departments	103	97	100	102	100	95
AFRC	108	105	100	99	93	89
SERC	84	85	100	96	99	92
TOTAL	97	95	100	99	101	99

Figure 2.1

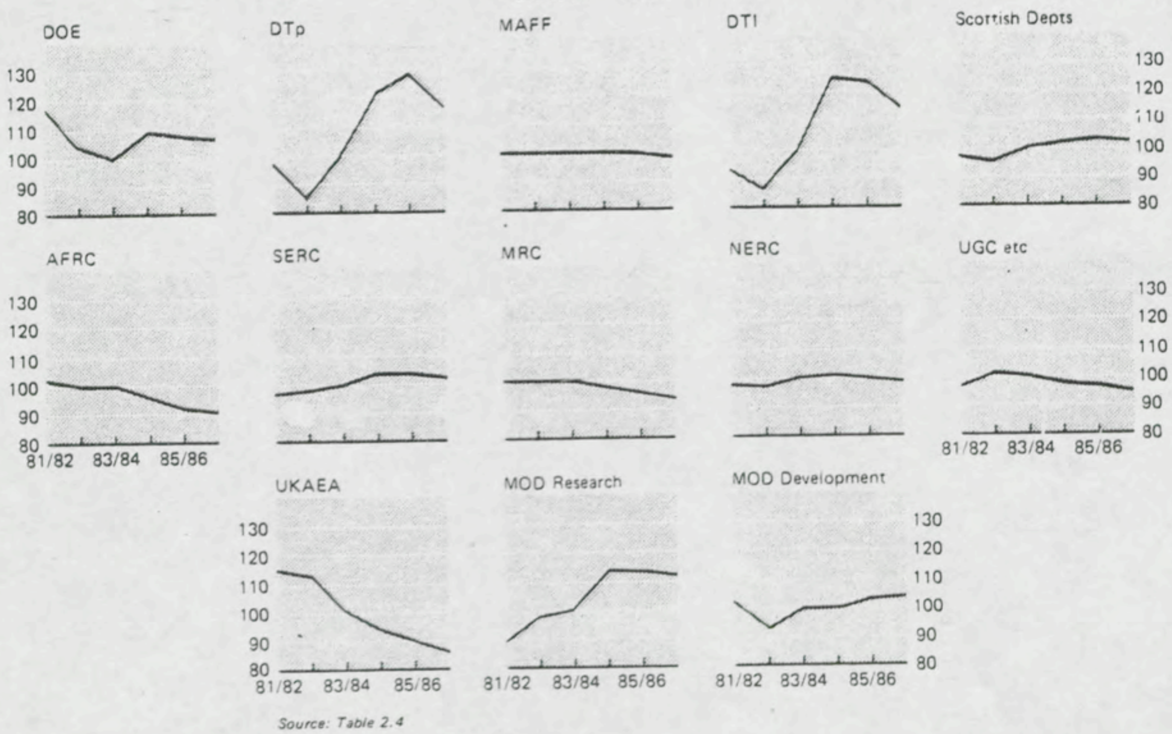
GOVERNMENT R & D EXPENDITURE IN CASH TERMS, 1984/85 PLAN



Source: Table 2.2

Figure 2.2

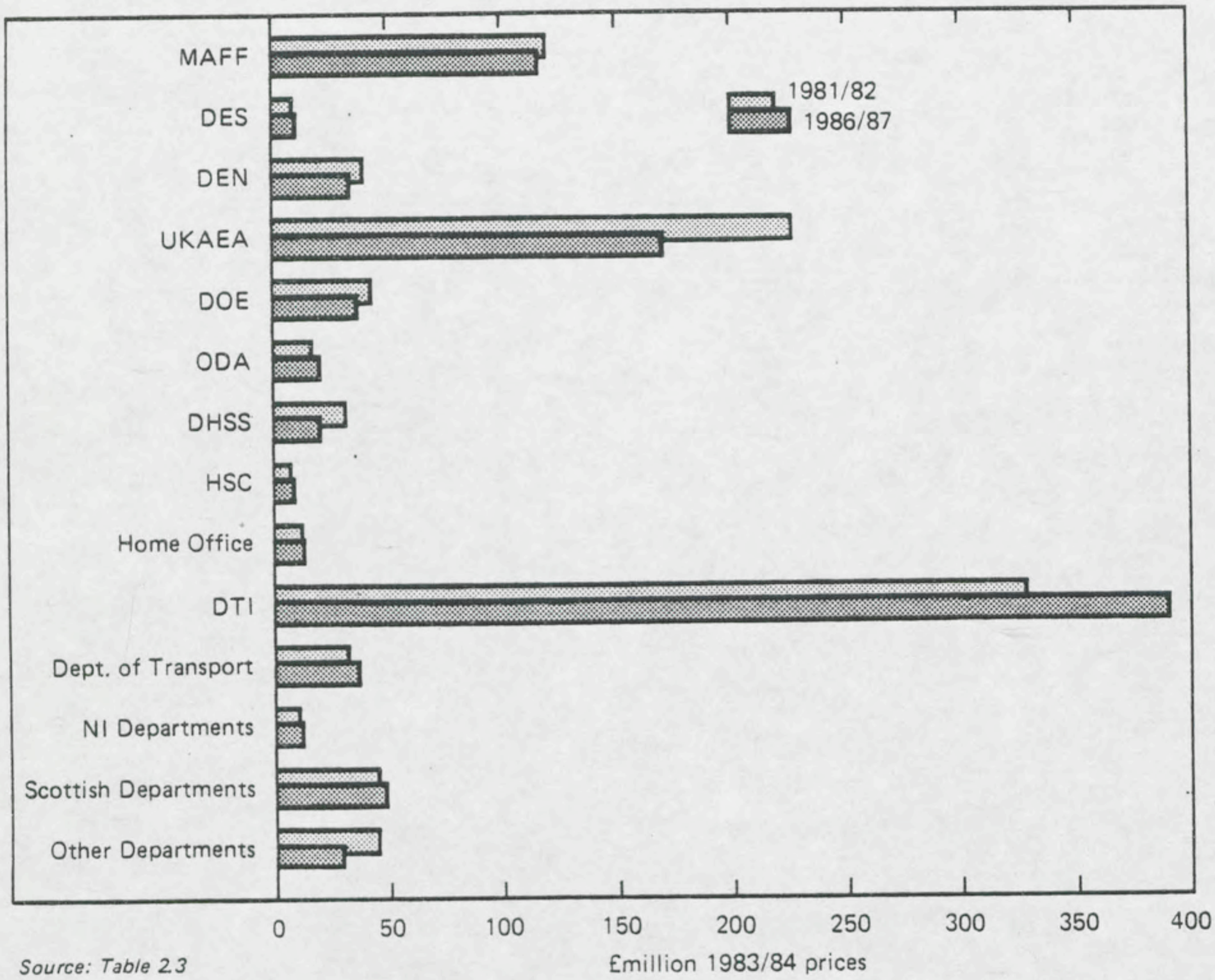
DEPARTMENTAL R & D EXPENDITURES IN COST TERMS
1983/84 = 100



Source: Table 2.4

Figure 2.3

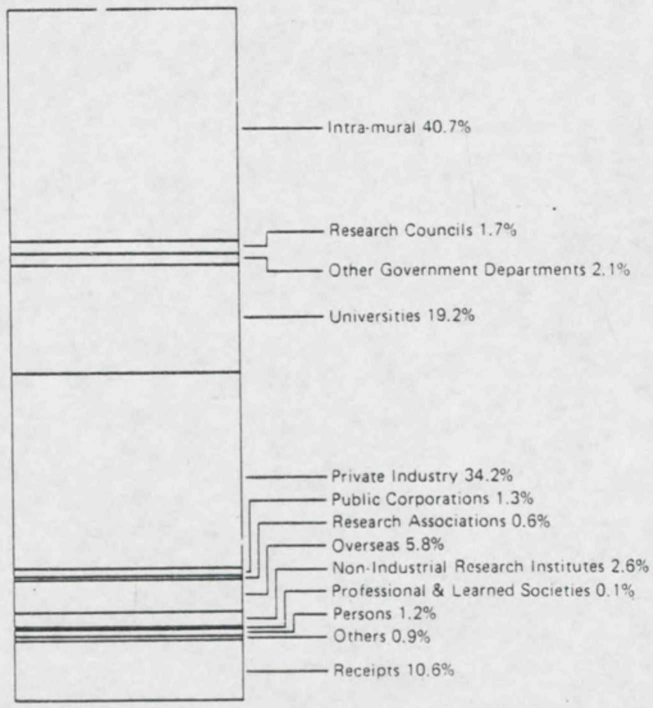
CHANGES IN CIVIL DEPARTMENTAL R & D EXPENDITURES IN COST TERMS
1981/82 - 1986/87



Source: Table 2.3

Figure 2.4

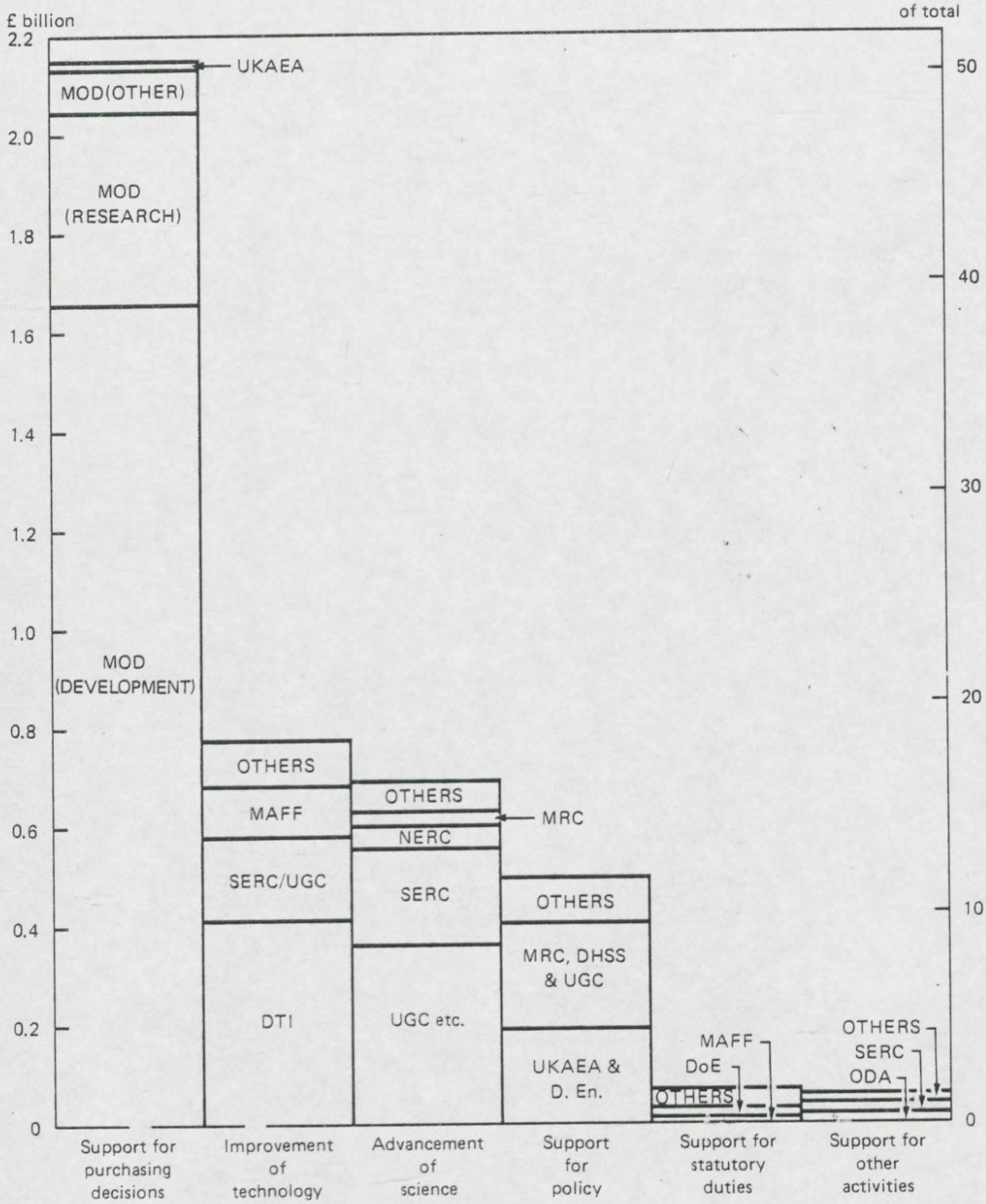
OVERALL DISTRIBUTION OF FUNDING, 1982/83



Source: Table 2.5

Figure 2.5

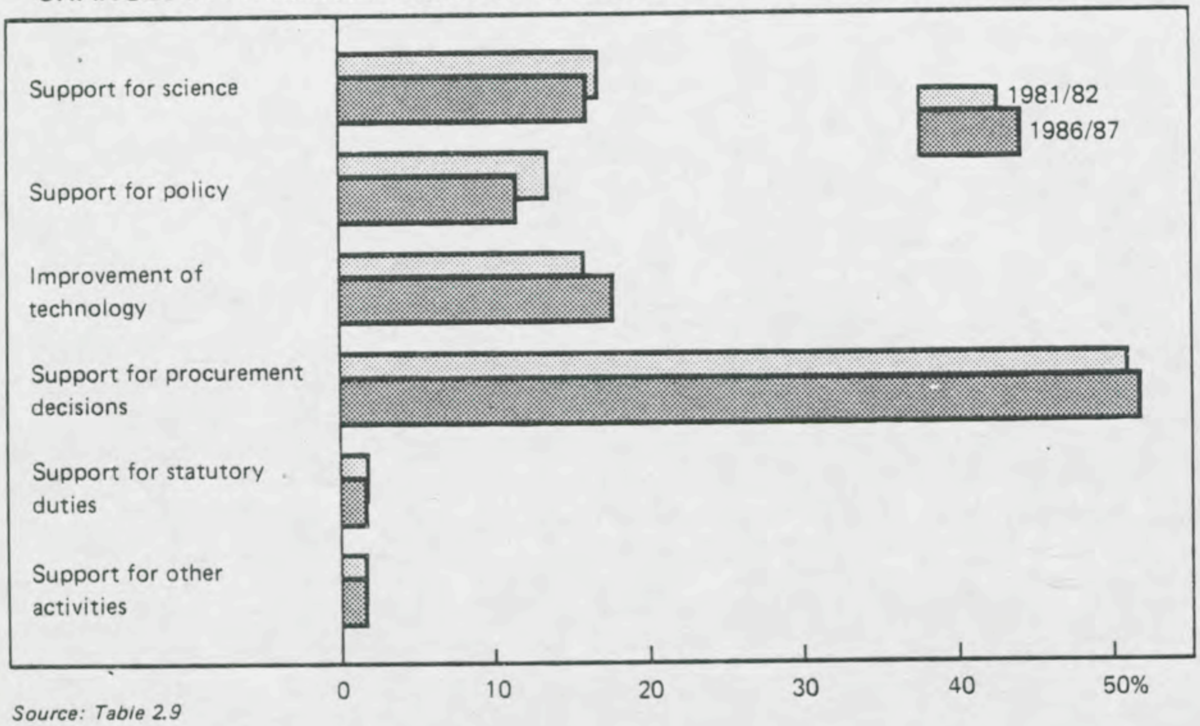
DISTRIBUTION OF R & D EXPENDITURES BY PRIMARY PURPOSE – 1984/85



Source: Tables 2.8, 2.9, 2.11, 2.13, 2.15, 2.17, 2.19, 2.21

Figure 2.6

CHANGES IN PRIMARY PURPOSES FOR GOVERNMENT R & D, 1981/82 - 1986/87

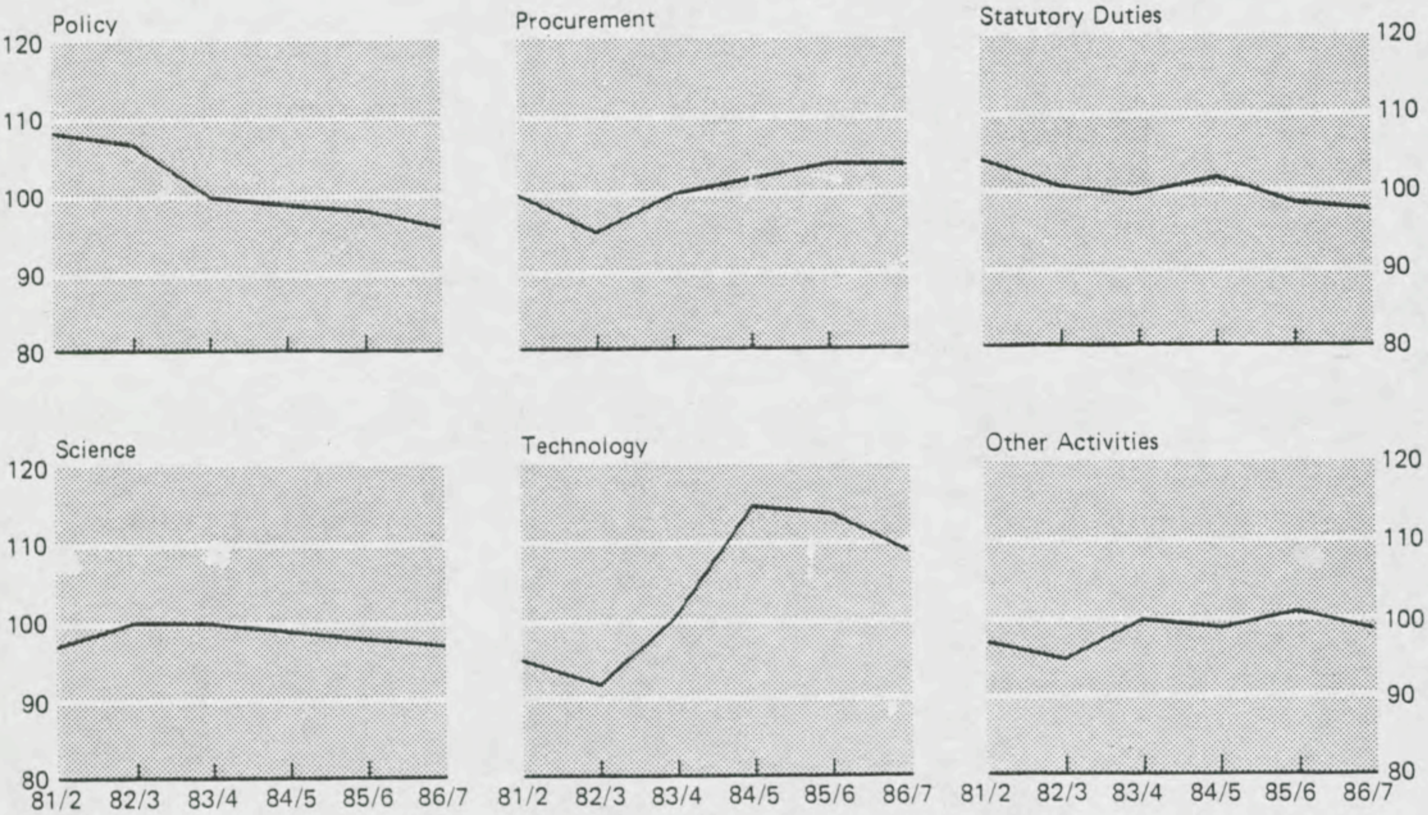


Source: Table 2.9

Figure 2.7

CHANGES IN PRIMARY PURPOSES FOR GOVERNMENT FUNDED R & D 1981/82 - 1986/7 IN COST TERMS

INDEX 1983/4 = 100



Source: Table 2.10

3. INTERNATIONAL COMPARISONS

3.1 Neither firms nor countries have a "correct" level of expenditure on R & D. Comparisons within their industrial sector will demonstrate to the management of a firm whether their expenditure is in line with that of their competitors. But even if it is not, there may be good reasons for the difference. Similarly, comparisons among countries can show whether the pattern of R & D spending in, for example, the UK differs markedly from that in other major industrialised countries - and can therefore indicate where questions over the balance of expenditure might be asked - but they do not of themselves enable any judgements to be made.

3.2 This chapter therefore examines, with the aid of OECD statistics, the broad pattern of government R & D expenditures in six countries - France, the Federal Republic of Germany, Italy, Japan, the UK and the USA. In such comparisons, care is always required because of the different responsibilities of governments, for example in the United Kingdom the nationalised industries undertake R & D which might fall to governments elsewhere. However, in defining how the statistics should be collected OECD seek to ensure that the same activities are included in each country. In general, much greater differences arise from the variation from country to country in government funding of R & D in different sectors of the economy. OECD also seek to allow for the fact that exchange rates do not necessarily reflect purchasing powers by converting national currencies to $US on a "purchasing power parity" basis, thus facilitating comparisons of the volume of R & D funded in each sector.

3.3 Comparisons of absolute expenditures give some indication of the relative resources available for R & D in different countries and therefore the ability of each country to cover a wide spread of scientific and techonological developments. Relative priorities within any country may be illustrated by representing R & D expenditures as percentages of its GDP. Table 3.1 shows absolute expenditures and corresponding percentages of GDP for the total of government R & D expenditures, and major subdivisions, in the six countries selected. The data are the latest available, in general for 1981, but the broad outlines of the expenditure patterns revealed change little from one year to another and may be taken to reflect 1984 spending also.

3.4 It may be seen that government R & D expenditures, expressed as a proportion of GDP, are substantially smaller in Italy and Japan than in the other four countries. In absolute terms, the dominance of US government expenditures is clear and the high proportion of the national total attributable to defence expenditures in the UK and USA, and to a lesser extent in France, is also evident. Other features include: the high proportion of US expenditures on civil space; the low proportion apparently devoted to "advancement of knowledge" in the US (because American practice is to fund much basic research through "mission orientated" agencies such as NASA) ; the high US expenditure on health research (MRC expenditure in the UK is split between "health" and "advancement of knowledge"); and the difference in GDP terms between the European countries on the one hand and the US and Japan on the other in expenditures for industrial growth.

3.5 The contributions of industry, agriculture etc to each country's GDP differ in their relative importance (Table 3.2). It is illuminating to derive, for each country, the ratio between government support for R & D in a broad economic sector, which in general has the aim of improving the technology and hence the competitiveness of that sector, and the sector's contribution to GDP. One aspect that has to be borne in mind is that the manufacturing sector of an economy includes the products of the defence industries. Defence R & D, however, is not undertaken primarily for industrial support purposes. It is therefore appropriate to make the comparison both including and excluding defence R & D expenditures.

3.6 The result is shown in Fig.3.1. This shows that in 1981 government R & D expenditures on industrial development and civil space in France, Germany and the UK were all about 0.65% of the contribution of industry to the respective GDPs whereas the proportion in the USA and Japan was much lower. Because of their larger GDPs, French and German expenditures exceeded those of the UK in absolute terms. If defence expenditures are added, the UK figure rises to about 4%, somewhat above that of the USA. There is considerable variability in other figures, but the UK spends, in GDP terms, more than the other countries on agricultural R & D and, in general, less than France, Germany and the USA in other categories.

TABLE 3.1 GOVERNMENT FUNDED R & D IN OECD COUNTRIES, 1981 BY OECD SOCIO-ECONOMIC OBJECTIVE OF THE R & D PROGRAMME

OECD Objective	France $m(1)	France %GDP(2)	Germany $m	Germany %GDP	Italy $m	Italy %GDP	Japan $m 1980	Japan %GDP	UK $m	UK %GDP	USA $m	USA %GDP
1. Agriculture, Forestry, Fishing	272.5	5.1	145.4	2.3	89.2	2.0	642.8	6.4	242.6	5.2	787.0	2.7
2. Industrial Growth	611.8	11.4	797.5	12.5	553.5	12.2	308.7	3.1	483.8	10.4	106.0	0.4
3. Production of Energy	513.2	9.5	1115.5	17.5	730.8	16.1	664.0	6.6	407.9	8.7	3,501.0	12.0
4. Transport & Telecommunications	166.1	3.1	154.1	2.4	10.1	0.2	73.3	0.7	27.5	0.6	869.0	3.0
5. Urban and Rural Planning	92.2	1.7	134.5	2.1	15.2	0.3	59.3	0.6	56.8	1.2	104.0	0.4
6. Environment Protection	73.4	1.4	131.7	2.1	52.3	1.1	86.0	0.9	70.9	1.5	271.0	0.9
7. Health	309.8	5.8	301.8	4.7	83.6	1.8	154.8	1.5	69.2	1.5	4,014.0	13.8
8. Social Development Services	86.1	1.6	301.9	4.7	40.7	0.9	42.9	0.4	65.5	1.4	557.0	1.9
9. Earth and Atmosphere	197.4	3.7	207.9	3.3	56.1	1.2	74.6	0.7	44.3	0.9	662.0	2.3
10. Advancement of Knowledge	1,710.4	31.8	3,104.2	48.7	964.6	21.2	2804.0	28.1	1,403.2	30.0	1,340.0	4.6
11. Civil Space	291.7	5.4	303.1	4.8	174.0	3.8	302.8	3.0	127.9	2.7	4,924.0	16.9
13. Other	46.3	0.9	-	-	13.1	0.3	-	-	-	-	-	-
Total Civil	4,370.8	81.2	6,698.1	105.0	2,783.1	61.2	5,213.0	52.2	3,000.0	64.2	17,134.0	58.9
12. Defence	2,591.3	48.2	646.7	10.1	192.1	4.2	123.7	1.2	3,256.2	69.7	18,413.0	63.4
TOTAL	6,962.1	129.4	7,344.8	115.1	2,975.2	65.4	5,336.7	53.4	6,256.2	133.9	35,547.0	122.3

Source: OECD Science and Technology Indicators, Basic Statistical Series
Volume A, The Objectives of Government R & D Funding, May 1983

Notes

1. $m - Millions of US $ at Current Prices and Exchange Rates (Purchasing Power Parities);
2. % GDP - Percentage of Gross Domestic Product * 100.

TABLE 3.2: COMPONENTS OF GROSS DOMESTIC PRODUCT BY KIND OF ECONOMIC ACTIVITY IN OECD COUNTRIES, 1981. PERCENTAGES

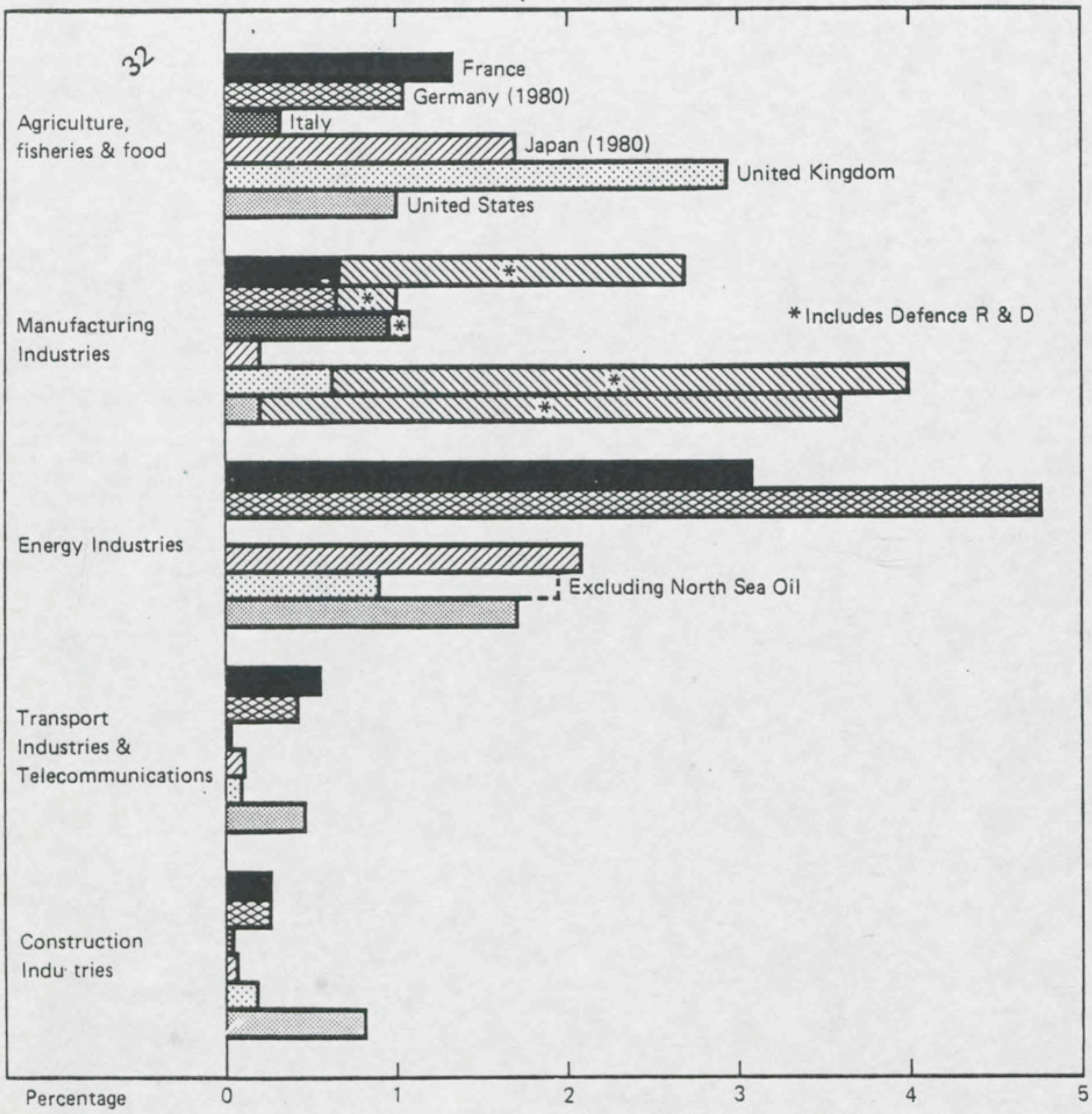
	France	Germany (1)	Italy	Japan (1)	UK	UK (2)	USA
A INDUSTRIES							
Agriculture, hunting forestry and fishing	3.8	2.1	5.9	3.5	2.0	2.1	2.7
Mining and quarrying	0.9	0.9)	29.1	0.5	6.2	1.5	4.4
Manufacturing	25.1	33.1)		30.7	20.1	21.2	22.4
Electricity gas & water	2.2	2.6	4.4	2.9	2.7	2.8	2.6
Construction	6.6	6.7	8.0	9.0	5.6	5.7	4.4
Wholesale and retail trade, restaurants and hotels	12.4	11.0	15.2	12.4	8.1	8.5	16.9
Transport storage and communication	5.5	5.7	6.5	6.9	6.8	7.1	6.4
Finance, insurance, real estate, & business services	17.7	10.0)	18.5	15.4	13.4	14.0	20.6
Community, social and personnel services	8.1	10.8)		11.8	11.7	12.3	8.1
Less: imputed bank service charge	-4.6	-3.7	-4.7	-4.1	-5.0	-5.2	-2.4
Statistical discrepancy	-	-	-	-	-	-	1.3
Sub-total: Industries	77.7	79.2	82.7	88.9	71.4	70.0	87.5
B PRODUCERS OF GOVERNMENT SERVICES	12.4	11.6	13.5	8.8	13.1	13.8	12.3
C OTHER PRODUCERS	0.7	1.8	0.7	1.8	1.4	1.4	-
Import Duties	9.2	0.9	3.1	0.4	14.8	15.6	0.3
Statistical Discrepancy	-	6.5	-	0.1	-0.7	-0.7	-0.1
TOTAL	100.0	100.0	100.0	100.0	100.0		100.0

Source = National Accounts 1964-1981, Organisation for Economic Co-operation and Development Paris 1983, Volume II Detailed Tables

(1) 1980 data
(2) UK Excluding North Sea Oil and Gas

Figure 3.1

Ratio of Government R & D expenditure in support of certain sectors of the economy to the contribution by those sectors to the GDP
International comparison



Sources: R & D data – Table 3.1 plus OECD (unpublished)
GDP data – Table 3.2

4. R & D EXPENDITURE AND THE ECONOMY

4.1 Expenditures for the purposes of improving technology or in support of public purchasing decisions have an impact on the economy. Such expenditures have where possible been related to 1980 Standard Industrial Classification (SIC) product groups, the result being Tables 4.1. and 4.2. Defence expenditures particularly appear heavily concentrated in a few product groups, mainly related to aerospace and electronics, but some care is required in interpreting Table 4.2 since a number of major defence products (eg torpedoes) are not easily accommodated within the product group structure and the concentration of expenditures in certain groups may therefore be enhanced. Expenditures to improve technology in agriculture, forestry and fisheries and the construction industry are included in the tables for completeness.

4.2 Other aspects of the UK economy may also be related to these product groups. The latest information on total R & D expenditures in the private sector of industry, public corporations and Research Associations was provided by DTI's 1981 survey, the first results of which were reported in late 1983(1). Table 4.3 therefore concentrates on 1981 and gives information on the distribution by broad industrial sector and by product group of the following aspects of the UK economy in that year:

Gross output
Gross value added
Private industry's funding of R & D
Exports
Imports
Employment

4.3 The distribution of Government R & D expenditures may then be compared with the distributions of these or derived features of the economy, as shown in Figure 4.1. This compares Government R & D expenditures with:

Industrial R & D expenditures
Gross output
Gross value added per employee

Proportion of exports
Balance of trade.

4.4 It may be seen that there is, in general, no clear correlation among these aspects of the economy. Aerospace, for example, is heavily supported by Government funds and successful in international markets, but does not have a particularly high gross added value per employee. Chemicals and pharmaceuticals are also successful internationally, have high added value per employee, but receive little Government support for R & D. The relationship between R & D expenditure and commercial success is not straightforward and will need to be explored in more detail in future Reviews.

(1) British Business, 9 December 1983.

Table 4.1

CIVIL R & D EXPENDITURE FOR IMPROVEMENT OF TECHNOLOGY OR IN SUPPORT OF PUBLIC PURCHASING BY PRODUCT GROUP, WHERE APPLICABLE
£millions

PRODUCT GROUP	81/82	82/83	83/84	84/85	85/86	86/87
1. Extractive industries	4.2	4.7	4.7	5.8	5.9	5.0
2. Mineral oil refining	0.6	0.6	0.6	0.4	0.0	0.0
4. Iron and Steel	8.5	5.0	6.5	7.3	7.4	7.5
5. Non-ferrous metals	4.1	2.8	3.4	3.7	17.7	3.9
6. Bricks, cement building materials	1.3	0.7	0.8	0.5	0.5	0.5
7. Pottery, china and glass	1.4	0.6	1.1	1.1	1.2	1.2
8. Synthetic resins and plastic materials	2.0	3.6	3.9	4.1	4.3	4.3
9. Paint	0.3	0.4	0.4	0.5	0.5	0.5
10. Pharmaceutical products	0.9	1.7	2.4	3.8	5.0	6.0
11. Other chemical products	1.8	2.3	4.5	6.4	8.4	8.7
12. Metal goods	0.0	0.0	0.0	0.0	0.0	0.0
13. Industrial plant and steelwork	3.8	6.4	9.3	6.6	6.8	4.0
14. Metal-working machine tools	4.9	8.3	9.7	7.7	8.1	6.6
15. Construction, earth-moving equipment	2.2	3.6	4.2	2.8	3.1	2.3
16. Other machinery and equipment	9.5	11.2	13.1	11.6	10.4	6.6
17. Office machinery	0.0	0.5	2.0	0.0	0.0	0.0
18. Electronic data processing equipment	13.2	23.4	23.1	19.5	20.1	19.0
19. Insulated wires and cables	0.1	0.1	0.1	0.3	0.1	0.2
20. Basic electrical equipment	0.9	2.8	4.2	1.3	1.5	1.6
21. Telegraph and telephone apparatus	0.7	2.1	5.2	5.2	6.0	6.0
22. Electrical instruments & control systems	7.7	9.6	15.3	18.3	19.9	18.3
23. Radio and electronic capital goods	2.7	5.2	5.5	5.6	5.8	5.8
24. Components other than active components	1.3	1.2	0.4	0.8	1.0	1.1
25. Active components and electronic sub-assemblies	0.1	0.2	0.2	0.3	0.3	0.3
26. Other electronic equipment	2.7	8.2	6.2	12.2	10.2	10.2
27. Other electrical goods	0.2	0.5	4.7	8.9	14.4	14.9
28. Motor vehicles and parts	8.4	8.3	11.8	13.3	10.8	11.4
29. Shipbuilding and repairs	2.5	2.5	2.3	3.1	3.1	3.1
30. Aerospace equpmnt, manufacture & repair	118.6	87.0	112.2	129.9	141.9	131.3
31. Instrument engineering	0.6	1.2	1.3	1.3	1.4	1.7
32. Food and drink	15.9	18.0	18.8	19.6	20.2	22.3
34. Textiles other than man-made fibres	1.8	2.1	1.9	3.0	2.8	2.3
35. Leather, footware and clothing	1.3	1.0	1.1	2.2	1.8	1.5
37. Paper etc, printing and publishing	1.4	1.0	1.4	2.1	2.1	1.9
38. Processing of rubber and plastics	2.9	2.4	3.0	3.6	4.1	4.6
39. Other manufacturing industries	1.5	1.3	1.7	2.8	3.2	3.7
40. Construction	11.1	11.7	13.3	14.8	15.8	16.5
42. Agriculture, forestry, fishing	161.8	169.0	180.4	187.6	156.5	157.4
TOTAL	403.1	411.3	480.9	518.2	522.5	492.5

Table 4.2

DEFENCE R & D EXPENDITURES - DISTRIBUTION BY PRODUCT GROUP, WHERE APPLICABLE, 1981/82.

PRODUCT GROUP NO	£million
8 - 11	31
13	1
14	1
16	147
18	20
20	5
21 - 24	346
25 - 26	62
27	4
28	26
29	56
30	483
31	125
35	2
37	3
41	5
TOTAL	1317

Table 4.3 UK ECONOMIC INDICATORS BY PRODUCT GROUP

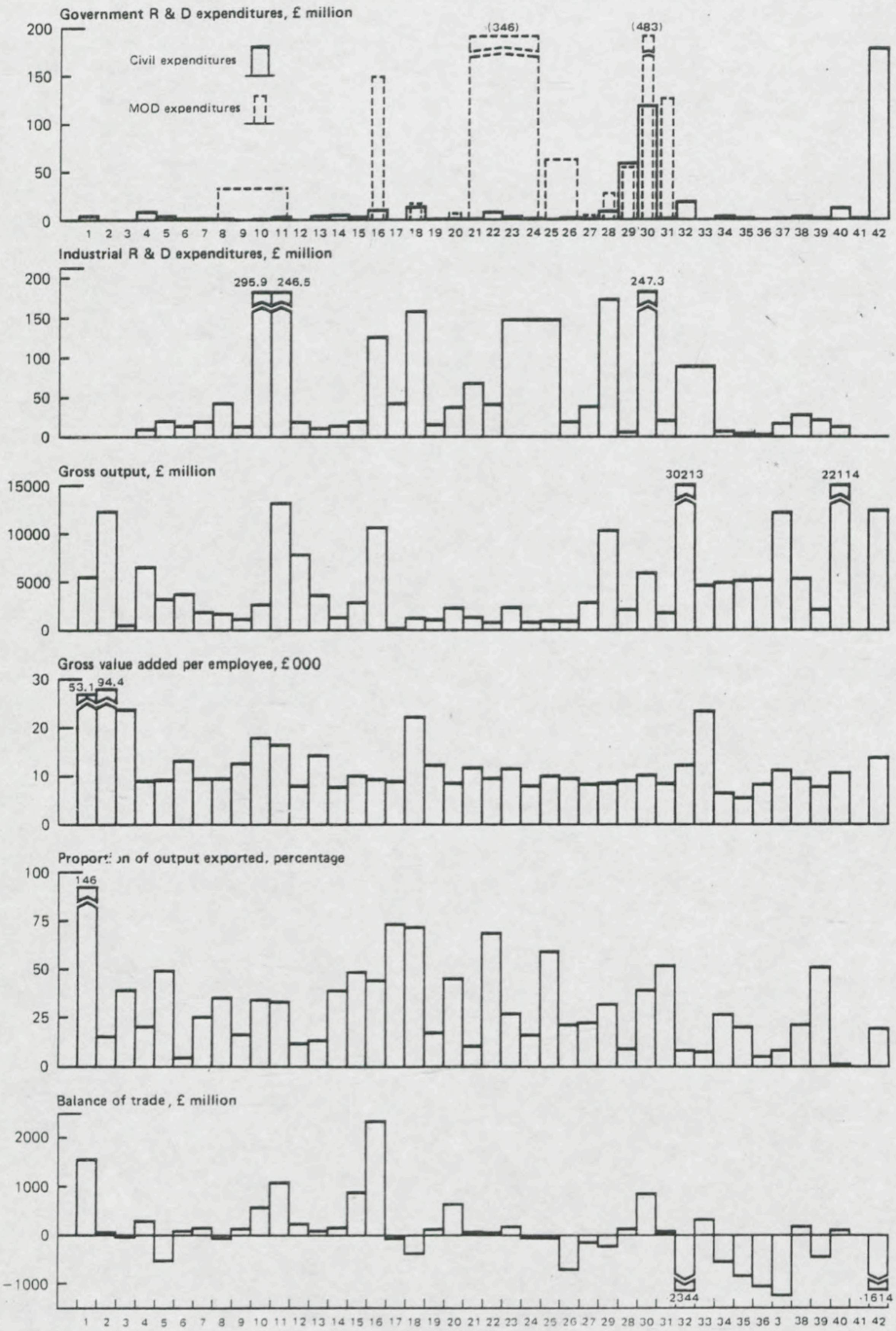
£millions

PRODUCT GROUP	GROSS OUTPUT	GROSS VAL ADDED	INDUSTRIAL R & D	EXPORTS	IMPORTS	EMPLOYMENT thousands
1. Extractive industries	19105	15731	)	(8122	6577	296.1
2. Mineral oil refining	12335	1621	) 120.0	(1898	1869	17.2
3. Other treatment of petroleum products	539	150	)	(211	224	6.3
4. Iron and steel	6517	1566	9.3	1330	1033	172.9
5. Non-ferrous metals	3233	600	19.2	1589	2118	65.5
6. Bricks, cement, building materials etc	4255	1664	12.5	203	118	125.5
7. Pottery, china and glass	1979	957	19.3	498	340	101.4
Chemical industry						
8. Synthetic resins and plastic materials	1653	269	41.2	586	659	28.3
9. Paint	1136	364	13.1	184	62	29.0
10. Pharmaceutical products	2641	1255	295.9	892	344	69.8
11. Other chemical products	13143	3727	246.5	4387	3191	224.6
12. Metal goods	7826	3204	19.2	950	739	399.6
Mechanical engineering						
13. Industrial plant and steelwork	3662	1856	10.6	495	419	129.7
14. Metal-working machine tools etc	1318	660	11.5	520	384	82.6
15. Construction, earth-moving, equipment etc	2954	1105	19.9	1420	545	109.5
16. Other machinery and equipment	10665	4521	126.6	4661	2293	486.2
17. Office machinery	189	85	41.4	139	172	9.6
18. Electronic data processing equipment	1270	641	157.4	917	1317	28.9
Electrical and electronic engineering						
19. Insulated wires and cables	1058	367	15.7	177	76	30.2
20. Basic electrical equipment	2324	1020	38.4	1043	405	118.5
21. Telegraph and telephone apparatus etc	1352	725	68.6	131	96	61.0
22. Electrical instruments & control systems	707	333	40.4	485	473	34.5
23. Radio and electronic capital goods	2361	1104	147.5	635	453	95.5
24. Components other than active components	742	378	) 55.4	(117	172	47.1
25. Active components and electronic subass'ys	907	424	)	(535	624	41.6
26. Other electronic equipment, active compts and electronic sub-assemblies	895	218	19.8	187	904	23.0
27. Other electrical goods	2929	1195	37.5	645	791	144.5
28. Motor vehicles and parts	10317	3265	173.0	3316	3526	381.6
29. Shipbuilding and repairs	2044	1070	5.7	182	65	118.4
30. Aerospace equpmnt, manufacture & repair	5298	2030	247.3	2329	1506	199.6
31. Instrument engineering	1745	771	20.0	905	869	92.1
32. Food and drink	30213	7637	) 88.2	(2569	4913	623.6
33. Tobacco	4629	786	)	(354	50	33.3
34. Textiles other than man-made fibres	4917	1793	8.7	1317	1865	267.3
35. Leather, footware and clothing	5070	2049	4.1	1010	1832	360.1
36. Timber and wooden furniture	5189	1760	2.5	278	1390	216.1
37. Paper etc, printing and publishing	12422	5384	17.5	984	2224	483.6
38. Processing of rubber and plastics	5379	2092	29.2	1126	[illegible]	221.1
39. Other manufacturing industries	2154	881	20.7	1104	1567	115.6
40. Construction (1)	22114	12955	13.0	136	22	1252.0
42. Agriculture, forestry, fishing (1)	12487	4901	0.0	893	2507	351.0
TOTAL	231673	93114	2216.8	49460	49737	7694.0

(1) The economic indicators for Construction and Agriculture etc are not necessarily on the same basis as those of the other product groups

Figure 4.1

R & D EXPENDITURE AND THE UK ECONOMY 1981, BY PRODUCT GROUP



5. R & D IN SUPPORT OF PUBLIC PURCHASING.

5.1 As Table 2.17 indicated, expenditures in support of defence procurement are by far the largest component of this category. Defence makes great demands of technology and R & D accounts for a correspondingly high proportion of procurement costs, but this proportion has fallen in recent years, as shown below:

	1978/9(O)	1981/2(O)	1984/5(E)
Defence procurement (excluding R & D) £million	2275	4433	6428
R & D as a proportion of procurement	45%	38%	33%

E - Estimate O - outturn
Source - Statement on the Defence Estimates 1984, Cmnd 9227 - II

5.2 At the other extreme, the Supply Estimates for 1984/5 show that the Government intend to spend approximately £1600 million on the purchase and maintenance of buildings, £822 of this being for capital works. This is directly supported by a £2.5 million R & D programme (0.3% of the capital expenditure) and, indirectly, by the other research funded to improve building and construction technology (£3.8 million).

5.3 The Supply Estimates also show that in 1984/5 the Government intend to spend £943 million on the construction of motorways and major trunk roads and £100 million on their maintenance. This is supported by a £9.1 million R & D programme (1% of capital expenditure).

5.4 Substantial R & D programmes in support of public purchasing decisions are carried out by nationalised industries. Some of these come to Ministers for formal approval. Information on these has not been assembled in the same detail as in the remainder of the Review but the table below indicates the scale of the expenditures. It also includes the capital investment of the industries; some of the R & D, of course, is related to operation rather than purchasing but the division is, in general, not indicated in annual reports.

£million			
	R & D	Capital expenditure	R & D as a proportion of capital expenditure
British Gas	45(1)	801	5.6
NCB	32(1)	740	4.3
CEGB	40(2)	925	4.3
British Telecom	172	1324	12.8
British Rail	14(4)	400	3.5

(1) excluding R & D on utilisation

(2) some UKAEA costs are relevant to the electricity supply industry.

(3) total "investment" expenditure

(4) including Departure of Transport contribution to joint programme.

Sources: 1982/3 annual reports and British Rail.

6. "SEEDCORN" RESEARCH

6.1 In the past few years concern has been expressed over a possible national decline in "strategic" research. Such research is not formally defined in the Frascati framework but is essentially research which, while having some application in view (ie it is not undertaken purely in order to gain knowledge) is not expected to find application for some years, typically of the order of a decade. In order to gain an insight into Government funding of such long term research, Departments and Research Councils were asked to indicate their expenditures on applied research that would not find application before 1990. In total some £140 million of expenditures, mostly by MOD, DTI and the Research Councils were so classified.

6.2 Some care is, though, required in drawing conclusions from this figure. Respondents had some difficulty in identifying expenditures which fell into this category and the true total may therefore be higher. Further, it is possible for research defined in the Frascati framework as "basic" ie that in the "advancement of science" category in the Review, to have long term, but unspecific, application in view and it can be argued that such research should be included in this category. Finally, some research areas (eg plant breeding and weapons development) have long timescales and so results will find application later even though the work is no more speculative or "basic" in character than work in other fields that will find application before 1990. The Advisory Board for the Research Councils are to consider further the definition of strategic research, with a view to the provision of improved data in the 1985 Review.

7. MANPOWER IN R & D

7.1 Table 7.1 shows the numbers of qualified scientists and engineers (QSEs) engaged on R & D in Departments and Research Councils in the years covered by the Review. In general, the numbers reflect the decline in Civil Service complement over these years. For comparison, private industry in 1981 employed 67,000 QSEs on R & D (1) and public corporations and Research Associations a further 3000. In 1981/2 there were 19,300 full-time staff undertaking teaching and research in relevant subjects in universities (2) and a further 8000 full-time research staff. In total, these might be taken to be equivalent to about 14000 full time research staff. Government therefore accounted for about 20% of the national total of QSE´s engaged on R & D.

(1) British Business, 9 December 1983

(2) Universities Statistical Record, 1981/2, Volume 1

Table 7.1

R & D MANPOWER (PERSONS WITH DEGREE OR EQUIVALENT ONLY)

Department	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Civil Departments						
MAFF	1575	1572	1487	1470	1464	1458
DES	4	4	5	5	5	5
DEn	40	37	37	38	39	39
UKAEA	3430	3481	3509	3392	3160	2957
DoE	615	565	562	559	555	552
FCO	2	2	2	2	2	2
ODA	172	170	170	165	165	162
DHSS	224	228	233	234	234	220
HSC	111	89	107	107	107	107
Home Office	200	187	192	199	203	203
DTI	947	917	783	783	780	770
Department of Transport	395	368	356	339	334	327
N I Departments	113	115	116	116	116	116
Scottish Departments	169	158	193	189	189	189
Other Departments	440	420	456	452	448	448
TOTAL Civil Departments	8437	8313	8208	8050	7801	7555
Research Councils						
AFRC	2585	2590	2595	2550	2345	2175
ESRC	113	102	102	91	100	100
MRC	1472	1499	1500	1500	1490	1490
NERC	1662	1650	1635	1593	1542	1498
SERC	1110	1143	1147	1147	1147	1140
TOTAL Research Councils	6942	6984	6979	6881	6624	6403
TOTAL Civil	15379	15297	15187	14931	14425	13958
Ministry of Defence	5262	5165	4878	4844	4812	4758
TOTALS	20641	20462	20065	19775	19237	18716

ANNEX A

BACKGROUND TO THE ANNUAL REVIEW PROCESS

The following is an extract from Cmnd 8591, the Government's observations on the first report of the House of Lords Select Committee on Science and Technology, "Science and Government", dated July 1982.

> "The Government have therefore decided to introduce a system of "Annual Reviews of Research". Departments will submit a summary of their research programmes and budgets to be reviewed-inter-departmentally, with independent advice from ACARD, during the early months of the year; this timetable would allow Departments to revise their plans during the next PES cycle in the ight of the results of the Review".
>
> "The analyses required will not be a fascile choice of areas where more money should be spent. In the Govenment's view, overall UK expenditure on Research and Development as a percentage of GDP is sufficient. Skillful valued judgements as to allocation of financial and manpower resources are, however, needed. This will involve distinguishing between vital and dormant areas, identifying gaps, disparities and duplications, and considering the opportunity cost of relinquishing certain areas of research. The emphasis will be on review of long-term plans".

(Paragraphs 20-21)

ANNEX B

FRASCATI DEFINITION OF R&D

The following is an extract from "The Measurement of Scientific and Technical Activities, Frascati Manual 1980", OECD, Paris 1981.

BASIC DEFINITIONS AND CONVENTIONS

2.1 RESEARCH AND EXPERIMENTAL DEVELOPMENT (R&D)

43. Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications.

R&D is a term covering three activities: basic research, applied research and experimental development. Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view. Applied research is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective. Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience that is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.

2.2 ACTIVITIES TO BE EXCLUDED FROM R&D

44. For survey purposes R&D must be distinguished from a wide range of related activities with a scientific and technological base. These other activities are very closely linked to R&D through flows of information and in terms of operations, institutions and personnel, but they should, as far as possible, be excluded when measuring R&D.

45. These activities will be discussed here under three headings -

- Education and training (see 2.2.1);
- Other related scientific and technological activities (see 2.2.2);
- Other industrial activities (see 2.2.3).

The definitions here are practical and designed solely to exclude these activities from R&D. They are thus slightly different from the broader concepts of scientific and technological services (STS) and "innovation" discussed in an earlier Chapter.

2.2.1. Education and Training

46. All education and training of personnel in the natural sciences, engineering, medicine, agriculture, the social sciences and the humanities in universities and special institutions of higher and post-secondary education. However, bona fide research by post-graduate students carried out at universities should be counted, wherever possible, as a part of R&D.

2.2.2 Other Related Scientific and Technological Activities

47. The following activities should be excluded from R&D except where carried out solely or primarily for the purposes of an R&D project (see also examples in section 2.3.1).

2.2.2.1 Scientific and Technical Information Services

48. The specialised activities of -

- collecting)		- scientific and technical personnel
- coding)		
- recording)		- bibliographic services
- classifying)		- patent services
- disseminating)	by	- scientific and technical information extension and advisory services
- translating)		
- analysing)		
- evaluating)		- scientific conferences

except where conducted solely or primarily for the purpose of R&D support (eg the preparation of the original report of R&D findings) should be included in R&D.

2.2.2.2 General Purpose Data Collection

49. Undertaken generally by government agencies to record natural, biological or social phenomena that are of general public interest or that only the government has the resources to record. Examples are routine topographical

mapping, routine geological, hydrological, oceanographic and meteorological surveying, astronomical observations. Data collection conducted solely or primarily as part of the R&D process is included in R&D (eg data on the paths and characteristics of particles in a nuclear reactor). The same reasoning applies to the processing and interpretation of the data. The social sciences, in particular, are very dependent on the accurate record of facts relating to society in the form of censuses, sample surveys, etc. When these are specially collected or processed for the purpose of scientific research the cost should be attributed to research and should cover the planning, systematising etc, of the data. But data collected for other or general purposes, such as quarterly sampling of unemployment, should be excluded even if exploited for research. Market surveys are excluded.

2.2.2.3 Testing and Standardisation

50. Refers to the maintenance of national standards, the calibration of secondary standards and routine testing and analysis of materials, components, products, processes, soils, atmospheres, etc.

2.2.2.4 Feasibility Studies

51. Investigation of proposed engineering projects using existing techniques in order to provide additional information before deciding on implementation. In the social sciences, feasibility studies are investigations of the socio-economic characteristics and implications of specific situations (eg a study of the viability of a petro-chemical complex in a certain region). However, feasibility studies on research projects are part of R&D.

2.2.2.5 Specialised Medical Care

52. Refers to routine investigation and normal application of specialised medical knowledge. There may, however, be an element of R&D in what is usually called "advanced medical care", carried out, for example, in university hospitals.

2.2.2.6 Patent and Licence Work

53. All administrative and legal work connected with patents and licences. (However, patent work connected directly with R&D projects is R&D.)

2.2.2.7 Policy Related Studies

54. Policy in this content refers not only to national policy but also to policy at the regional and local levels, a well as that of business enterprise in the pursuit of their economic activity. Policy related studies cover a range of activities such as the analysis and assessment of the existing programmes, policies and operations of government departments and other institutions; the work of units concerned with the continuing analysis and monitoring of external phenomena (eg defence and security analysis); and the work of legislative commissions of inquiry concerned with general government or departmental policy or operations.

2.2.3 Other Industrial Activities

55. These can be considered under two, to some extent overlapping, headings -

2.2.3.1 Industrial Innovation (not elsewhere classified)

56. All those scientific, technical, commercial and financial steps, other than R&D, necessary for the successful development and marketing of a manufactured product and the commercial use of the processes and equipment.

2.2.3.2 Production and Related Technical Activities

57. Industrial production and distribution of goods and services and the various allied technical services in the Business Enterprise sector and in the economy at large, together with allied activities using the disciplines of the social sciences such as market research.

2.3 THE BOUNDARIES OF R&D

2.3.1 The Basic Criterion

58. The basic criterion for distinguishing R&D from related activities is the presence in R&D of an appreciable element of novelty. (Supplementary criteria are suggested elsewhere in the Manual.) One aspect of this criterion is that a particular project may be R&D if undertaken for one reason but if carried out for another reason will not be considered R&D. This is shown in the following examples -

a. In the field of medicine, routine autopsy on the causes of death is simply the practice of medical care and not R&D; special investigation of a particular mortality in order to establish the side effects of certain cancer treatments is R&D. Similarly, routine tests such as blood and bacteriological tests carried out for doctors are not R&D but a special programme of blood tests in connection with the introduction of a new drug is R&D.

b. The keeping of daily records of temperatures or of atmospheric pressure is not R&D but the operation of a weather forecasting services or general data collection. The investigation of new methods of measuring temperature is R&D, as are the study and development of new systems and techniques for interpreting the data.

c. R&D activities in the mechanical engineering industry often have a close connection with design and drawing work. Usually there are not special R&D departments in small and medium size companies in this industry and R&D problems are mostly dealt with under the general heading "design and drawing". If calculations, designs, workshop drawing and operating instructions are made for the setting-up and operating of pilot plants and prototypes, they should be included in R&D. If they are carried out for the preparation, execution and maintenance of production standardisation (eg jigs, machine tools) or to promote the sale of products (eg offers, leaflets, spare parts catalogues) they should be excluded from R&D.

d. Many social scientisits perform work in which they bring established methodologies and facts of the social sciences to bear on a particular problem, but which cannot be classified as research. The following are examples of work which might come in this category and are not R&D: interpretative commentary on the probable economic effects of a change in the tax structure, using existing economic data; forecasting future changes in the patterns of the demand for social services within a given area arising from an altered demographical structure; operations research (OR) as a contribution to decision marking eg planning the optimal distribution system for a factory; the use of standard techniques in applied psychology to select and classify industrial and military personnel, students, etc, and to test children with reading or other disabilities.

End of extract.

The manual then discusses problems at the borderlines between R&D and education and training, other related scientific and technological activities, and other industrial activities. Further chapters cover the classification of institutions involved in R&D, functional classifications, the measurement of personnel and expenditure devoted to R&D, survey procedures, R&D deflaters (used for trend analysis in reel terms) and exchange rates (to facilitate international comparisons) and the classification of the socio-economic objectives of Government R&D funding.

The Manual is available through HMSO.

MARINE SCIENCE AND TECHNOLOGY

Introduction

1. Cmnd 8591 stated that the Annual Review would seek to identify gaps and overlaps in research expenditure. The information in the first part of the Review is too general for this purpose; more detailed investigations of specific areas of science and technology are required. Marine science and technology was chosen as the first area for study because of the wide range of Departmental and Research Council interests in this field.

The data

2. Following consultation with the principal funding bodies, a two-dimensional scheme for classification of expenditures was drawn up. This reflected both the policy aims arising from Departmental responsibilities and the scientific and technological areas of study. R & D expenditures (using the Frascati definition) were then analysed in accordance with this scheme, the result being shown in Table C.1. More detailed information on the largest areas of expenditure - the design and operation of ships, submarines etc - is shown in Table C.2.

3. Inevitably, some compromises were necessary in the construction of the classification scheme. Work on pollution, for example, is split between three main subject headings, and some research undertaken with the objective of energy production will also be relevant to mineral extraction. But the tables illustrate the range of Departments and Research Councils funding work in particular subject areas - SERC, DOE, MAFF and DAFS, for example, all undertake work on sea bed sediments with the objective of environmental protection; DTI, NERC, MAFF and DAFS undertake work on fish cultivation with the objective of obtaining food from the sea. The tables also illustrate the dominance, over the total field, of funding for defence needs (Figure C.1). In line with the main part of the Review, Figure C.2 shows the distribution of expenditures by primary purposes.

4. In addition to the data on R & D expenditures, information on major capital facilities was also sought. These mainly take the form of ship (or offshore

structure) model testing facilities, details of which are shown in Table C.3.

Commentary

5. As is evident from the list of subject areas, marine science and technology covers a very wide range of subjects. Co-ordination across the whole range may not be required, but it is clearly necessary for all funding bodies to be aware of the interests of others within a particular subject area. Some cross-membership of research committees takes place and joint research programmes exist, but the expected winding-up of the Marine Technology Directorate of SERC in 1985 will remove from some subject areas a focus of research interest.

6. As for the provision of capital facilities, further investigation would be required, including comparisons with other countries, before any conclusions could be reached on whether there was over-provision in the UK. Different facilities have different characteristics and capabilities, but there seems cause for considering whether the present provision of facilities, as shown in Table C.3, is excessive for a shipbuilding industry whose output declined in real terms by some 30% between 1975 and 1981, even when the needs of the off-shore industry are taken into account.

Table C.1 ANNUAL EXPENDITURE ON R&D IN MARINE SCIENCE AND TECHNOLOGY

All figures are in £ thousands SUBJECT AREA	Transport	Energy production	Environmental protection	Mineral extraction	Food from the sea	Defence	Underpinning research	TOTAL
1 PHYSICAL OCEAN ENVIRONMENT								
Circulation - including distribution & monitoring of pollution		DEn 210	SERC 10 DOE 150 MAFF 3040 DAFS 340				NERC 870 SERC 10	
Tides	Met.Off. 20	SERC 100 DEn 50	Met.Off. 40				NERC 190	
Dynamics			DOE 170				NERC 1860	
Ocean - atmosphere interactions/climate	Met.Off. 300	DEn 420	Met.Off. 610				NERC 740	
Waves	DTp 200	DEn 240 DTI 40 SERC 180					NERC 240 SERC 110	
Chemistry							NERC 910	
Other: Sea ice/Benthic boundary layer processes		SERC 10	DOE 490				NERC 10	
Sub-total	520	1250	4,850			3,430	4,940	14,990
2 SEA BED STUDIES								
Sediments			SERC 30 DOE 580 MAFF 340 DAFS 30				SERC 30 NERC 490	
Survey	SERC 30	SERC 30	DOE 350				SERC 30 DTI 40	
Sea bed investigations/sampling		DEn 150	SERC 60 DOE 450				SERC 30	
Other - Anchoring theory		SERC 20					SERC 20	
Sub-total	30	200	1840				640	2,710
3 UNDER SEA-BED STUDIES								
Geology/geophysics		SERC 20 NERC 1130		NERC 60			NERC 2830	
Mineral exploration/production (oil and gas)		DEn 3500 SERC 260	SERC 40					
Mineral exploration/production (other)			MAFF 10	SERC 50				
Sub-total		4910	50	110			2830	7900
4 MARINE BIOLOGICAL STUDIES								
Fish stock assessment					DANI 110 DAFS 3300 MAFF 3320		DAFS 460 MAFF 1070	
Fish cultivation					DTI 50 NERC 160 DAFS 120 MAFF 570		SERC 50	
Effects of pollution/waste disposal			DOE 370 MAFF 610 DAFS 480 DANI 10 NERC 1300 SERC 10				SERC 10	
Ecology			DOE 20		DAFS 900 MAFF 1750		NERC 6810	
Basic biology of marine organisms							NERC 1490	
Marine mammals: conservation, exploitation			MAFF 140				NERC 600	
Other: Biogeochemistry/Marine Bacteria							NERC 390 MAFF 120	
Sub-total			2840		10,280		11,000	24,120

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SUBJECT AREA	Transport	Energy production	Environmental protection	Mineral extraction	Food from the sea	Defence	Underpinning research	TOTAL
5 COASTAL ZONE								
Coastal protection			MAFF 620 DOE 420 SERC 70	DOE 60			SERC 70	
Sedimentation/erosion	DTp 270		SERC 30 NERC 20 DOE 80				NERC 1300 SERC 30	
Hydrocarbon and chemical spill clearance			DTp 920					
Estuary and coastal dynamics	DTp 260		SERC 40 DOE 100				NERC 410 SERC 40	
Other: Estuarine chemistry/pollution			DOE 750				NERC 100	
Sub-total	530		3,050	60			1,950	5590
6 SHIP, SUBMARINE, SUBMERSIBLE AND MARINE STRUCTURE DESIGN								
Materials		DEn 90 SERC 210					SERC 210	
Hydrodynamics	SERC 40 DTp 50	DEn 470 SERC 110 DTp 20			SERC 30		DTI 1800 SERC 110	
Structural Design	DTI 650 DTp 20 SERC 100	DEn 1990 SERC 440	DOE 80		SERC 30		SERC 440	
Propulsion	DTI 140 SERC 70	DEn 220 SERC 30					DTI 60 SERC 30	
Fabrication/construction	SERC 50	DEn 660 SERC 40					SERC 40	
On-board equipment	DTI 500 SERC 20	SERC 150					SERC 150	
Other: See 6(a), (d) and (e) in Table Y		DEn 200			MAFF 540 DAFS 1310		NERC 750	
Sub-total	1640	4630	80		1,910	78,770	3,590	90,620
7 SHIP, SUBMARINE, SUBMERSIBLE AND MARINE STRUCTURE OPERATION								
Navigation	SERC 20 DTp 440 DTI 800	DEn 80						
Communications	DTp 520 DTI 200	DEn 40 SERC 70					SERC 70	
Safety	SERC 40 DTp 900 DTI 100	DEn 100 SERC 100	SERC 30 DTp 60				SERC 140	
Pollution prevention			DTp 10					
Repair and maintenance		DEn 700 SERC 130	SERC 40				SERC 130	
Other: See 7(a), (c) and (d) in Table Y	DTp 30	DEn 110 SERC 250	SERC 60				SERC 250	
Sub-total	3,050	1,580	200			37,110	590	42,530
8 HUMAN HEALTH AND PERFORMANCE								
Diving		DEn 240 SERC 30 HSC 360					SERC 30	
Non-diving: Ergonomics	MRC 110	DEn 60 SERC 30						
Human safety (including hypothermia)	MRC 390	SERC 20						
Sub-total	500	740				3,140	30	4,410
TOTAL	6,270	13,310	12,910	170	12,190	122,450	25,570	192,870

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Table C.2

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SUBJECT AREA	OBJECTIVE: Transport	Energy production	Environmental protection	Mineral extraction	Food from the sea	Defence	Underpinning research	TOTAL
6.a. SHIP DESIGN								
Materials								
Hydrodynamics	SERC 40						DTI 1800	
Structural design	SERC 100							
Propulsion	DTI 100 SERC 70						DTI 60	
Fabrication/construction	SERC 50							
Equipment	SERC 20 DTI 500	SERC 150					SERC 150	
Other: Fish trawl design					DAFS 1310 MAFF 540			
Sub-total	880	150			1850	15,860	2,010	20,750
6.b. SUBMARINE DESIGN								
Materials								
Hydrodynamics								
Structural design								
Propulsion								
Fabrication/construction								
Sub-total						57,130		57,130
6.c. MARINE STRUCTURE DESIGN (including floating and tethered rigs and semi-submersibles)								
Materials		DEn 90 SERC 210					SERC 210	
Hydrodynamics	DTp 50	SERC 110 DTp 20 DEn 190			SERC 30		SERC 110	
Structural design	DTp 20	DEn 1790 SERC 440	DOE 80		SERC 30		SERC 440	
Propulsion		DEn 220						
Fabrication/construction		DEn 490 SERC 40					SERC 40	
Equipment								
Sub-total	70	3,600	80		60	2,800	800	7,410
6.d. SUBMERSIBLES DESIGN (MANNED AND UNMANNED)								
Materials								
Hydrodynamics		DEn 280						
Structural design	DTI 650	DEn 200						
Propulsion	DTI 40	SERC 30					SERC 30	
Fabrication/construction		DEn 170						
Other - not defined		DEn 200						
Sub-total	690	880					30	
6.e Unspecified						2,980	750	3,730
Σ	1,640	4,630	80		1,910	78,770	3,590	90,620

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SUBJECT AREA	OBJECTIVE: Transport	Energy production	Environmental protection	Mineral extraction	Food from the sea	Defence	Underpinning research	TOTAL
7.a. SHIP OPERATION								
Navigation	SERC 20 DTp 440 DTI 800							
Communications	DTp 520 DTI 200							
Safety	DTp 860 DTI 100 SERC 40		DTp 60 SERC 10				SERC 40	
Pollution prevention			DTp 10					
Repair and maintenance								
Other: Hovercraft stability study	DTp 30							
Sub-total	3,010		80			24,580	40	27,710
7.b. SUBMARINE OPERATION								
Navigation		DEn 10						
Communications								
Safety	DTp 40							
Pollution prevention								
Repair and maintenance								
Sub-total	40	10				11,940		11,990
7.c. MARINE STRUCTURE OPERATION								
Communications		DEn 20						
Safety		DEn 100 SERC 100	SERC 20				SERC 100	
Pollution prevention								
Inspection, repair and maintenance		DEn 700 SERC 340	SERC 100				SERC 340	
Other: not defined		DEn 60						
Sub-total		1,320	120				440	1,880
7.d. SUBMERSIBLES OPERATION (MANNED AND UNMANNED)								
Navigation		DEn 70						
Communications		DEn 20 SERC 70					S[illegible] 70	
Safety								
Pollution prevention								
Repair and maintenance								
Other: control/not defined		DEn 50 SERC 40					SERC 40	
Sub-total		250				590	110	950
TOTAL	3,050	1,580	200			37,110	590	42,530

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Footnotes to tables C.1 and C.2

i. `underpinning research´ covers work of a fundamental nature with no immediate single objective, but with potential relevance in the longer term to some or all of the other stated objectives.

ii. figures were as far as possible based on 1983-84 estimated outturns, to the nearest ten thousand pounds, and full economic costs;

iii. only that work funded through the Science Vote is included in Research Council figures; work commissioned by Departments with Research Councils is included in the Departments´ entries.

iv. expenditure on fish utilisation, freight handling and freight movement through ports was regarded as falling outside the scope of marine science and technology. Research undertaken by the Hydrographer of the Navy was not included because it could not be identified in financial terms. The management costs of the programme at the Marine Technology Support Unit at Harwell were similarly excluded from the Department of Energy´s return. Some of the geological studies funded by the Department of Energy Offshore Energy Technology Board (and largely undertaken by the Natural Environment Research Council) were excluded on the grounds that they fall outside the Frascati definition; if these were added DEn´s total financial commitment to the field would be some £20 million per annum, ie about twice the figure quoted.

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TABLE C.3

Summary of UK Ship and Offshore Structure Model Testing Facilities

Organisation	Towing tank	Cavitation tunnel	Seakeeping & manoeuvring	Seakeeping only	Manoeuvring only	Circulating water tank	Multi-directional wave tank
NMI	3	2	1*		1	1	
British Shipbuilders Hydrodynamics	1						
British Hover-craft Corporation	3	1	1	1			
Glasgow Univ.	1						
Haslar - AMTE	2	2	1			1	
Newcastle University	1	1					
Southampton University	2						
Vosper -Thornycroft	1	1					
H R Ltd							1
Heriot-Watt University				1			
University College, London	1						
Sea Fish Authority, Hull						1	
Wavepower Limited, Southampton				2			
TOTALS	15	7	3	4	1	3	1

* To be modified to provide a multi-directional wave-tank, which will be commissioned in autumn 1984.

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Figure C.1.

GOVERNMENT EXPENDITURE ON MARINE SCIENCE AND TECHNOLOGY
BY FUNDING DEPARTMENT OR RESEARCH COUNCIL
1983/84

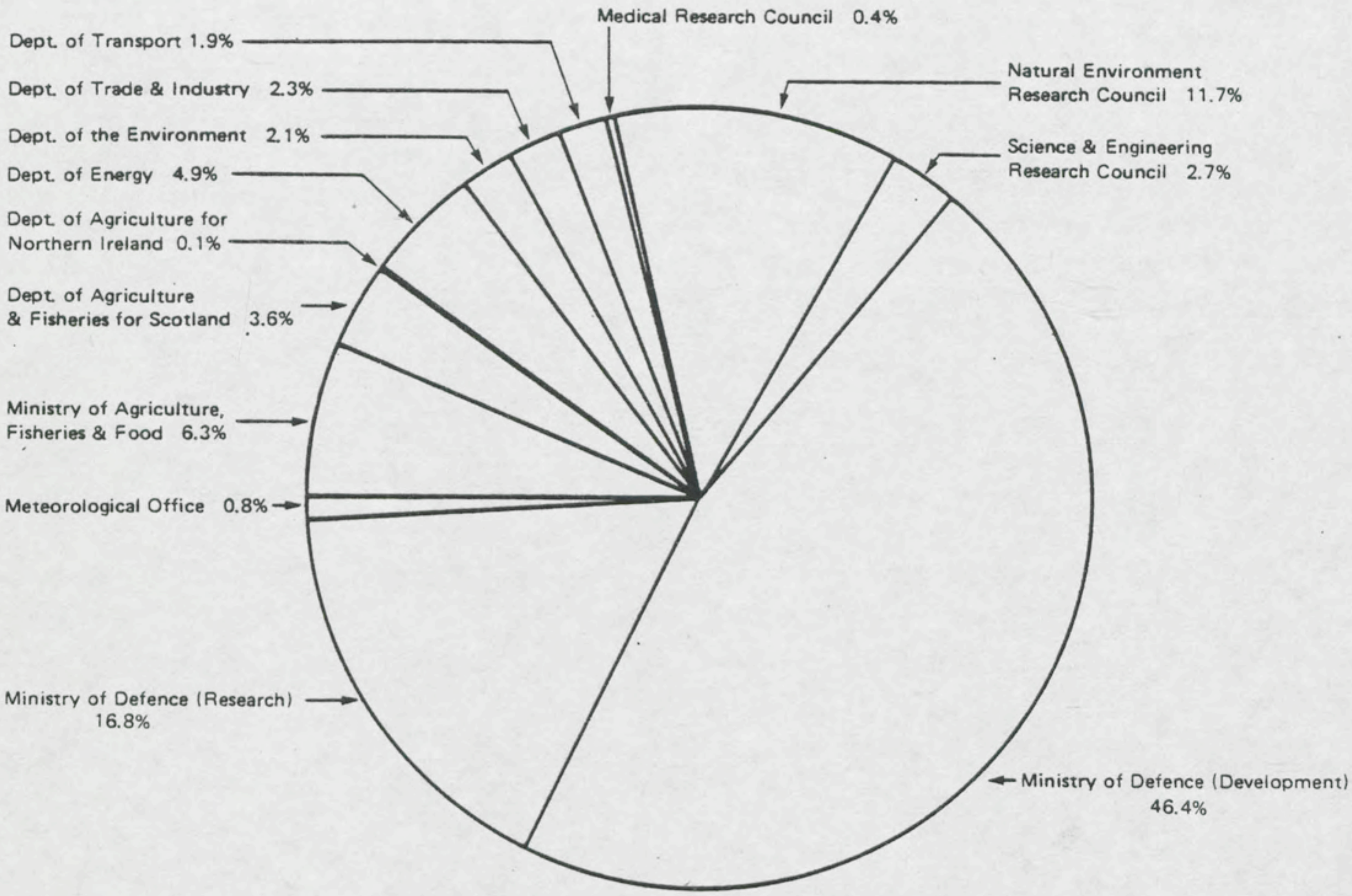

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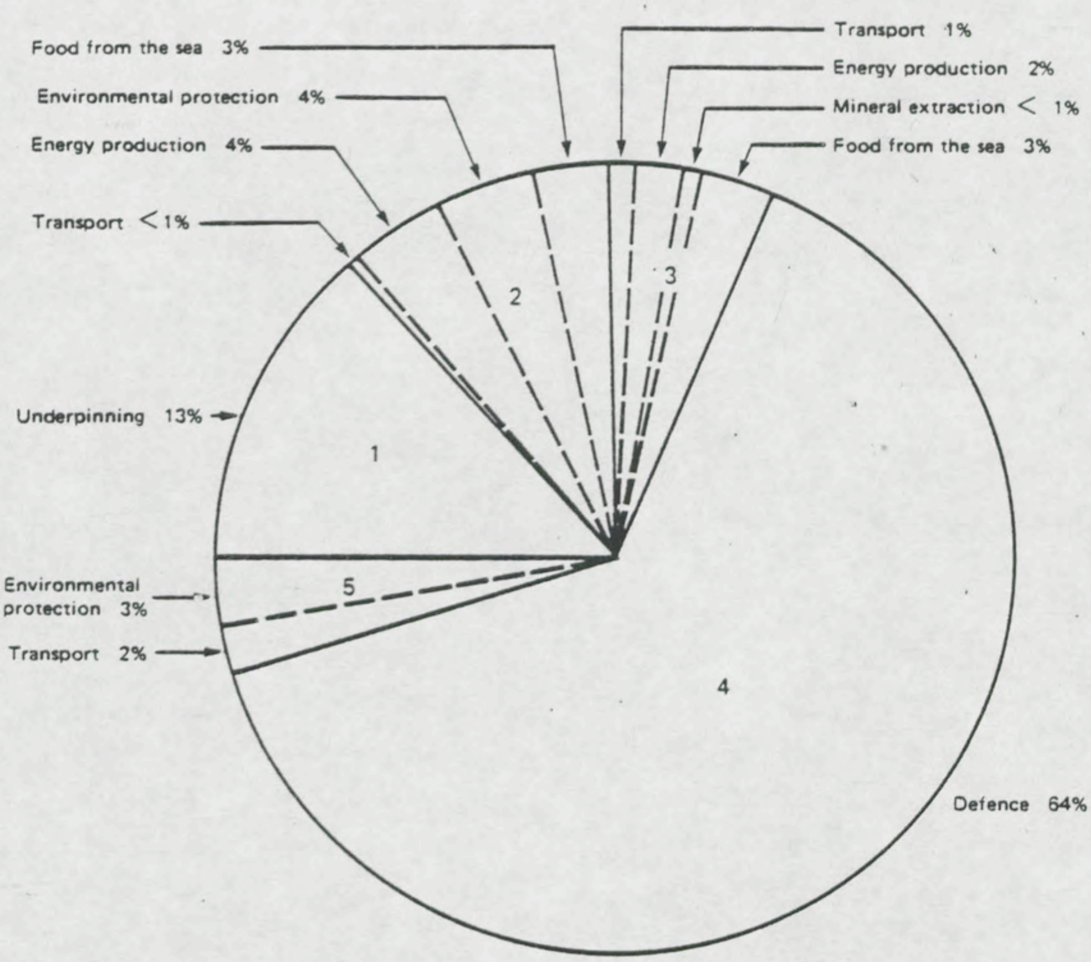
Figure C.2

GOVERNMENT FUNDING FOR MARINE SCIENCE AND TECHNOLOGY
BY PRIMARY PURPOSE
1983/84



Primary purpose:
1 Advancement of science
2 Support for policy
3 Improvement of technology
4 Support for purchasing
5 Support for statutory duties

ANNUAL REVIEW OF GOVERNMENT FUNDED

RESEARCH AND DEVELOPMENT

1984

PART II

Cabinet Office
July 1984

ANNUAL REVIEW OF GOVERNMENT FUNDED R & D

PART II

R & D EXPENDITURES OF INDIVIDUAL DEPARTMENTS

CONTENTS

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INTRODUCTORY NOTES

1. This section of the Review contains, for each Department or other organisation with a substantial R & D programme;

i. a statement of the objectives of the R & D programme and its principal features;

ii. (in the "a" tables) details of the subjects covered by the programme, the primary purpose for which each component was funded and the expenditure in cash terms for the years 1981/2 to 1986/7 (the basis of which is set out in paragraph 1.5 of Part I);

and iii. (in the "b" tables) the distribution of funding among different classes of recipient. These tables provide a measure of the work carried out within each organisation since the "intra-mural" component of expenditure includes receipts from other bodies, eg Departments' commissions with Research Councils. These are then identified and subtracted from the other expenditures in order that final totals in both tables should match.

2. Brief details of minor R & D programmes funded by Departments are also included.

3. In the "a" tables, the primary purposes for which the work is being funded are indicated by a numerical code viz:

1. Advancement of science

2. Support for policy formulation and implementation

3. Improvement of technology

4. Support for purchasing decisions

5. Support for statutory duties

6. Support for other activities

4. The use of the symbol .. in the tables means less than £50,000, but not zero.

5. Totals between the "a" and "b" tables may not tally because of rounding.

6. Two Research Councils (AFRC and NERC) have asked for the inclusion of a "c" table showing work commissioned with them by Government Departments. These are not used to calculate the summary tables in Part I of the Review.

MINISTRY OF AGRICULTURE, FISHERIES AND FOOD (MAFF)

All MAFF's R & D has the following common objectives:

i. to advance scientific knowledge relevant to agriculture (including horticulture), fisheries and food in order to increase the efficiency of industry;

ii. to safeguard and improve the quality of food for the community; and

iii. to protect the environment and prevent adverse social effects.

Within these general objectives are more specific aims:

i. sponsorship and support of UK industry

a. to maintain and improve the competitive position, efficiency and productivity of the UK agriculture, food and fisheries industries;

b. to reduce imports and to increase exports;

c. to maintain and improve the quality (including nutritional quality) of fresh and processed foods;

d. to reduce wastage;

e. to ensure that the producer has available to him appropriate structures, machines, and mechanisation systems and that knowledge is available to use these in the most efficient and effective manner;

f. to develop new fisheries from presently under-exploited or un-exploited stocks with commercial potential.

ii. to aid Government policy and decision making

-in particular to enable the UK Government to negotiate internationally in respect of fish stocks subject to EC agreements with third countries, and in respect of such sensitive subjects as whales and other cetaceans and seals.

iii. <u>consumer and environmental protection</u>

a. to protect the safety of food;

b. to minimize any adverse impact of the agriculture and food industries on the environment;

c. to protect life and property on both urban and agricultural land against flooding and waterlogging.

iv. <u>conservation</u>

a. to avoid danger to humans and reductions in the value of UK landings or reduction in the stocks due to fish disease and parasitic infection;

b. to protect and improve the health and welfare of farm stock;

c. to conserve the stocks and manage the fishery in respect of those species of fish which are of commercial importance to the UK fishing industry;

v. to support necessary <u>basic research</u> in support of the other objectives.

Table 1a

MINISTRY OF AGRICULTURE FISHERIES AND FOOD
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Food science	1	..	..	..	..	..	..
	2	1.2	1.5	1.6	1.5	1.6	1.6
	3	0.2	0.3	0.3	0.3	0.3	0.3
	5	0.1	0.1	0.1	0.1	0.1	0.1
Agriculture	2	2.1	2.2	2.4	2.5	2.6	2.7
	3	72.4	76.4	81.1	83.9	86.5	89.8
	5	6.5	6.9	7.3	7.6	7.8	8.2
Fisheries	2	4.8	4.9	5.2	6.2	6.3	5.8
	3	4.6	4.7	4.9	5.9	6.0	5.5
	5	3.1	3.2	3.3	4.0	4.1	3.7
Food	3	8.2	9.7	9.9	10.2	10.4	10.8
Flood protection and drainage	5	0.9	1.2	1.3	1.4	1.4	1.5
Royal Botanic Gardens, Kew	6	2.8	2.8	3.0	3.1	3.2	3.3
TOTAL		106.8	113.9	120.3	126.5	130.5	133.2

Table 1b

MINISTRY OF AGRICULTURE FISHERIES AND FOOD
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	57.2	59.2	62.5	67.3	69.9	70.8
Research Councils	46.7	51.0	53.5	54.9	56.0	57.6
Other Government departments	0.7	0.7	0.8	0.7	0.7	0.7
Universities	0.5	1.4)				
Private industry	0.3	0.6)				
Public corporations	..	..)				
Research associations	3.2	3.6)				
Overseas	..	..)	8.2	8.5	8.8	9.1
Non-industrial research institutes	0.1	0.1)				
Professional and learned societies	..	..)				
Persons	..	..)				
Others	1.9	1.9)				
<u>less</u> Receipts	3.7	4.8	4.7	4.9	5.0	5.1
TOTAL	106.8	113.9	120.3	126.5	130.5	133.2

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MINISTRY OF DEFENCE (MOD)

The R & D programme of MOD has the objective of meeting the needs of the Armed Services for equipment and weapons in a timely and cost effective manner. The research programme is aimed at producing an underlying basis of scientific and technological expertise for application in the short or longer term in the selection, development, production and operation of weapon systems and equipments. Development work, although drawing on the knowledge and expertise obtained from research, is directly related, item by item, to the procurement of specific military equipments, such as particular aircraft or radars, and is the essential forerunner to the production of those equipments.

Research Programme

The research programme is undertaken both intramurally in MOD establishments, and extramurally as funded research in industry, universities and other institutes of higher education. The contributions of these separate sources are brought together into a coherent programme through an integrated management structure within which responsibility for specific fields is delegated to relevant MOD R & D establishments. Within the broad aims of providing the foundations for defence science and technology the research programme has a number of interrelated and significant facets:

i. Seed corn research. Although MOD makes use of contributions from universities and other institutes of higher education, it is found to be essential for R & D establishments to have an effective programme of \`seed corn´ research to form a foundation for future innovation. This is maintained at a level equal to at least 5% of the defence scientific effort available within them.

ii. Applied research. This is closely co-ordinated with research undertaken by industry on a private venture basis, or with support from other Government sources, and has the following objectives:

a. provision of the basis for impartial scientific and technological advice to the Armed Services in the determination of equipment policy and in the formulation of staff targets and staff requirements

b. formulation of weapon and equipment systems concepts

c. the evaluation of the likely contributions of proposed weapons and equipments in future operational scenarios, including analysis of the benefits of incorporating advances in technology

d. technical input to equipment purchasing decisions

e. advice and assistance to industry in application of new technologies in defence equipment

f. provision of the basis for the formulation of statutory and safety rules and regulations, such as airworthiness and scientific advice to the Ordnance Board on the safety of munitions.

The research programme covers a wide range of scientific disciplines and technologies. Priorities within it are reviewed annually having regard for the Services' latest assessment of their needs, the timescales of application opportunities, and the varying prospects of making significant progress in different fields. The current trend is broadly to place emphasis on weapons, sensors, under-sea warfare, electronic components and electronic systems, with less attention being given to platforms such as aircraft, ships and tanks which have relatively long life and for which equipment can be up-dated. The major funding contribution of MOD to the Alvey Information Technology programme reflects the importance ascribed by MOD to this area of work. Other disciplines of wide ranging significance for defence equipment include human factors and new materials. Collaborative links exist with our Allies in most active fields of research.

Towards the "development" end of the research spectrum falls the Technology Demonstrator Programme, built up of items of work where a need is seen to prove, before commitment to development and production, that a scientific or technological concept can be exploited in engineering terms at an acceptable cost and within the required timescale. Over the past year, MOD has been placing increased emphasis on such activity and further aeroengine work in this category has, for example, been launched recently. Demonstrator work is undertaken, for the greater part, in industry, on a shared funding basis.

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Development Programme

Development work is carried out predominantly in industry. Current development programes cover the whole spectrum of MOD requirements. On the weapon side they include the airborne defence suppression weapon (ALARM), further developments of Rapier and Seawolf and, in the context of international collaboration, anti-tank weapons (with France and the Federal German Republic) and the short range air-to-air missile (also with the Federal German Republic). Important communications projects include the Skynet IV communication satellite and the introduction for air defence purposes of the Joint Tactical Information Distribution System. So far as platforms are concerned, major projects include the Harrier GR5 offensive support aircraft, the Type 23 Frigate and main battle tank improvements (including thermal imaging). The EH101 helicopter being developed in collaboration with Italy has importance not only in anti-submarine warfare, but also in the civil market; both DTI and industry are contributing to the funding of its development. MOD policy continues to be to devolve to industry as much as possible of the project support role previously undertaken by the R & D establishments, with their continuing involvement limited where practicable to the initial conceptional aspects, independent technical assessments and advice on proposals from industry, peformance evaluation, and safety and statutory aspects (eg airworthiness). The establishments will, however, have also a continuing role in `fire brigade´ action when unanticipated problems arise in development or in service.

Spin Off

Although the remit of the MOD R & D programme is to obtain the most cost effective equipment and systems for our Armed Services, the Department is strongly aware of the potential value of its research to industry at large. There are, moreover, many instances where advances initiated for defence purposes have been exploited successfully by civil industry. Examples range from new materials and electronic devices to advanced aerodynamics application to civil transport aircraft and jet engines. Nevertheless, there appears to be scope for improving the effectiveness of the spin-off process and to this end arrangements are being made whereby venture capital groups will

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have better access to the R & D establishments; means are being considered also whereby spin-off from work undertaken by MOD contractors can be further encouraged.

Support to DTI

The MOD also carries out civil work on repayment terms, the principal element of which is civil aerospace and gas turbine research funded by the Department of Trade and Industry.

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Table 2.1a

MINISTRY OF DEFENCE (Research)
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Aerodynamics, Structures and Materials	4	27.6	22.6	22.2	25.6	25.9	26.5
Gas Turbines	4	16.2	17.4	13.2	13.8	14.1	14.4
Rocket Propulsion	4	8.6	9.6	9.7	13.1	14.2	14.1
Military Vehicles & Army Engineering Equ	4	9.1	11.9	12.9	17.0	16.6	17.0
Ships and Submarines	4	22.2	23.5	24.4	29.3	29.5	30.1
Guided and Air Launched Weapons	4	24.3	32.5	32.7	40.7	41.4	42.3
Undersea Warfare	4	23.4	26.4	29.4	34.4	35.4	36.1
Conventional Weapons, Armament & Pyrotcs	4	25.6	30.7	32.1	40.4	40.8	41.6
Chemical & biological Defence	4	7.6	9.0	10.8	14.4	16.8	15.0
Electronic Components	4	26.4	27.5	28.1	32.2	33.2	34.0
Electronic Systems	4	41.4	45.1	53.5	62.5	63.4	64.6
Navigation & Avionics	4	21.0	27.6	26.9	29.6	30.1	30.8
Space	4	0.6	0.9	2.0	2.9	3.6	3.7
Other Research	4	9.3	20.1	31.3	36.6	42.6	49.7
TOTAL		263.3	304.8	329.2	392.3	405.7	419.8

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Table 2.2b

MINISTRY OF DEFENCE (Development)
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
SEA SYSTEMS							
Ships	4	66.3	71.2	77.5	79.5	75.6	69.6
Weapons	4	214.9	190.8	261.2	301.1	326.7	314.0
LAND SYSTEMS							
Guns, Small Arms, Chemical Defence Store	4	12.6	16.1	17.3	21.9	13.7	15.9
Ammunition, Mines and Explosives	4	23.1	17.8	30.0	10.2	15.4	14.6
Fighting Vehicles	4	36.2	44.7	44.9	61.3	65.4	62.9
Load Carrying Vehicles	4	3.3	3.6	7.6	7.7	6.7	6.8
Engineering Equipment	4	0.7	1.3	1.3	6.5	8.1	9.9
Guided Weapons, Electronic Equip and Ins	4	160.5	127.8	142.7	164.3	157.5	158.8
Other Stores	4	0.1	0.1	0.4	0.2	0.2	0.2
AIR SYSTEMS							
Aircraft, Aero-engines & Air Equipment	4	299.4	271.4	313.3	320.5	366.4	425.6
Guided Weapons & Electronic Equipment	4	213.7	189.3	280.1	262.5	280.0	287.1
CENTRAL STAFF SUPPORT							
IM Development and Other Support	4	393.6	461.7	399.2	419.0	450.2	488.6
TOTAL		1424.4	1395.8	1575.5	1654.8	1766.0	1854.0

Table 2.3a

MINISTRY OF DEFENCE (Other Costs)
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Central Staff Element	4	2.9	3.0	2.9	3.0	3.1	3.2
Superannuation	4	54.2	61.2	65.0	67.1	69.7	71.4
TOTAL		57.1	64.2	67.9	70.1	72.8	74.6

Table 2b

MINISTRY OF DEFENCE
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	559.1	644.5	619.8	680.9	722.4	777.4
Research Councils	0.1	0.1	0.1	0.3	0.4	0.0
Other Government departments	5.4	29.1	14.9	36.2	39.9	39.1
Universities	7.3	8.1)				
Private industry	1165.8	1019.2)				
Public Corporations	22.6	16.1)				
Research Associations	1.4	1.8)	1414.9	1486.5	1574.1	1626.3
Overseas	76.5	105.8)				
Non-Industrial Research institutes	0.8	0.4)				
Others	0.5	0.9)				
less Receipts	95.0	61.1	77.0	-86.7	-92.3	-94.4
TOTAL	1744.6	1764.8	1972.7	2117.2	2244.6	2348.4

DEPARTMENT OF EDUCATION AND SCIENCE (DES)

The DES's direct support for research is generaly allocated to areas of policy priority. The aim of the programme is to obtain from research information which will:

i. help to guide policy decisions which need to be taken;

ii. help to improve the quality of the educational process in areas of policy concern; or

iii. facilitate, or evaluate the effects of, the implementation of policy decisions.

The aims of the DES research programme are therefore closely linked with the Department's overall policy objectives.

In addition to its own research programme, DES has also promoted research activity via the Further Education Unit and the Schools Council; the Schools Curriculum Development Committee and the Secondary Examinations Council, which have succeeded the Schools Council, can be expected to continue to sponsor research and development in their areas of responsibility.

The DES Science Budget is one of the main sources of public funds for the support of civil scientific research (the other major source being the grant made to the universities through the University Grants Committee). It is the sum of the annual grants-in-aid paid by the Secretary of State for Education and Science (in exercise of his responsibilities under the Science and Technology Act 1965) to the Agricultural and Food Research Council (AFRC), Medical Research Council (MRC), Natural Environment Research Council (NERC), Science and Engineering Research Council (SERC) and the Economic and Social Research Council (ESRC); and to the British Museum (Natural History), the Royal Society and the Fellowship of Engineering.

The purpose of the Science Budget is to develop the natural and social sciences, including engineering, to maintain a fundamental capacity of research and scholarship and to support relevant higher education at the post-graduate level. Research ranging from the most fundamental through to work with a practical application is supported. The Research Councils, which are chartered bodies, support these objectives in various ways. They provide for research by making grants to research workers in universities or elsewhere; and they directly operate research establishments. These may be units associated with universities, or central facilities for the use of universities, or separate institutes which carry out research programmes agreed by the Councils. The Councils participate in international scientific programmes where they see this as the most effective way of undertaking research in a particular field. They are responsible for the UK subscriptions to, and participation in the management of, a number of international research centres/facilities (eg the European Organisation for Nuclear Research (CERN), the European Molecular Biology Laboratory and the International Agency for Research on Cancer) which extend UK research capacity. They also support students undertaking post graduate training, and research fellows.

The Secretary of State is advised on his responsibilities for civil science by the Advisory Board for the Research Councils (ABRC). This advice includes recommendations on the distribution of the Science Budget among the various research bodies. The ABRC membership includes representatives of the Government Departments spending substantial sums in commissioned research in support of their departmental objectives with AFRC and NERC.

Universities' General Expenditure on R & D

Some university expenditure on R & D is funded by specific research grants or contracts, from Research Councils, Government departments, industry, and a variety of other bodies. Additionally, universities support research activity from their own general funds, which are received primarily from grants made by the University Grants Committee (UGC), as well as from student fees and other sources. The UGC allocates resources to universities in the form of block grants covering both research and teaching, within the general principle that university staffs should normally be concerned with both these purposes. In the science fields the intention of the UGC input into research is that it shall provide the basic "floor" of research capability in university departments which is necessary if speculative ideas are to be generated and developed to the stage where they may attract support from external sponsors (the combination

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of these two types of money constitutes the "dual support system"). Since universities' research activities and expenditure cannot be clearly distinguished, and thus the UGC's objectives in funding that expenditure cannot be clearly distinguished from its wider objectives in funding the university system, the assignment of resources to research for the purposes of this review is based on a notional attribution of universities' departmental and central expenditure between research and teaching.

Table 3a

DEPARTMENT OF EDUCATION AND SCIENCE
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
General educational research	1	6.1	6.8	7.1	9.4	9.7	9.3
Council for Educational Technology	1	0.5	0.4	0.5	0.5	0.5	0.5
National Foundation for Educational Research	1	..	..	..	..	..	..
Schools Council and two successor bodies	1	1.5	1.4	1.0	1.3	1.3	1.3
OECD - Centre for Education Research and Innovation	1	0.1	0.1	0.1	0.1	0.1	0.1
Other Costs (Total)	6	..	..	..	..	..	..
TOTAL		8.3	8.8	8.8	11.4	11.7	11.3

Table 3b

DEPARTMENT OF EDUCATION AND SCIENCE
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	0.1	0.2	0.2	0.2	0.2	0.2
Universities	2.5	2.1)				
Research associations	0.1	0.1)				
Overseas	0.1	0.1)				
Non-industrial research institutes	0.9	1.3))	8.8	11.5	11.7	11.2
Professional and learned societies	0.2	0.0))				
Persons	..	..)				
Others	4.9	5.6)				
<u>less</u> Receipts	0.2	0.4	0.2	0.2	0.1	..
TOTAL	8.3	8.8	8.9	11.4	11.7	11.3

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Table 4a

UNIVERSITY GRANTS COMMITTEE ETC(1)
SUBJECT AREA AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Medical research(2)	1	28.0	31.0	32.0	33.0	34.0	35.0
	2	92.0	104.0	108.0	111.0	115.0	117.0
Social sciences	1	83.0	92.0	97.0	97.0	100.0	102.0
Natural sciences	1	197.0	214.0	223.0	229.0	236.0	240.0
Engineering and technology	3	84.0	94.0	98.0	100.0	103.0	106.0
TOTAL		484.0	535.0	555.0	570.0	588.0	600.0

(1) The figures under the heading `UGC etc´, here and elsewhere in this document, are estimates of expenditure through universities own funds, but originating from a central government source. The great majority of this expenditure is funded by capital and recurrent grants from the UGC (or, in the case of universities in Northern Ireland, from the Department of Education of Northern Ireland), but it also includes a share attributed to fees from home students, most of which is refunded by DES to the Local Education Authorities which paid the fees.

(2) The following points should also be noted:

i. The figures are shown rounded to the nearest £million, but since they are estimates they cannot be considered accurate to this level.

ii. Of a total UGC support for research of some £600 million in the year 1982/83 (including around £65 million on humanities research which is excluded from the table above), the approximate breakdown by type of expenditure is estimated as follows:

		£ million
Academic salaries	-	154
Wages	-	60
Consumables	-	20
Central expenditure attributed to "internal" research	-	199
Central expenditure attributed to research grants and contracts	-	126
Capital expenditure - land and buildings	-	2
Capital expenditure on equipment	-	41
Total	-	601

Table 4b

UNIVERSITY GRANTS COMMITTEE
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Universities	484.0	535.0	555.0	570.0	588.0	600.0
TOTAL	484.0	535.0	555.0	570.0	588.0	600.0

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AGRICULTURAL AND FOOD RESEARCH COUNCIL (AFRC)

1. The primary aims of AFRC are the advancement of scientific knowledge relevant to agriculture, horticulture and food and the application of this knowledge to increase the efficiency of related industries, without detriment to the environment or to the welfare of farm animals.

2. The AFRC draws approximately half its funds from the Science Budget, with a similar sum from MAFF for commissioned research and about five per cent from other sources including industry. MAFF commissioned research, and that funded by industry, is largely applied. DES funds are devoted to strategic research aimed at increasing knowledge within scientific areas that contribute to an understanding of biological systems and on which agricultural advances may ultimately be based, including wholly novel production systems.

3. The AFRC advises the Department of Agriculture and Fisheries for Scotland on matters concerning the seven grant aided agricultural research institutes in Scotland financed by the Department and which, together with the AFRC institutes and those it grant aids, form the Agricultural and Food Reseach Service.

4. The AFRC has recently changed the emphasis of its research to increase the investment in university research and in food research at the expense of research in other parts of its programme. To give effect to this change and to enable priorities to be assessed more effectively, its Head Office has been restructured, three Research Committees have been appointed and an additional Research Grants Board set up.

5. AFRC Units in universities have progressively been closed, as they were found to be relatively inflexible and capital-intensive; university research will in future be supported in University Groups appointed to support identified programmes of work for renewable 5 year periods, and Link Groups will be fostered, where appropriate, to bring together cognate research in institutes and universities. Six University Groups and two Link Groups have

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already been formed. Funds available for short term university research will be increased; they will be disbursed on the advice of the three Research Grants Boards, who receive grant applications from scientists in universities for research they consider important and relevant to AFRC's aims. The Research Grants Boards, consisting mainly of independent academic members, award grants on their merits, and in addition may solicit applications in areas deemed to be of high priority.

6. Council is advised on objectives and priorities by its three Research Committees (Plants and Soils Research Committee, Animals Research Committee and Food Research Committee) whose membership includes scientists, industrialists and the chairman of the appropriate Research Grants Board.

(i) The Plants and Soils Research Committee is concerned with research relevant to the breeding, cultivation, growing and protection of crops, and agricultural engineering relevant to these interests. It considers priorities in four activity areas.

(a) Plant Breeding is carried out in order to improve the quality and increase the productivity of agricultural and horticultural crops by the production of improved genetic material either as finished varieties or as parental material for other breeders to incorporate in finished varieties. Programmes in several crops are based on basic genetics and cytogenetics research that together provide information for advances in breeding technology, and on the genetic structure of crop species to improve precision in conventional breeding programmes. Tissue culture techniques provide alternative approaches for plant breeding, and recently much effort has been devoted to genetic manipulation (cf para 7 below).

(b) Crop Protection research is intended to remove constraints to crop productivity and quality imposed by pests, pathogens and weeds without adversely affecting the natural environment. Understanding of the biology of pests, disease organisms and weeds is essential for effective control measures, and research is necessarilly devoted to this area. In the study of the establishment and development of fungal and bacterial disease, more precise immunological and biochemical procedures will be applied to studies of host-pathogen genotype interactions than have previously been available. For elucidating pest movement patterns, electronic methods of detecting and following insects in flight using shortwave radar and infra-red emitters have been developed and are in use experimentally. Naturally occurring compounds are studied for their potential in controlling behaviour and numbers of pest insects.

(c) Soils and Crop Nutrition research provides for the mapping and description of soils in order to understand their genesis and spatial distribution, and to aid identification and amelioration of the physical and chemical constraints to crop production posed by soil factors. Quantitative approaches are increasingly used, both in the laboratory and in field experiments where micro-electronic techniques have been devised for precise measurements of soil properties. Modelling studies of solute movement and related processes in soil are providing information of value to reduce the levels of fertiliser needed for efficient crop production. Soil microbiology is an important area of study in soil metabolism and organic waste breakdown and may provide for biological control of root-infecting organisms. The genetic regulation of nitrogen fixation in free-living bacteria and in legume symbionts is being investigated with the aim of reducing the usage of nitrogen fertiliser.

(d) Crop production research aims to understand plant processes and establish growing systems for crops so that harvestable yields of defined quality are limited only by the genetic constitution of the crops concerned. Within this research activity area, basic research on photosynthesis forms a co-ordinated programme involving several institutes and universities, the objective of which is to determine which steps limit the total process under different environmental conditions. The photosynthesis programme is complemented by a wide range of work on carbon assimilation, partition and utilisation in many crops at all levels of organisation. Increasingly attention is being paid to the part plant growth substances play in controlling different stages of crop growth and in the partition and deposition of assimilates.

(ii) The Animals Research Committee determines objectives and priorities in the AFRC's research programmes concerned with animal breeding, animal diseases, animal nutrition and production; and research on agricultural engineering relevant to these interests.

(a) Animal breeding. The objectives of the animal breeding programme are to study the physiology of reproduction and methods of reproductive and genetic improvement and manipulation which, by exploiting the diversity of farm livestock, will increase efficiency of output for the future requirements of agriculture and food production. Molecular biology has recently been added to the more traditional aspects of animal breeding within the programme. New work seeks to identify gene products in poultry as a prelude to genetic manipulation.

(b) Animal disease research aims to improve animal health and welfare by formulating methods of control of the important diseases of farm animals in Britain that cause loss and/or pain and of exotic infections that could cause loss to British agriculture. Research encompasses a wide range of subjects from simple etiological studies to the use of sophisticated molecular genetic techniques. Of particular importance are the multifactorial infectious diseases that cause significant livestock losses; these have to be investigated by multidisciplinary teams set up for the purpose and using high grade experimental facilities. A joint programme with MRC on scrapie disease encompasses central nervous system degenerative conditions in general.

(c) Animal Nutrition research seeks to understand the basic processes of nutrition, digestion and metabolism of farm livestock in relation to the chemical and physical constituents of animal feeds and to predict the response of animal production systems to nutrient intake. In order to understand the functioning of the rumen in farm livestock, the genetics of rumen flora, the metabolism of essential fatty acids, neuroendocrine function in metabolism and the utilisation of absorbed nutrients are currently studied. Monoclonal antibodies are being made for identifying rumen bacteria, and DNA transfer between individual species of rumen micro-organisms is investigated. The chemical structure of plant cell walls is studied because of its importance in understanding breakdown in the rumen.

(d) Animal Production. The objectives of the animal production programme are to conduct research into aspects of production and to combine the components into efficient new and improved systems of food production from the varied vegetation and climatic regions of the UK. Concern with animal welfare is an essential component of AFRS animal production research; programmes studying motivational systems in farm animals, including poultry, involve work on appetite, seasonal and maternal behaviour, and group interactions in natural outdoor environments and in animal pens. A principal objective of research in animal production has been the understanding of the control of growth by the balance of hormones, and this has reached the stage where it is possible experimentally to manipulate hormone levels immunologically to enhance growth.

(iii) The Food Research Committee advises on the objectives and priorities in the expanding food and nutrition programme of the AFRS. Research into the physicochemical and biophysical properties of proteins and polysaccharides is being expanded, with particular reference to the effects of their functional properties in food processing behaviour and the quality of food. This, together with reseach into food process engineering, will lead to improvements in the operation of existing processes and will provide information for the development of new technology for novel products of enhanced quality. Improvements in food safety and quality are sought in a programme of research into rapid, modern methods of identifying microbes and microbial products. An increasing effort is being devoted to the research effort in human nutrition which is maintained in collaboration with MRC: emphasis in this programme is placed on nutrition related diseases, food acceptability and intake and maternal and child nutrition.

7. Two important aspects of the Council's work span several research areas.

Agricultural Engineering is not identified as a separate research activity because it usually contributes to a specific commodity or aea of work. To ensure that opportunities are not missed in such a wide ranging activity, Council and its Reseach Committees are advised by an Agricultural Engineering Advisory Committee. The objective of the AFRS engineering research programme is to apply engineering principles and methods to the improvement of farm buildings, machines and processes. There is increasing use of electronic engineering and computing and many improvements in design of building ventilation systems, in grass, grain and hop drying, in control engineering and in electrostatic spraying stem from computer simulation models constructed for the purpose.

Biotechnology forms a major commitment of the AFRC programme, and a member of the Council's staff is the present chairman of the Inter Research Council Co-ordinating Committee on Biotechnology (IRCCCOB) which co-ordinates the activities of the Research Councils in this area. The major part of the AFRC's programme, that on genetic manipulation of crop plants, was critically reviewed in 1983, 5 years after its inception. As a result, emphasis is changing from research on the isolation and characterisation of plant genes, the construction of vectors for transforming plant cells and the regeneration of transformed cells to research on identifiction of the opportunities for plant improvement by genetic manipulation and the characterisation of these processes at the biochemical level. The conventional areas of plant biotechnology, aimed at providing biological control of organisms, degradation of organic wastes (eg straw or animal waste), and micropropagation of horticultural plants, will

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continue. The Agricultural Genetics Company was formed in 1983 to exploit commercially the findings from these areas of research. Genetic manipulation now forms a major component of several aspects of animal science. Antigens to several animal disease viruses are being cloned with the objective of producing safer and novel vaccines. Monoclonal antibodies are playing an increasing role in the study of disease organisms of both animals and plants, for the identification of organisms and diagnosis of disease. The Monoclonal Antibody Centre established at the Institute of Animal Physiology is stimulating a wide range of plant and animal studies.

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Table 5a

AGRICULTURAL AND FOOD RESEARCH COUNCIL
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Plant breeding	1	2.9	3.0	3.6	4.0	3.9	4.0
	3*	0.2	0.2	0.3	0.3	0.3	0.3
Crop protection	1	2.2	2.3	2.5	2.5	2.3	2.1
	3*	1.7	1.8	1.9	1.9	1.8	1.6
	6*	1.7	1.7	1.9	1.9	1.7	1.6
Crop nutrition	1	2.1	2.2	2.8	2.3	2.0	1.8
	3*	1.2	1.2	1.3	1.3	1.2	1.1
Crop production	1	6.0	6.3	6.6	7.0	6.9	7.0
	3*	2.0	2.0	2.2	2.1	2.1	2.2
Animal breeding	1	1.7	1.8	1.6	1.8	1.8	2.0
	3*	0.8	0.9	0.8	0.9	0.9	1.0
	6*	2.1	2.2	2.0	2.2	2.3	2.4
Animal disease	1	2.1	2.2	2.3	2.1	1.9	1.5
	3*	3.8	3.9	4.2	3.7	3.4	2.7
Animal nutrition	1	1.3	1.3	1.2	1.2	1.1	1.1
	3*	1.2	1.2	1.1	1.1	1.0	1.0
Animal production	1	0.7	0.8	0.8	0.8	0.8	0.8
	3*	1.5	1.6	1.5	1.6	1.5	1.6
	6*	0.2	0.2	0.2	0.2	0.2	0.3
Food science	1	2.1	2.2	2.1	2.4	3.0	4.2
	3*	2.4	2.5	2.4	2.7	3.5	4.8
Other research	1	0.9	0.9	1.1	1.1	1.1	1.1
	3*	0.8	0.8	0.9	0.9	0.9	1.0
TOTAL		41.4	43.1	45.5	45.9	45.6	46.9

* This is considered to be applied R & D - "seedcorn research"

Table 5b

AGRICULTURAL AND FOOD RESEARCH COUNCIL
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	34.8	39.9	43.6	45.6	45.2	44.9
Universities	3.7	4.4)				
Non-industrial research institutes	51.1	52.2))	57.3	57.1	56.7	59.9
less Receipts	48.2	53.4	55.3	56.7	56.4	57.9
TOTAL	41.4	43.1	45.6	45.9	45.6	46.9

Table 5c

AGRICULTURAL AND FOOD RESEARCH COUNCIL
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

Expenditure by the Ministry of Agriculture, Fisheries and Food on work commissioned with the AFRC(1)

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Plant Breeding	3	4.4	4.9	5.8	5.0	4.8	4.8
Crop Protection	3	7.1	7.8	8.6	7.3	7.2	7.3
Crop Nutrition	3	3.5	3.9	4.2	3.7	3.7	3.8
Crop Production	3	6.2	6.8	6.5	6.6	6.9	7.4
Animal Breeding	3	1.8	1.9	2.4	1.7	1.7	1.7
Animal Disease	3	6.6	7.3	7.2	7.1	7.1	7.1
Animal Nutrition	3	1.3	1.5	1.7	1.6	1.7	1.7
Animal Production	3	6.6	7.3	8.1	7.1	8.1	8.3
Food Science	3	5.8	6.3	5.9	6.0	6.8	7.2
Other	3	0.9	1.0	0.5	0.8	0.8	0.8
TOTAL		44.3	49.0	51.0	52.1	53.1	54.8

(1) This table has been included to illustrate the overall scope and scale of AFRC activities. The data refer to expenditures included in Tables 1a and 1b.

ECONOMIC AND SOCIAL RESEARCH COUNCIL (ESRC)

ESRC encourages and supports research in the social sciences. In recent years ESRC has given greater weight to strategic judgements about the relative long-term importance of research opportunities in the social sciences, and in particular research which might assist in the formation of public policy. This trend will continue and will bring ESRC closer to Departments in the choice of topics and to a strategy which will complement work funded by Departments.

A dominant theme, `change in contemporary Britain: context, adaptation and management´ has been adopted for ESRC´s research programme for the next five years. It is concerned with understanding what is wrong, what needs to be done and when, and how adaptation might be facilitated. Emphasis on Britain does not imply a parochial view. Work under the theme must improve understanding of influences and pressures from outside leading to change within the UK.

Context

On many criteria contemporary Britain is very different from the society of thirty years ago and underlying sources of change are likely to produce a very different society to today´s thirty years hence. Periods of rapid change can give rise to particular problems of understanding. Not all developments set in train by past events, for example, work themselves out before further change is superimposed on them. It is difficult to disentangle the long-term effects of earlier events from the impact of more recent ones. How far are patterns of change cyclical or linear? How far are cycles short or long? And what is the role of discontinuities and inertia? A more substantial and systematic effort will be made either to resolve these and related issues or, at least, to increase understanding of current developments as the basis for further debate.

Adaptation

Change has a different impact when it is rapid relative to the lifespan of the organism concerned. Today, many individuals have to live through several major changes during their own lifetime. This explains many of the lags and apparently irrational delays in adapting to problems that seem physically and economically straightforward. Individuals bring with them impediments from experience and training. Ideologies and belief systems have also changed. Research will be encouraged on the impact of change; on the constructive and

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destructive reactions to change stemming from the impediments of the past; on the impact of change on human adjustment and maladjustment.

Management

Lying behind ESRC's approach to the management of economic change is the importance of technology, whose effective harnessing will depend largely on British management. The current technological revolution is geared directly to basic science. An important element in the research programme will, therefore, be the identification of obstacles to the development and introduction of new products, processes and systems. Not all the resources to be managed, though, are in industry. The quality of British public administration is attracting substantial and increasing interest in Parliament, the press and among the public. The debate has extended to the nature of Civil Service powers and the need for a wider reform of Northcote-Trevelyan proportions. There is a real possibility that public administration, widely regarded in the past as the Cinderella of the social sciences, will find itself occupying an important place in the wider discussion of strategies for economic recovery.

Particular operational objectives are as follows:

Economic Policy

Two ESRC Committees share an interest in improving the performance of the British Economy, Economic Affairs and Industry and Employment. The first has supported the new Centre for Economic Policy Research and also work on Fiscal Studies. A new programme is to be mounted on Public Expenditure, in association with the Treasury. The second has a particular interest in the competitiveness of individual firms, and especially in the performance of their management. It is expected that a substantial new programme on competitiveness will begin this year.

Social Policy

The Social Affairs Committee has given high priority to work on Health which is likely to continue. A new Centre for Health Economics has been established in York, and a Centre for the study of drug addiction has been set up in Hull. Consideration is also being given to a new programme on the Future of the Welfare State. The public expenditure implications of social policy will be explored alongside the programme on Public Expenditure.

Environmental Issues

Economic changes have altered fundamentally both the old divisions between town and country and North and South, and the purposes and scope of development planning. A programme will be mounted to analyse the location and land-use aspects of these changes. Environmental issues remain under-researched in their social and economic dimensions. More work will be started on pollution abatement, risk reduction and other contemporary issues especially as these are affected by slow economic growth, and by public expenditure reductions.

Grants support

It is likely that a substantial part (about a half) of research expenditure will continue to be committed through the research grants scheme, and that this will contribute to the sustenance both of timely and promising research and to the nation's research capacity. A growing emphasis will be placed on small grants to support scholars and the protection of major research centres.

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Table 6a

ECONOMIC AND SOCIAL RESEARCH COUNCIL
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Economic affairs	1			(2.3	2.3)		
Education and human development	1			(2.5	2.2)		
Environment and planning	1			(2.1	1.8)		
Government and law	1	15.3	16.4	(2.2	2.1)	16.5	16.6
Industry and employment	1			(2.6	2.7)		
Social affairs	1			(3.5	3.2)		
Other social science	1			(2.1	2.5)		
TOTAL		15.3	16.4	17.3	16.8	16.5	16.6

Table 6b

ECONOMIC AND SOCIAL RESEARCH COUNCIL
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	2.9	3.1	3.3	3.2	2.6	2.6
Other Research Councils	0.2	0.4	0.5	0.3	0.3	0.3
Government departments	0.1	0.3	..	.. ..	..	
Universities	8.4	8.7)				
Non-industrial research institutes	0.4	0.4))	13.8	13.7	13.8	14.0
Persons	3.6	3.7)				
<u>less</u> Receipts	0.3	0.2	0.3	0.4	0.3	0.3
TOTAL	15.3	16.4	17.3	16.8	16.5	16.6

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MEDICAL RESERCH COUNCIL (MRC)

1.1 The primary objective of the MRC is to advance knowledge that will improve the health of individuals in the community; this objective includes social, environmental and preventive medicine, as well as the treatment of the sick. To achieve this objective, MRC identifies and encourages studies in developing fields and in new areas, to promote a balanced advance of knowledge ranging from fundamental research to the solution of practical problem in medicine and public health. Where the problems of research require investigations overseas, these are funded in collaboration with the Overseas Development Administration. The Council has a special relationship with the Health Departments in providing advice on medical problems, in undertaking research at the request of the Departments, and in sponsoring a programme of health services research.

1.2 In pursuing these objectives in particular areas of medical research, the Council is advised by, and delegates substantial responsibility to, its four Research Boards: Neurobiology and Mental Health; Cell Biology and Disorders, Physiological Systems and Disorders; Tropical Medicine. Each is responsible for awarding support for work within the fields which come under its aegis and for evaluating the progress of that work, as well as for identifying opportunities for new research initiatives in specific areas. The Boards in their turn are assisted by Grants Committees, responsible for making short-term awards, and by a range of specialist advisory committees. Some of the latter are standing committees which keep particular fields under review; others are temporary, set up to take initiatives or to supervise particular investigations; others again are committees appointed jointly by the Council and other organisations to consider issues of common interest. Approximately one-third of Board membership is made up of Health Department officers and nominees; this ensures a strong day-to-day influence of Health Department interests in determining allocation of funds.

1.3 Grant applications from medical scientists in the universities for work which they themselves feel is important are considered by the Research Boards and Grant Committees. They are funded according to merit, although applications which are technically competent but of lesser originality may nevertheless be funded if they fall within areas of high social need or where it is seen as worthwhile to foster areas in which hitherto there had been little activity.

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1.4 In addition, the Council funds "special project grants", short-term awards given to selected workers to enable them to pursue defined objectives identified by the Boards and their advisory committees. This scheme can bypass the normal machinery of competition as long as the proposed work is judged sound.

1.5 Exceptionally, where a long-term need is perceived, the Council may set up a research Unit (or a Division at one of its major institutes) around a particularly talented individual, or to ensure that opportunities for new developments are not missed, or to meet a particular public need. The Council is responsible for nearly 100 such teams, the work of each of which is supervised by the relevant Research Board, to whom it reports in detail every three years. The research programmes of these teams develop and change as new opportunities arise. Units are closed down when they are no longer required, or when a Director leaves and a new leader of equivalent standing cannot be found. Nine new units have been set up since 1976 and the establishment of four others has recently been approved. These ensure a period of stability in funding for research in such important areas as hearing and deafness, trauma, environmental epidemiology, dentistry, tuberculosis, molecular haematology, tumour immunology, child psychiatry, perception and cognition, neuroendocrinology, neuropathogenesis (jointly with AFRC) and anatomical neuropharmacology.

1.6 The majority of applications for studentships and research fellowships are considered in open competition, but others are earmarked for the support of training in particular research areas which MRC wishes to encourage at a particular time; for example, currently in biotechnology, child psychiatry, epidemiology, nutrition, anaesthesia, radiotherapy and dentistry.

2. Priorities arise when new scientific developments identify a need to increase the scale of investment in particular fields of research, and where gifted individuals are available to exploit these developments. Many of the research programmes supported by the MRC represent long-term investments in the study of intractably difficult problems: hence, the Council does not produce a completely new set of priorities each year. In times of no growth, resources for the support of new initiatives taken up by the Council must be derived by reducing the level of support in other

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areas. The major responsibility for identifying priorities rests with the four Research Boards and their advisory committees. The fields covered by the respective Boards, and an indication of their current priorities, are given below.

3. The Neurobiology and Mental Health Board covers the nervous system; fundamental and applied neurobiology and psychology; research into neurological and psychiatric diseases, special senses, anaesthesia and medical sociology. Current priorities are as follows:

3.1 Neurotransmitters in neurological and psychiatric diseases: neurotransmitter abnormalities have been reported in a number of psychiatric and neurological conditions, including Parkinson´s disease, Huntington´s chorea, schizophrenia, epilepsy and Alzheimer´s disease.

3.2 Regeneration: the central nervous system cannot re-wire itself after damage or disease, eg head and spinal injury or stroke. To understand this limitation two sorts of research are carried out. The first is to analyse the developing body and its nervous system to discover the underlying mechanisms of regeneration and what is lacking in organisms that cannot regenerate. The hope is that factors will be identified which, by appropriate manipulation, will cause damaged or surviving parts to grow and compensate for missing parts. The second approach is more direct: to attempt to graft new nervous tisue directly into the brain.

3.3 Vision: new techniques for studying nerve fibres and their connections allow a precise and quantitative description of the structure-function relationships important in the development and operation of the visual system.

3.4 Hearing: in particular to provide artificial electrical input as a substitute for the normal acoustic stimulus in patients with profound hearing loss; to study the function of the cochlea.

3.5 Cognitive psychology: both the theoretical and practical aspects.

3.6 Child psychiatry: in particular the development of normal and abnormal behaviour during childhood and adolescence; the ethological approach to the development of objective methods for describing, recording and analysing behaviour.

3.7 Employment and unemployment, and effects on psychological and physical health, and on behaviour.

3.8 Information technology: work on man-machine interactions contributes to the `Alvey´ programme for advanced information technology.

4. The Cell Biology and Disorders Board covers biochemistry and biophysics, cellular and molecular biology, developmental biology and cell ageing, immunology, genetics and basic microbiology; structural studies, experimental pathology, transplantation, medical physics, cancer, radiobiology and radiological protection. Current priorities are as follows:

4.1 Biotechnology: The MRC´s intention is to balance support for the exploitation of discoveries with potential applications to the NHS and industry with support for fundamental research, whose success (eg in building up the framework of molecular genetics and in leading to the discovery of monoclonal antibodies) has created the present opportunities. MRC plans to establish a new team - possibly an MRC Unit - in a suitable university setting to serve as another focus for research and training in this area. MRC is giving particular attention to strengthening the following aspects of biotechnology: (a) recombinant DNA technology, (b) monoclonal antibodies, (c) synthetic peptides as vaccines, (d) microbial physiology.

4.2 Diagnostic imaging. MRC regards this as an area of great practical importance, particularly in relation to the development and evaluation of techniques which are not invasive and also minimise or eliminate exposure to harmful radiation. Major initiatives cover (a) nuclear magnetic resonance imaging, (b) emmission computerised axial tomography, (c) X-ray computerised axial tomographic scanning, (d) ultrasound.

5. The Physiological Systems and Disorders Board covers cardiovascular, respiratory, gastrointestinal, reproductive and urinary systems; blood, infections, nutrition, dentistry, obstetrics and gynaecology, paediatrics, endocrinology, dermatology and environmental medicine. Current priorities are as follows:

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5.1 Nutrition and Health: MRC has strong working links with AFRC in this area. Research is focussed in particular on protein malnutrition, pregnancy, lactation and breast feeding, on studies on nutrition and food absorption in neonates, on the physiology of the colon, vitamin D status and obesity.

5.2 Dentistry. Even though the statistics indicate that the incidence of dental caries in children is falling, dentistry is still an expensive item of public expenditure and MRC places great importance on supporting good dental research. A newly established research unit at the London Hospital Medical College will focus on the prevention and treatment of periodontal disease, which is responsible for the loss of more teeth after the third decade of life than dental caries.

5.3 Cardiovascular and respiratory diseases. MRC is acutely aware of the importance of these conditions in reducing life expectancy and in lowering efficiency during the working years. Examples of the research supported are studies on the treatment of high blood pressure, the pathophysiology of ischaemic heart disease and the effects of coronary artery bypass surgery, a trial of long-term oxygen therapy for chronic hypoxic cor pulmonale and a major national study of regional variations in coronary heart disease and stroke with reference to environmental, socio-economic and personal risk factors.

6. The Tropical Medicine Research Board covers tropical communicable diseases, malnutrition in the tropics, non-infectious disease as manifest in tropical environments; epidemiology in relation to the tropics, medical entomology, microbiology related to tropical environments, parasitology and the zoology of zoonoses. The Board also advises the Secretary of State for Foreign and Commonwealth Affairs on all biomedical research for developing countries financed from the funds of the Overseas Development Administration. MRC continues to support a range of research designed to throw light on problems affecting Commonwealth countries, UK visitors to those countries and certain patients in the UK. It has always been sympathetic to the needs identified by the World Health Organisation (WHO), and workers in MRC laboratories have been successful in attracting WHO funding for research on the topics identified by that body as priority areas: leprosy, malaria, trypanosomiasis (sleeping sickness),

schistosomiaisis (bilharzia), leishmaniasis and onchocerciasis. While the MRC supports two Units and a small number of scientific staff based overseas, in recent years it has preferred to give support to researchers based in UK laboratories (who then make working visits overseas as necessary) as a more cost-effective way of supporting tropical medicine research by individuals and small teams.

Table 7a

MEDICAL RESEARCH COUNCIL
SUBJECT AREAS AND PRIMARY PURPOSES(1)
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Neurosciences	1	4.5	4.6	4.8	5.0	5.1	5.2
	2	13.4	13.8	14.5	14.9	15.3	15.6
Molecular and cell biology & immunology	1	3.7	4.0	4.2	4.4	4.5	4.6
	2	11.0	12.1	12.7	13.1	13.4	13.7
Skin	1	0.1	0.1	0.1	0.1	0.1	0.1
	2	0.4	0.3	0.4	0.4	0.4	0.4
Reproduction and development	1	2.8	2.8	2.9	3.0	3.1	3.2
	2	8.4	8.4	8.8	9.1	9.3	9.5
Ageing	1	0.4	0.4	0.4	0.4	0.4	0.4
Cancer	1	1.1	1.3	1.4	1.4	1.4	1.5
	2	9.5	11.7	12.3	12.7	13.0	13.2
Blood and cardiovascular system	1	1.0	1.2	1.3	1.3	1.3	1.4
	2	3.1	3.6	3.8	3.9	4.0	4.1
Respiratory system	1	0.2	0.2	0.2	0.2	0.2	0.2
	2	0.6	0.7	0.7	0.7	0.7	0.7
Environment	1	0.6	0.6	0.7	0.7	0.7	0.7
	2	5.7	5.7	6.0	6.2	6.4	6.5
Services and techniques	1	2.1	1.9	2.0	2.0	2.1	2.1
	2	6.3	5.6	5.9	6.1	6.2	6.4
Gastrointestinal tract	1	0.4	0.3	0.3	0.3	0.4	0.4
	2	1.2	1.0	1.0	1.0	1.1	1.1
Kidney and urinary tract	1	0.2	0.2	0.2	0.2	0.2	0.2
	2	0.6	0.6	0.6	0.7	0.7	0.7
Teeth and associated tissues	1	0.1	0.1	0.1	0.1	0.1	0.1
	2	0.7	0.5	0.6	0.6	0.6	0.6
Endocrine glands	1	0.3	0.4	0.4	0.4	0.4	0.5
	2	0.8	1.2	1.3	1.3	1.3	1.4
Infections (other than tropical)	1	1.3	1.4	1.4	1.5	1.5	1.6
	2	3.8	4.1	4.3	4.5	4.6	4.7
Nutrition	1	0.2	0.2	0.2	0.2	0.2	0.2
	2	1.7	1.9	1.9	2.0	2.1	2.1
Organisation of medical care	1	0.1	0.1	0.1	0.1	0.1	0.1
	2	0.5	0.5	0.5	0.5	0.6	0.6
Tropical medicine	1	0.5	0.6	0.6	0.6	0.6	0.6
	6	4.6	5.1	5.3	5.5	5.6	5.6
Muscle, bone and joints	1	0.9	0.9	0.9	0.9	1.0	1.0
	2	2.7	2.6	2.7	2.8	2.9	2.9
Anaesthetic agents	2	0.6	0.6	0.6	0.6	0.6	0.6
Training awards not readily classifiable	1	2.5	2.7	3.3	3.3	3.2	3.3
	2	2.5	2.7	3.3	3.3	3.2	3.3
TOTAL		100.6	106.4	112.8	116.2	118.5	120.9

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Table 7b

MEDICAL RESEARCH COUNCIL
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	66.8	70.7	73.1	74.4	74.9	76.4
Universities	25.8	26.2)				
Overseas	1.5	1.8)				
Non-industrial research	3.8	5.0)				
institutes		)	46.5	48.5	49.9	51.0
Persons	4.9	5.4)				
Others	2.8	2.8)				
<u>less</u> Receipts	5.0	5.5	6.8	6.7	6.3	6.5
TOTAL	100.6	106.4	112.8	116.2	118.5	120.9

(1) The MRC have stressed the difficulty they have had of classifying their R&D by Primary Purpose and the results should be treated as estimates only. They also emphasise that the Subject Areas should not be taken on mutually exclusive. Thus for example, although direct expenditure on "cancer" was £13.7 million in 1983/4, substantial elements of other programmes were (and are) relevant to cancer research.

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NATURAL ENVIRONMENT RESEARCH COUNCIL (NERC)

The NERC is responsible for encouraging, planning and executing research in those sciences, physical and biological, that relate to man's natural environment and its resources. Such investigations seek to provide a better understanding not only of the nature and processes of the environment in which we live and on whose resources we depend, but also of their influence on man's activities and welfare and, of growing importance today, of man's influence on them.

The fields of research are summarised below and may be broadly defined as: The Solid Earth - its physical properties and mineral resources (geology, geophysics and geochemistry); The Seas - their characteristics and living and mineral resources (physical oceanography and marine ecology); Inland Waters - their characteristics and living resources (hydrology and freshwater ecology); The Terrestrial Environment - the structure, interactions and productivity of plant and animal populations and communities (terrestrial ecology and soil science); Atmosphere - its structure and interactions; and Interdisciplinary Studies of the Physical and Biological Properties of the Antarctic Environment (atmospheric, earth and life sciences).

NERC supports work in its own 9 institutes, in 3 grant-aided institutes and in universities through research grants and support for postgraduates, and indirectly by the provision of research vessels, payment of the UK contribution to the International Phase of Ocean Drilling and the maintenance of large equipment pools. Total NERC support for universities now comprises some 26 % of science budget funding. It is NERC's policy to maintain and, wherever possible, to increase this level of support and to continue to develop collaborative research between its institutes and universities.

The main criteria for deciding on scientific priorities in basic research are the excellence of the research, the extent to which it will complement other work or fill a gap, the development of a new technique or technology allowing a problem to be explored from a new direction, and the recognition of an area as being of particular importance. Decisions are reached through the peer review system with an input from a wide range of experts from the academic profession both at home and abroad, from industry, and from research institutes and

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government departments. Care is taken to ensure that the Science Budget element of NERC's programme of strategic and applied research complements work commmissined by departments. With this in mind, a continuing dialogue takes place between NERC and the departmental Chief Scientists Groups.

NERC has identified a number of areas of high scientific priority on which it is concentrating resources, including deep geology, the marine sciences, biotechnology, estuarine processes and atmospheric processes. The potential of remote sensing in its application to the environmental sciences is being furthered through research programmes in this area on a collaborative basis with other Research Councils, with universities and, notably, with industry.

1. The Solid Earth

Objective: To define the physical properties and mineral resources of the earth and to understand its structure and the processes which have contributed to its formation and evolution.

The community of earth scientists in the UK, in institutes and universities, has a wide range of interests, studying problems of economic relevance and laying the basis for future understanding through a mapping programme that combines advanced skills and techniques from many fields. The work covers and unites the whole range of research from the most basic through strategic to the strictly applied and is of practical importance in the search for energy and minerals, to the construction and water supply industries and in the prediction and alleviation of the impact of such disparate events as earthquakes and radioactive waste disposal. Strategic research funded through the British Geological Survey is important both to the development of basic science and to future application work.

On the continental landmass research concentrates on maintaining an up to date knowledge and understanding of the geology through a detailed mapping programme. This surface coverage is extended to three dimensions by the drilling of deep boreholes and geophysical profiling. Three permanent magnetic observatories are maintained in the UK and a network of

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seismographs has been developed which now cover a large part of the country, giving results which are used for research into the composition and structure of the earth's core and mantle.

Geochemical research is aimed at dating the sequence of events which have affected the earth and understanding the processes which have led to the evolution of different rock types. Geochemical maps provide a database for mineral reconnaissance programmes. Studies of the motion of liquids filtering through rocks and sediments are vital to understanding the origination of exploitable veins of metallic ores and to clarifying the possible paths of contaminants, notably toxic wastes buried underground.

Research on marine geology ad geophysics is carried out in the shallow seas surrounding the UK, where work continues on the location of further deposits of oil and gas, and in the deep oceans, including the International Ocean Drilling Programme. Increased knowledge in these areas is, of course, of value to oil companies and to the Department of Energy; it is also important in furthering understanding of fundamental geological processes. Many of the features of significance to the further development of the theory of plate tectonics occur under the ocean. Their study and further exploration is of importance to the understanding of geological processes. The NERC funded British Institutes Reflection Profiling Syndicate links universities and NERC institutes in an attempt to develop understanding of the deep structure of the earth.

Finally, teams of NERC funded earth scientists are working overseas as part of aid projects to discover mineral and energy resources, and water, in locations in South East Asia, the Pacific, South America and Africa, often in co-operation with UK consulting engineering houses.

2. The Seas

Objectives: To describe and understand the physical and chemical processes operating within the seas and oceans, ranging in scale from estuarial and in-shore phenomena to processes which operate on a global scale. To achieve a more comprehensive knowledge of the characteristics of organisms in the sea, the processes that underlie the structure and function of marine ecosystems and their response to changing external factors.

Despite the fact that they occupy some 70 per cent of the earth's surface, the oceans are an only partially understood part of our natural environment. Again, researches funded by NERC cover the range from highly applied through strategic to basic. The evolution of instrumentation, of the platforms to carry such instruments and of the means to analyse and interpret the data provided by such instruments, is proceeding rapidly.

NERC funds work on waves and currents and their interactions with the atmosphere and the sea floor. The modelling of ocean currents and ocean circulation are seen as a high priority. Ocean circulation is a major determinant of climate and both causes and regulates climatic change. Remote sensing has offered opportunities in this area which promise to further basic understanding and offer opportunities for an increasing range of applied work.

One of the five major priority areas of science within the NERC remit at present is estuarine research. These studies are inevitably multidisciplinary. Physical, chemical and biological processes interact strongly within estuaries and help to determine their capability to deal with pollutant loads without unacceptable environmental damage.

The shallow seas and the shelf break are ocean areas with characteristics which merit particular attention. Work is being carried out on physical mixing processes, bio-geochemical cycling and biological activity in frontal zones and at the shelf break.

Research into chemical processes is aimed at understanding the large scale processes occurring in the oceans and provides information on the compostion of sea water, the fluxes of particular materials on the ocean bed and the formation of sediments and post-depositional chemical

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processes. This work furthers basic understanding and also offers applied opportunities, such as examining the potential effects of radioactive waste sea bed disposal. There are also strong links between this area and climatology (see section on atmosphere) because of the ocean's ability to absorb atmospheric CO_2 and so ameliorate the effect of continued man-made CO_2 production and the possible consequent climatic warming.

Sedimentation studies are aimed at an understanding and quantification of the conditions of sediment deposition, erosion and transportation. Increased knowledge in this area is of value both for engineering and commerce and has major environmental implications in terms of pollution entrainment.

Studies of the biology of organisms and their adaptations and responses to the environment at the behavioural, physiological, biochemical and genetic level are continuing. This is an area of research where marine organisms can prove to be suitable as a means of studying more general scientific problems (such as nerve transmission and larval development).

The ecology of the southern ocean ecosystem has relevance to the continued search for new exploitable living resources. Current research focusses on the role of krill in the southern ocean food web and includes biological studies in relation to its environment and its principal predators.

In addition to the research effort described above, NERC provides the marine information and advisory service to both the industrial and scientific communities throughout the UK.

3. Inland Waters

Objective: To investigate the physics and chemistry of the hydrological cycle involving rainfall, run-off, percolation and groundwater flows, storage and evapo-transpiration. To increase understanding of the ecology of rivers and lakes.

Research (funded in Institutes and in universities) concerned with the entire hydrological cycle has important implications for the examination of land use changes. A major objective of this work has been to solve the problem of measuring evaporation from different types of vegetation in climatic conditions. Continued development of numerical modelling techniques has and will create a UK capability for hydrological forecasting. There is considerable collaboration in this field between NERC scientists and UK consulting engineering houses. Recent work on inland waters has shown a renewed emphasis on water chemistry, particularly in relation to the effects of atmospheric pollution. Research focusses on the interdependence of organisms in rivers and lakes and their

response to the input of pollutants. Work is carried out on the linkage between physical, chemical and biological characteristics of streams.

4. Terrestrial environment

Objective: To improve the understanding of organisms, biological processes and ecosystems and provide the scientific basis for environmental management in relation to the assessment of the impact of natural and man-made changes upon organisms and their environments and the exploitation and conservation of relevant natural resources.

Understanding of complex ecosystems has increased through the application of modern methods of observation, analysis, experimentation and modelling to traditional field ecology. Thus it is becoming feasible to forecast the effects of human activities on the environment. Current work examines the implications of increasing urbanisation, of the large scale application of fertilisers and pesticides to the land, the effect of atmospheric pollutants such as acid deposition on soils and forests and the pathways of radionuclides in the environment.

Priority continues to be given to work on the effects of land use options and changes, genetic variation in relation to the environment, virology, population dynamics and soil processes. Recognition of these priorities has led to a reduction in funding for more traditional areas such as applied conservation research and taxonomy.

5. <u>The Atmosphere</u>

<u>Objective:</u> To understand the physical and chemical behaviour of the lower atmosphere. To investigate the ionosphere and magnetosphere with particular reference to the Antarctic.

As has been noted above, NERC is devoting increasing resources to work on the chemistry of the atmosphere, particularly in relation to the effect of man-made inputs such as sulphur. Priority work is being carried out into CO_2 cycling within the atmosphere and the climatic effects of increases in CO_2 levels. The particular ionospheric conditions in the Antarctic are being explored through the use of the advanced ionospheric sounder. NERC plays a major part in the World Climate Research Programme.

Table 8a

NATURAL ENVIRONMENT RESEARCH COUNCIL
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
The solid earth	1	18.5	19.2	19.9	20.9	21.6	22.2
	2	1.8	2.3	3.5	3.8	3.9	4.0
The seas	1	13.2	13.9	14.4	15.2	15.7	16.2
	2	1.9	2.1	2.7	3.2	3.3	3.3
	5	0.2	0.2	0.2	0.2	0.2	0.2
Inland waters	1	5.2	5.5	5.9	6.3	6.5	6.7
	2	1.0	1.0	1.0	1.2	1.3	1.3
The terrestrial environment	1	7.2	7.7	8.6	8.8	9.1	9.4
	2	0.5	0.6	0.7	0.6	0.6	0.7
The atmosphere	1	2.6	2.6	2.6	2.5	2.6	2.7
	2	0.0	0.2	0.6	0.6	0.6	0.7
TOTAL		52.1	55.2	60.0	63.3	65.4	67.4

Table 8b

NATURAL ENVIRONMENT RESEARCH COUNCIL
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	66.6	66.9	68.9	76.2	79.0	81.7
Universities	6.4	6.0)				
Private industry	1.5	2.1)				
Public Corporations	..	..)				
Non-industrial research institutes	5.3	5.2)	17.3	11.6	11.8	11.9
Persons	3.7	4.2)				
less Receipts	31.5	29.3	26.3	24.6	25.4	26.2
TOTAL	52.1	55.2	60.0	63.3	65.4	67.4

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Table 8c

NATURAL ENVIRONMENT RESEARCH COUNCIL
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

Expenditure <u>including</u> Commissioned Research(1)

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
The solid earth	1	18.5	19.2	19.9	20.9	21.6	22.2
	2	21.6	20.4	20.0	20.2	20.8	21.5
The seas	1	13.2	13.9	14.4	15.2	15.7	16.2
	2	7.9	7.3	7.4	7.9	8.1	8.4
	5	0.2	0.2	0.2	0.2	0.2	0.2
Inland waters	1	5.2	5.5	5.9	6.3	6.5	6.7
	2	3.2	3.0	2.8	2.9	3.1	3.2
Terrestrial environment	1	7.2	7.7	8.6	8.8	9.1	9.4
	2	1.5	1.4	1.5	1.4	1.4	1.5
The atmosphere	1	2.6	2.6	2.6	2.5	2.6	2.7
	2	0.0	0.2	0.6	0.6	0.6	0.7
TOTAL		81.2	81.5	83.8	86.9	89.8	92.6

(1) These expenditures include all work commissioned with the NERC from Government Departments. The work has been classified as Frascati R & D, and as primary purpose 2 by the NERC. These assumptions are not necessarily in line with those made by the Departments concerned in response to the present Review. It has been included to illustrate the full scope and scale of NERC R & D, but since it includes expenditure by other Government Departments, the data are not used elsewhere in the Review.

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SCIENCE AND ENGINEERING RESEARCH COUNCIL (SERC)

The primary function of SERC is to maintain and enhance the research capability of the UK in all areas of pure and applied science and engineering, outside those covered by the more specialised AFRC, MRC and NERC. SERC's responsibilities consequently range over a very wide field from the most fundamental to the severely practical. The Council has pioneered ways of bringing the universities and industry closer together in research on engineering and applied problems of national importance.

In allocating its resources, SERC looks to the peer review system to achieve and maintain high standards of research, and to support programmes regarded as being timely and promising. SERC and its Boards and Committees are made up of representatives from the institutions of higher education, industry and Government. The membership is subject to regular review.

When SERC was formed in 1965, the bulk of its funds went into the "big" science areas of nuclear physics and astronomy. The years since have seen a dramatic shift towards "small" science and engineering. It is SERC's view that "big science" should consume a still smaller proportion of its resources, but the present investment in high energy physics and astronomy is near the minimum necessary if the UK is to keep any first-rate research activity in these subjects. In order to obtain the most benefit from its "big science" expenditure, SERC policy has been, and is, to obtain the maximum amount of international collaboration possible, consistent with the Council's scientific objectives. This policy has been very successful, and further developments are expected.

In engineering, by identifying areas of real practical importance, and co-ordinating the efforts of academic and industrial researchers in an active way, both the intellectual content and the practical effect of university research have been dramatically improved. "Focussed" research of this kind has been carried out within the Council's Specially Promoted Programmes and Directorates, whilst more recently the Science Board has identified "themes" within "core science" for special support. In addition, many activities which the Council supports are co-ordinated with those of other major spending organisations whose interests are complementary to those of the Council. Joint research programmes are undertaken, in particular, with Government Departments and nationalised industries.

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The priorities of the four Boards of the Council are set out in more detail in the following paragraphs.

The Engineering Board covers all the engineering disciplines and technologies. These include materials and information technology as essential enabling and underpinning technologies for the whole of its programme. The Board's priorities are largely reflected by its establishment of Special (In-House) Directorates and its initiative of Specially Promoted Programmes through which it operates in an active mode in the promotion and co-ordination of research in areas or topics that are judged important in the national interest. These embrace:

Special Directorates

Application of Computers in Manufacturing Engineering
Biotechnology (jointly with the Science Board)
Information Technology (primarily related to the Alvey Programe)
Marine Technology (until September 1985)
Polymer Engineering (until September 1984)
Teaching Company Scheme

Specially Promoted Programmes

Chemical Engineering Committee: Particulate Technology

Environment Committee: Construction Management in Buildings and Civil Engineering; Energy in Building (shortly to be terminated)

Information Engineering Committee (Non-Alvey): Instrumentation and Measurement (shortly to be terminated); Radio Communication Systems

Machines and Power Committee: Coal Technology (jointly with the Chemical Engineering Committee, but shortly to be terminated); Combustion Engines; High Speed Mechanisms (not yet started)

Materials Committee: Electroactive Polymers; Materials and Energy Conservation in the Materials Processing Industries; Medical Engineering

The Board plans for a continuing strong emphasis on industrial involvement in its activities through the Teaching Company Scheme, Co-operative Grants and CASE awards, through co-funded programmes with industry and the continuing strong intervention of its Special Directorates and Co-ordinators for Specially Promoted Programmes.

The Astronomy Space and Radio Board covers astronomy and solar system studies. The great advances made in the understanding of the universe over the last few decades have come largely by astronomers who are able to bring together observations of particular features - eg neutron stars or black holes - over a wide range of wavelengths. UK astronomers have been particularly successful in this period, largely because of the SERC's policy of providing access to a wide range of facilities. This has only been possible through a comprehensive international approach to facilities, whether ground or space-based. The SERC intends to continue this policy, which has proved so productive of science and cost effective with limited revenue. Two major projects to which the Board attaches high importance are the provision of three new optical telescopes at La Palma (two of which are now almost operational) and the provision of a millimetre wavelength telescope in Hawaii. These last two projects are being developed in collaboration with the Netherlands, although the UK is the major partner in the enterprise. The Board intends to seek approval in the near future to fly an atmospheric sounding instrument on NASA's Upper Atmosphere Research Satellite.

Science Board supports basic research in biology, chemistry, physics, and mathematics. These are the "core" sciences which underpin the activities of the other science-based Research Councils and the science-based industries of the nation.

The Board's first priority is for the direct support of universities and polytechnics provided through research grants and studentships. The Board has recently completed a statement of its strategy for support of core science. This includes: steps to ensure the vitality of each of the core sciences; identification of research themes within the core sciences and a review of the balance of support between these themes; support of multidisciplinary research including the establishment of special programmes where necessary; and adequate funding for the very best research ideas of timeliness and promise in any area.

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The Chemistry Committee has made a more detailed study of the balance of support between themes and has highlighted areas where more work is needed (eg in its theme on synthesis and properties of new materials) or where the emphasis should be changed (eg studies of hetereogeneous catalysis under more realistic pressures). Some Committee themes (or sub-themes) are considered to be sufficiently important to be the basis of the new multidisciplinary programmes described in paragraph 21. Other areas such as mathematical biology and non-linear systems (Mathematics Committee themes), molecular recognition and brain/neurochemistry (Biological Sciences Committee) are emerging as areas for further expansion. Other examples from the many Committee themes are: instrumental techniques (Chemistry and Physics Committees); plasma physics (Physics Committee); plant science and productivity (Biological Sciences Committee); quantum fluids (Physics); stochastic modelling, and analysis (Mathematics Committees).

The Board is convinced of the importance of multidisciplinary activities and has recently recognised the need to support new programmes in low dimensional structures, protein engineering and chemical sensors.

The Board also provides the research community with access to expensive central facilities that are necessary for front-line research in many areas of science.

The main objectives of the Science Board over the next five years are:

i. to develop and fully exploit the Synchrotron Radiation Source at the SERC Daresbury Laboratory;

ii. to continue to run and enhance the Central Laser Facility at the Rutherford Appleton Laboratory;

iii. to provide access by UK scientists to the best neutron sources at minimum cost. This will mean continued UK participation in the successful Institut Laue Langevin at Grenoble and seeking major international partnerships in the Spallation Neutron Source (SNS), nearing completion at the Rutherford Appleton Laboratory, so as to allow it to be fully exploited.

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The Science Board hopes the UK will be able to participate in the propsed European Synchroton Radiation Facility (ESRF), a hard x-ray high energy storage ring.

The Nuclear Physics Board covers particle physics and nuclear structure physics. Particle physics is carried out wholly on overseas facilities, in particular those at CERN, and nuclear structure uses both UK and overseas facilities. Its priorities over the next 5 years are:

i. In particle physics there will be an almost complete transition from mainly fixed target experiments to a programme relying largely on colliders. At CERN the Super Proton Synchrotron (SPS) proton-antiproton (pp) collider is being upgraded and the new Large Electron Positron accelerator (LEP) will start operation at the end of the period. About half of the UK particle physicists are planning to work on these machines and experiments for LEP are already under construction. At DESY (Hamburg) an electron-positron (ep) collider HERA will replace PETRA and about a quarter of UK particle physicists will work on this machine. The remainder of particle physicists will use residual fixed target facilities at CERN or non-accelerator experiments. These are priorities which are being pursued by closing other facilities at CERN or reducing other activities.

ii. In nuclear structure, SERC has recently reviewed its priorities. The Nuclear Structure Facility at Daresbury will first be vigorously exploited at 20 MV and could then be upgraded by superconducting modules from 20 MV to 30 MV. Work on the Oxford Van der Graff accelerator will continue and a modest improvement at Oxford to allow research up to 15 MV is planned. The nuclear structure community will be encouraged to use the 900 MeV electron accelerator at Mainz and it is hoped to provide a magnetic spectrometer for experiments there.

iii. A new area of interest to both particle and nuclear physicists that will open up in the next few years is the study of meson and quark plasmas produced by relativistic heavy ion collisions. The first steps in this field will be taken at CERN in 1985 with the acceleration of heavy ions in the SPS. The study of new states of matter that could be produced is an exciting possibility and British physicists will be working in this area.

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Table 9a

SCIENCE AND ENGINEERING RESEARCH COUNCIL
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
ASTRONOMY SPACE AND RADIO (ASR) BOARD							
Solar systems	1	2.7	2.8	3.0	3.4	3.5	3.7
Astronomy	1	6.6	6.6	7.4	8.3	8.4	9.0
	6	0.1	0.2	0.2	0.2	0.2	0.2
Establishments and other domestic facilities	1	20.3	22.5	21.8	22.8	22.6	22.0
International contributions	1	9.6	9.7	11.6	13.4	16.1	16.3
TOTAL ASR		39.4	41.7	43.4	48.0	50.8	51.6
ENGINEERING BOARD							
Environment	1	0.6	1.0	0.8	0.7	0.7	0.8
	3	2.6	2.9	3.2	3.8	4.9	5.1
Engineering processes	1	0.8	1.3	0.7	0.7	0.8	0.9
	3	4.4	4.6	5.2	5.0	5.1	5.4
Machines and power	1	1.0	1.8	1.1	1.0	1.1	1.1
	3	5.2	5.7	6.3	7.4	8.7	8.6
Materials	1	1.1	2.2	0.7	0.8	0.9	1.0
	3	6.4	6.6	6.9	6.5	7.1	7.3
Marine technology	1	1.3	1.6	1.1	1.1	1.0	0.9
	2	0.3	0.3	0.3	0.3	0.2	0.2
	3	2.5	2.0	2.3	2.3	2.1	2.3
	5	2.4	2.0	2.1	2.1	1.9	2.0
Energy	1	0.0	0.2	0.2	0.2	0.2	0.2
	3	0.0	0.6	0.8	1.2	1.3	1.3
Teaching company	3	1.6	2.1	3.5	5.3	5.8	6.7
Polymer engineering	3	1.9	1.8	2.1	2.2	2.1	2.1
Biotechnology	3	0.0	1.3	2.3	3.2	3.6	4.5
Information technology	3	9.2	11.9	12.8	17.5	17.1	16.3
Establishments and other domestic facilities	3	8.8	6.2	7.7	9.0	8.9	8.2
TOTAL ENGINEERING		50.8	56.8	60.9	71.0	73.4	74.9

Table 9a Cont

SCIENCE AND ENGINEERING RESEARCH COUNCIL
SUBJECT AREAS AND PRIMARY PURPOSES

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
NUCLEAR PHYSICS BOARD							
Nuclear structure	1	2.5	2.9	2.1	2.0	2.0	2.0
Particle physics	1	3.9	4.4	5.0	5.6	5.8	6.1
Establishments	1	16.1	17.5	17.5	17.4	18.1	19.4
International contibutions(1)	1	24.5	26.6	32.3	35.3	36.0	36.4
TOTAL NUCLEAR PHYSICS		47.0	51.4	56.9	60.3	61.8	63.9
SCIENCE BOARD							
Biological science	1	13.5	13.6	13.8	15.0	16.1	17.1
Chemistry	1	13.7	15.0	14.4	15.7	16.9	17.9
Maths	1	2.5	2.5	2.6	2.8	2.9	3.1
Physics	1	6.5	6.8	7.3	8.0	8.7	9.2
Other research	1	1.0	2.1	2.6	3.6	4.0	4.4
Establishments	1	16.7	19.4	20.2	20.0	20.4	21.6
Other domestic	1	1.1	1.1	1.0	0.7	0.6	0.6
International contributions(1)	1	7.2	6.2	6.5	7.1	6.5	5.3
TOTAL SCIENCE		62.2	66.7	68.3	72.8	76.1	79.2
CENTRAL SUPPORT		12.8	13.7	16.9	17.0	18.2	17.6
TOTAL		212.1	230.0	246.4	269.2	280.2	287.2

(1) While the SERC allocation is increasing, the provision includes additional sums of £5 million and £7.5 million in 1983/84 and 1984/85 respectively and £10 million per annum thereafter in association with the Information Technology initiative (which the Council has had to supplement from within its base alloction) and £7M, £8.5M and £9.5M in 1984/85, 1985/86 granted partially to offset inescapable increases in the cost of international subscriptions.

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Table 9b

SCIENCE AND ENGINEERING RESEARCH COUNCIL
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	82.1	90.3	90.4	92.8	99.4	101.5
Government departments	1.9	1.9	1.6	1.6	1.6	1.7
Universities	67.7	74.7)				
Research associations	0.1	0.1)				
Overseas	41.2	43.7)	164.1	183.9	188.4	194.0
Persons	27.0	28.5)				
Others	0.1	0.3)				
less Receipts	7.9	9.3	9.7	9.3	9.2	9.9
TOTAL	212.1	230.0	246.4	268.9	280.2	287.2

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DEPARTMENT OF ENERGY (DEn)

Non-nuclear R & D

1. The overall objective of this expenditure is to support R & D which would not otherwise be undertaken in order to:

i. establish options for future energy supply, distribution and use;

ii. provide selective back-up to those industries associated with energy supply, distribution and use, and

iii. to enable DEn to carry out its statutory and regulatory responsibilities.

Offshore technology

2. This falls into two main areas. First, DEn assists the development of the UK offshore supplies industry in a market worth £3 billion a year. A number of projects have been assisted to the point of commercial exploitation, for instance an improved downhole pump. The overall objective is to maximise the UK share of the market (in recent years it has been around 70 per cent).

3. Second, DEn is involved in work on exploration and recovery technologies. This includes mapping of the seabed of the UK Continental Shelf. Data acquisition is 75 per cent complete and publication of maps 60 per cent complete; and work is on schedule for completion by 1989-90. In addition, a reservoir simulation model, jointly funded with the British Gas Corporation and Britoil, has been developed and co-operative work with the oil industry on enhanced oil recovery is leading to pilot oil field experiments.

Renewable and alternative resources

4. Sufficient progress had been made by early 1982 for a decision to be taken, in the light of advice from the Advisory Council on Research and Development on Fuel and Power, to concentrate on the more promising options. Work on active solar water and space heating is being terminated and that on wave energy reduced to a low level. Priority is being given to wind power and geothermal energy; and modest programmes are continuing on biofuels and passive solar heating.

Coal technology

5. The International Energy Agency programme to build and test a Pressurised Fluidised Bed Combustion Facility at Grimethorpe comes to an end in 1984. Participation has improved the UK's position as an informed potential customer and has reinforced our expertise in this new technology.

6. Support is being given to design studies of a combined cycle power plant and to the design of a coal liquefaction pilot plant.

<u>Nuclear R & D</u>

7. The main objectives are to help the electricity industry to exploit current reactors safely and commercially; and to assist in the choice and development of new designs. Most of the expenditure is by the United Kingdom Atomic Energy Authority (UKAEA).

8. Key objectives in the main areas of work are:

Advanced gas cooled reactors

- to assist the nuclear industry to achieve:

    i. power output at rated levels on all stations by 1988;

    ii. on-load refuelling at power levels of 70 per cent or higher by 1986-87;

- to provide data to meet evolving safety standards.

Pressurised water reactor safety

- to provide independent information to assist the Nuclear Installations Inspectorate in reviewing safety standards; and specifically

- to quantify reactor behaviour in Loss of Coolant Accidents by 1985.

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Fast reactor

- to retain the option of odering commercial fast reactor stations when it becomes economic to do so;

- to carry out R & D in international collaboration; and, specifically,

- to achieve sustained operation of the Prototype Fast Reactor at 240 M We gross output and 50 per cent availability;

- to establish by 1991-92 a conceptual design for a commercial scale lead reactor and criteria for the licensing of stations.

Nuclear materials management

- to provide technical advice to the Government on the managing of radioactive wastes;

- to develop plant for the UKAEA to manage their wastes; and specifically,

- to commission a cementation plant in 1987-88 for intermediate level UKAEA wastes;

- to commission a radiochemical facility at Harwell by 1985-86.

Fusion

- to establish whether nuclear fusion can be used to generate electricity economically; and specifically,

- to support the Joint European Torus (JET) project at Culham;

- to help decide by 1988 whether or not the European Community should initiate a project after JET.

Table 10a

DEPARTMENT OF ENERGY
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Renewable energy sources	2	15.3	12.7	7.7	12.4	12.7	13.0
Oceanography	2	1.5	1.5	1.0	1.4	1.5	1.5
Enhanced oil recovery	2	2.8	2.8	2.3	3.0	3.1	3.3
Reservoir simulation	2	1.0	1.2	1.2	1.4	1.4	1.5
General policy research	2	0.1	0.1	0.1	0.1	0.1	0.1
Energy conservation	2	0.8	1.2	1.5	2.0	3.0	3.1
Underwater initiative	3	0.9	0.8	1.0	1.1	1.1	1.2
Industrial support	3	3.2	2.2	2.9	4.7	3.5	3.7
Energy conservation demo project scheme	3	1.7	3.3	3.4	4.9	5.9	5.9
Safety	5	3.2	2.8	2.7	3.5	3.5	4.0
Coal technology (NCB Coal Marketing)	6	4.9	3.4	3.7	2.3	3.3	3.3
Other costs (Total)	6	0.2	0.2	0.2	0.2	0.3	0.3
TOTAL		35.6	32.1	27.8	36.9	39.4	40.7

Table 10b

DEPARTMENT OF ENERGY
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	2.2	2.1	2.2	2.3	2.5	2.5
Research Councils	1.3	1.3	0.9	1.3	1.4	1.4
Other Government departments	9.2	7.1	6.7	9.7	10.1	10.6
Universities	6.9	4.7)				
Private industry	10.3	10.8)				
Public Corporations	4.5	3.9)				
Research associations	1.1	1.4)				
Overseas	..	0.2)	19.3	24.7	25.8	26.8
Non-industrial research institutes	..	0.1))				
Professional and learned societies	..	..))				
Persons	..	..)				
Others	0.3	0.6)				
<u>less</u> Receipts	0.2	0.1	0.3	0.5	0.5	0.5
TOTAL (1)	35.6	32.1	28.9	37.5	39.3	40.9

(1) The small differences between the totals shown in tables 10a and 10b in the years 1983/84 to 1986/87 are as a result of slightly later estimates being included in Table 10a.

Table 11a

UNITED KINGDOM ATOMIC ENERGY AUTHORITY
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Fast reactor	2	82.2	110.9	118.5	103.8	100.1	95.3
Nuclear materials mngmt	2	35.3	17.0	11.1	21.7	25.7	28.0
	5	2.0	1.9	1.2	2.4	2.9	3.1
Fusion	2	18.0	23.4	20.6	20.2	22.1	21.9
Thermal reactor	4	27.4	26.3	22.0	20.2	15.6	15.7
Underlying research	2	18.4	20.9	19.6	20.4	19.9	21.3
	3	3.9	4.4	4.1	4.3	4.2	4.5
Other	2	16.1	7.6	1.8	3.7	5.7	5.4
TOTAL		203.2	212.4	199.0	197.0	196.2	195.3

Table 11b

UNITED KINGDOM ATOMIC ENERGY AUTORITY
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	315.3	332.9	346.6	363.5	355.3	360.7
Research Councils	0.2	0.2	..	0.1	0.1	..
Other Government departments	0.7	0.9	0.8	0.7	0.7	0.6
Universities	2.2	2.2)				
Private industry	26.0	23.6)				
Public Corporations	1.1	0.7)				
Research associations	..	..)				
overseas	2.1	0.1)	30.0	17.9	17.3	16.1
Non-industrial research institutes	..	..)				
Others	0.1	0.0)				
less Receipts	144.7	148.4	178.5	185.4	177.3	182.2
TOTAL	203.2	212.4	199.0	196.7	196.1	195.3

DEPARTMENT OF THE ENVIRONMENT (DOE)

The DOE R & D programme covers a wide range of activities which affect people's social, physical and economic environment and public health. The results of the research are used to guide the progressive improvement of the environment, to make public investment more cost effective and to encourage greater efficiency in the construction industry. Most of the research provides an input to policy and/or assists with commitments within UK legislation or EC Directives and some provides "sponsorship" support to industry. The programme has six main subject areas and the principal themes of each are described below.

Environmental Protection

The environmental protection programme has four main component topics: radioactive waste management, toxic substances, air and noise pollution and general waste management.

i. Radioactive waste management research is the largest component. DOE's responsbilities for it are set out in Cmnd 6820 (1977) and Cmnd 8607 (1982). Increasing attention will be given in future to research on monitoring the pathways whereby radioactive waste can get back to man or to other targets. The need for this work has been fully demonstrated by the problems at Sellafield. The main aspects of the radioactive waste programme aim to:

   a. prepare an inventory of wastes;

   b. develop effective methods for managing and disposing of existing radioactive wastes and those arising in future;

   c. understand the reasons for public concern about radioactive wastes;

   d. provide a basis for assessing the suitability of possible underground disposal sites for non-heat generating waste;

   e. evaluate alternative possible methods of disposal of heat generating waste on land or on or below the sea bed;

f. define the properties of intermediate level wastes, examine treatment techniques and develop procedures for assessing the environmental safety of disposal methods;

g. examine the effects of radioactivity on man and the environment;

h. evaluate new methods of radioactive waste management (eg solidification of highly-active liquid wastes);

i. assess potential techniques for minimising waste production and for decommissioning nuclear facilities.

ii. The research on toxic substances and pollution control concentrates on the environmental effects of chemicals. Fibrous minerals (particularly asbestos) and toxic metals (such as lead) in dust and in land due for development are of particular concern. The research provides a basis for DOE policy in relation to:

a. operation of the New Chemicals Notification Scheme (under EC Directive 79/831/EEC);

b. limiting exposure to toxic metals, particularly lead and cadmium;

c. providing advice on the development of contaminated land;

d. evaluation of changing pollution abatement methods.

iii. The Department has substantially increased the research it undertakes on the effects of acid deposition on ecological systems, but of course this is only one part of a large amount of research on this subject. Air pollution, of which acid deposition is one facet, is becoming an increasingly important national and international issue. Further research will enable DOE to:

a. develop air pollution policy;

b. meet commitments in relation to the control of emissions and observance of air quality standards;

c. evaluate the need for control of acidifying emissions, and the likely effectiveness of different techniques.

iv. Research on noise pollution aims to identify trends, to evaluate public attitudes to noise nuisance, and determine effectiveness of noise control policy. DOE has specific responsibility for neighbourhood noise policy within the Control of Pollution Act and Planning Legislation.

v. The research on waste management provides information on the "best practicable environmental option" - the method combining minimal environmental risk and nuisance with reasonable cost. DOE funded the development of new mechanical waste sorting plants which are now being assessed to determine their suitability for applications and commercial exploitation. Treatment of toxic wastes and the behaviour of pollutants within land fill sites are important aspects.

Water

Following the recommendations of the House of Lords Select Committee on the Water Industry, a Research Requirements Committee has been set up by DOE to advise on the balance and policy for future long term water reseach. The current programme covers coast protection, water quality and conservation and sewerage.

i. Coast protection research will provide information to aid cost effective design and contruction. DOE commissions it as proxy customer for the 86 coast protection authorities who spend some £50m annually in this field:

DOE provided £15m of grant aid under the Coast Protection Act 1949. Research on reservoir safety studies risk associated with possible failures of dams and reservoirs of which there are about 1800 in Britain, and aids improved design; it provides support for the DOE in implementing the Reservoirs Safety Act 1975.

ii. Research on water quality will assess the causes and effects of impurities in drinking water and their health implications. An intensive research programme on sewage disposal techniques - 1.2m tonnes (dry weight) of sewage sludge is produced annually in the UK and nearly all is disposed of on land or into the sea - contributes to public health advice. Both drinking water quality and sludge disposal are the subject of EC Directives and International agreements.

iii. DOE part funds research on sewerage - the major funder is the Water Industry - to improve the design, use and maintenance of sewers. In this case DOE is fulfilling its role as sponsor to the civil engineering industry to achieve cost reductions for sewer replacement and maintenance in the UK.

Planning

Planning research covers not only the review of the statutory planning system and analysis of specific land-use issues, but also evaluation of Inner Cities Policy and the Urban Programme; the assessment and restoration of derelict and unstable land; methods for dealing with environmental and related problems arising from the extraction of coal and other minerals and the assessment of sources of minerals supply and related geological matters.

i. New research on the planning system provides the basis for recommendations for the introduction of measures to improve the efficiency and effectiveness of local plans, development control decisions and the quality of the information available to inspectors and appellants. Research on specific land use issues will focus on the land-use implications for industry of technological change.

ii. New Inner Cities Research will evaluate the impact on environment, employment and on the young unemployed of Urban Programme Projects and Expenditure. It will follow up current work on industrial land availability and the accommodation problems facing Inner City firms.

iii. Research into the problems of derelict and unstable land will provide guidance on cost-effective techniques for the restoration of sand and gravel and metalliferous mine workings, for the restoration to forestry of colliery spoil tips and on methods for ensuring the stability and safety of old limestone workings and for assessing the risk of slippage of unstable slopes.

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iv. In the field of energy minerals extraction the main focus of reseach action, following from the White Paper `Coal and the Environment´, is on spoil disposal and open-cast mining. Research will examine underground and other methods of spoil disposal and the problems of noise abatement at open-cast sites.

v. The programme on non-energy minerals resource assessment, the aim of which is to provide the information to ensure that an adequate and steady supply of minerals products for industry can be maintained, while keeping financial, social and environmental costs to an acceptable minimum, will continue, but at a more modest level than in previous years. More emphasis is being given to research on alternative sources of aggregates eg. high quality sandstone for road surfacing and Magnesian Limestone.

Rural Affairs (countryside)

The research provides an input to policy on rural affairs, the discharge of responsibilities under the Wildlife and Countryside Act and guidance on the best use of land for conservation, amenity and landscape. Its aims are:

i. to provide a data base for examination of landscape change and to assess the management and potential of rural common land.

ii. to provide guidance on ways to maintain and enhance the environment. Subjects include low-maintenance amenity greenspace and arboriculture. This research provides encouragement to local authorities and other land owners to contribute cost-effectively to the quality of the environment.

iii. to provide understanding of economic issues affecting rural communities. It covers, for example, integration of financial support in rural areas, mobile services, support for village shops and the impact of micro-technology. Research is also aimed at environmental education, sports and recreation eg. problems associated with football hooliganism.

Housing

Housing research falls into two groups; physical characteristics of the housing stock and research on housing in relation to the occupants.

i. DOE research on physical characteristics of housing stock has three policy aims: to monitor the condition of the stock, including the effects of improvement policies; to advise on cost-effective energy conservation in design, construction and improvement; to prevent and remedy housing defects. Research findings on changes in conditions of the stock contribute directly to the development of improvement policy, particularly by establishing how to secure better value for money from grant aided activity. Energy conservation research is directed towards achieving further energy savings with new building or improved existing dwellings and through the revision of standards. Research on commonly occurring defects will provide advice on how to prevent them or put them right.

ii. Most of the research about occupants is specific to one or another of the major forms of tenure - owner occupation, the private rented sector and the public rented sector - although there is some global research which monitors the overall social and economic trends in housing. This work provides key information on the development of Goverment policies, especially those aimed at increasing owner-occupation through various low cost home ownership initiatives, sustaining the private rented sector, and removing obstacles to the efficient operation of the housing market. The accent of research concerned with the public sector is on improving management, particularly "difficult-to-let" estates; and the mobility of tenants in public sector accommodation and access of others to it. Research also identifies the nature and quality of provision for particular groups, eg the disabled, in order to establish and subsequently publicise, examples as good practice.

Construction

The objectives of the construction research programme concern three of DOE's responsibilities. The first is building regulations, where there is statutory responsibility for health, safety and energy conservation. The second is for sponsorship of the industry where the research is intended to improve the

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performance and products of the industry, which had a gross output of about £20 billion in the UK in 1982. The third is for the Property Services Agency (PSA) to support its task of building and maintaining the Government estate; in 1982/83 PSA spent £599 million on new construction and £687 million on maintenance.

i. Research in support of building regulations covers:

a. Foundations and building structures: safe and economic foundations on difficult ground, safety aspects of modern structural codes (including Eurocodes), and investigation of various structural failures.

b. Fire: basic work on reduction of hazards to life, with new initiatives to examine current requirements to see if they are essential, and to assess their economic implications.

c. Safety in buildings: this includes an urgent investigation into safety aspects of water heating systems.

d. Energy conservation: statutory requirements for energy conservation measures in new buildings are set out in the building regulations; these are under constant review to ensure that they are practical and cost-effective.

e. Utilisation of materials such as timber, concrete and plastics. The aim is to provide information on the expected durability and performance of new materials and the reasons for failure of old ones.

Advice on this research is provided by the Building Regulations Advisory Committee.

ii. "Sponsorship" research is aimed at improving the performance of the construction industry and its products; support is given to important topics unlikely to proceed without a measure of Government funding. Research covers foudations, materials, the provision of design information, project management, quality assurance techniques, and some aspects of building services. Research on hydraulics civil engineering

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will in future be included in this programme. Advice on the research is provided by the Research Strategy Committee set up by the Economic Development Committee for Building and Civil Engineering, which takes account of related research.

iii. Research for the PSA covers building services, building with components to achieve improved performance, the maintenance and preservation of buildings and construction costs.

Table 12a

DEPARTMENT OF THE ENVIRONMENT
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Countryside Commission research	2	0.5	0.5	0.5	0.5	0.5	0.5
Nature Conservancy Council research	2	1.6	1.7	1.7	1.7	1.7	1.7
Policy research for the Sports Council	2	0.4	0.5	0.4	0.8	0.8	0.9
Planning, countryside & local government	2	5.4	4.3	4.0	5.0	5.3	5.4
Housing	2	2.5	1.9	1.8	2.4	2.5	2.6
Ancient monuments & historic buildings	2	..	..	..	..	..	..
Env Protection - General	2	5.1	4.7	5.0	5.1	5.3	5.9
Env Protection - Radioactive waste	5	9.3	8.5	9.3	10.3	10.7	10.9
Building and construction	3	2.5	3.3	3.0	4.0	3.7	3.8
	4	3.0	2.2	2.4	2.7	2.7	2.6
	5	4.1	4.6	4.5	4.4	4.3	4.4
	6	0.0	0.0	0.0	0.4	1.1	1.4
Water	5	3.9	3.8	3.9	4.3	4.4	4.5
TOTAL		38.3	35.9	36.5	41.5	43.0	44.2

Table 12b

DEPARTMENT OF THE ENVIRONMENT
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	18.1	15.6	15.5	16.4	17.5	17.6
Research Councils	8.5	6.0	5.8	7.1	7.5	7.7
Other Government departments	1.8	2.1	2.2	2.4	2.5	2.6
Universities	1.9	2.1)				
Private industry	3.3	3.5)				
Public Corporations	6.6	5.2)				
Research associations	2.8	3.6)				
overseas	..	..)	15.5	18.1	18.6	19.4
Non-industrial research institutes	0.3	0.3)				
Professional and learned societies	..	..)				
Persons	0.4	0.2)				
Others	..	..)				
<u>less</u> Receipts	5.2	2.8	2.5	2.6	3.1	3.2
TOTAL	38.5	35.9	36.6	41.5	43.0	44.2

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DEPARTMENT OF HEALTH AND SOCIAL SECURITY (DHSS)

DHSS commissions research in five main fields -

Health and Personal Social Services (HPSS)
Social Security (SS)
National Health Service (NHS) Building and Engineering
NHS Equipment and Supplies
NHS Scientific and Clinical Computer R & D.

HPSS and SS

The primary purpose of the HPSS research programme is to provide the DHSS with the means to evaluate and develop the programmes for the provision of high quality and cost-effective health care and relevant aspects of the social services. Particular attention is given to the effects of advances in medical technology, demographic changes, and changes in economic and social conditions.

About half the HPSS R & D effort is organised through Research Liaison Groups, consisting of departmental officers working with outside experts in relevant academic and scientific disciplines and relevant service provision. These are focussed on particular "client" groups eg "Children", "Elderly"; certain service providers, eg "Nursing", "Local Authority Social Services"; certain disease states eg "Mental Ilness", "Mental Handicap", "Physical Disablement"; certain social conditions eg "Homelessness and Addictions", "Forensic". Other less formal working groups, but again with external advice, cover eg Primary Care; Acute Hospital Services; Public and Environmental Health; NHS personnel matters; Finance, Organisation and Planning of Health Services.

Almost all the above work is commissioned in universities, in several of which the DHSS finances research units, mainly in order to strengthen the academic base required to support research needs (eg in health services research and health economics). The only purely `in-house´ research unit is concerned with the Social Security Research Programme which is directed to: the coverage, take up and impact of benefits, evaluation of changes in the benefit schemes, and effectiveness of administration. A good deal of survey work is also carried out in collaboration with the Office of Population Censuses and Surveys.

DHSS works in collaboration with the Medical Research Council and the Economic and Social Research Council as the Department's interests extend widely from the applied bio-medical (eg clinical pathology, artificial limbs) to the psychosocial (eg residential child care). Almost all the budget of the Office of the Chief Scientist goes on Research rather than Development, the latter being financed by other DHSS funds and by the NHS itself.

Research objectives under the Department's other three R & D sub-programmes are as follows:-

Building and Engineering

The replacement value of the NHS building stock is estimated to be £21 billion and at any one time there are, at planning, design, tender or construction stage some £2 billion of capital and maintenance projects. To support this considerable capital investment Works Group produces guidance to promote the cost efficient operation, maintenance, upgrading and replacement of the NHS Estate. To assist in formulating this body of guidance and to ensure that it is soundly based, private sector and public organisations are commissioned under the R & D programme to carry out research studies and investigations. Currently effort is concentrated on:

i. The preparation of the revised range of building notes and cost limits for hospital departments.

ii. The further development and updating of the "Nucleus" design system and the evaluation of the first "Nucleus" hospitals.

iii. Development work on two low-energy hospitals.

iv. Research into the most cost effective and efficient facilities for the mentally ill, mentally handicapped and the elderly.

v. Research into ways of rationalising and improving the management of the estate, including the development of procedures to implement the report on underused property in the NHS.

vi. Providing advice to the NHS on mitigating the cost consequences of new statutory requirements, including fire precautions.

NHS Equipment and Supplies

The development of medical equipment and supplies of substantial benefit in patient care, treatment or diagnosis; the improvement of the performance and reliability of UK manufactured equipment; the establishment of standards; and the stimulation of British Industry to promote the production of medical equipment and supplies. Of a budget for 1984/85 of £4.8 million it is anticipated that about £3.2 million will be devoted to projects with a direct effect on British industry.

NHS Computer R & D

To provide financial support to bodies, mostly NHS authorities, who assume responsibility for projects for research into, or development of, the use of computers in the management and provision of national health services.

The Department's interest in the use of computers in the NHS lies in:

i. The development of innovative systems in the fields of primary care and scientific and clinical computing, including studies and investigations into the technical aspects of computing;

ii. The support of the Government's information technology awareness programme through the sponsoring of suitable projects in the promotion of new technology in the NHS through conferences/seminars and publicity;

iii. The dissemination of information about computer systems and practices to assist local NHS and Regional management in their decision making roles.

Table 13a

DEPARTMENT OF HEALTH AND SOCIAL SECURITY
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Health and personal social services	2	13.4	12.0	11.4	10.8	11.1	11.6
Social Security	2	0.5	0.4	0.4	0.4	0.8	0.4
Standards	2	0.4	0.4	0.4	0.5	0.5	0.5
Standard systems	5	0.6	0.8	..	..	..	..
Information Technology	2	0.2	0.2	0.1	0.0	0.0	0.0
	5	0.0	0.2	0.1	0.2	0.3	0.3
Hospital building	2	0.8	0.9	0.9	1.0	1.1	1.1
Procurement techniques	2	0.0	0.1	0.0	0.0	0.0	0.0
Medical equipment	3	2.2	2.4	2.8	3.2	3.1	3.0
Component database	4	0.1	0.1	0.1	0.1	0.0	0.0
Scientific and clinical	5	0.2	0.1	0.2	0.3	0.4	0.4
Family practitioner services	5	0.5	0.3	0.4	0.3	0.3	0.3
Hospital management and organisation	5	0.2	0.1	0.1	0.0	0.0	0.0
Prescription pricing authority	5	0.6	0.8	..	..	..	..
Statutory regulations	5	0.2	0.2	0.2	0.1	0.2	0.2
Protection and promotion of human health	5	8.2	9.7	9.4	8.9	6.5	6.0
Staffing and training	6	0.1	0.1	0.1	0.1	0.0	0.0
TOTAL		28.2	28.9	26.5	25.7	24.2	23.8

Table 13b

DEPARTMENT OF HEATLH AND SOCIAL SECURITY
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	11.1	12.7	16.2	14.6	12.0	11.5
Research Councils	0.5	0.4	0.2	0.2	0.3	0.3
Other Government departments	1.0	1.0	0.3	0.2	0.2	0.2
Universities	9.5	9.1)				
Private industry	1.5	1.8)				
Public Corporations	..	..)				
Research associations	0.2	0.1)	14.4	13.9	14.7	14.8
Non-industrial research institutes	1.8	1.3))				
Others	3.3	3.6)				
<u>less</u> Receipts	0.6	1.1	4.6	3.3	3.0	3.0
TOTAL	28.2	28.9	26.5	25.7	24.2	23.8

HEALTH AND SAFETY COMMISSION (HSC)

The HSC and its Executive (HSE) have a duty to advise, inform, encourage, inspect and regulate in order to bring about the best practicable levels of health and safety in occupational activities. Their research programme is an integral part of, and is wholly determined by, this practical task.

The objectives of the research fall largely under the two primary purposes of policy definition and meeting obligations and are all directed towards improving the long-term health or reducing the risk of death or serious injury of persons at work.

Obligations

Here research is aimed at assisting field-based staff of HSE (eg Inspectors, Medical Advisers etc) in the enforcement of health and safety requirements. Objectives cover such activities as the development of methods for:

i. The analysis or evaluation of samples (eg body fluids, air, dusts, materials)

ii. The forensic examination of impounded equipment (eg from accidents or other incidents)

iii. The scientific assessments of hazards arising from articles, substances or systems of work

iv. The monitoring and control of known hazards (eg workplace environments containing explosives, flammable, toxic, carcinogenic substances).

Current priorities include problems associated with asbestos and other dusts, liquid petroleum gas, protective and respiratory equipment and automation of analytical methods to facilitate the handling of large numbers of medical samples.

Policy

Research objectives are aimed at providing policy makers with scientific and technological information relating to hazards that may accompany the introduction of new technology and new materials by industry. Such information is also of assistance in the setting of standards, the drafting of regulations, approved codes of practice and other guidance materials.

Current priorities include studies of the dispersion of gas clouds in relation to policy issues concerned with the siting of chemical complexes and the bulk storage of chemicals, and provision of information to facilitate the drafting of underground transport regulations, whilst studies of the problems associated with noise are assuming greater importance.

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Table 14a

HEALTH AND SAFETY COMMISSION
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Explosions, fire and explosives	2	0.2	0.2	0.2	0.2	0.3	0.3
	5	0.7	0.8	0.9	1.0	1.1	1.3
Major hazards	5	0.1	0.2	0.2	0.2	0.2	0.3
Electrical hazards	2	0.0	0.0	0.0	0.0	0.1	0.1
Nuclear installation hazards	2	0.2	0.3	0.3	0.3	0.3	0.4
	5	0.8	1.0	1.1	1.2	1.3	1.5
Engineering hazards	2	0.1	0.2	0.2	0.2	0.2	0.3
	5	0.6	0.7	0.7	0.8	0.9	1.0
Occupational medicine	2	0.2	0.3	0.3	0.3	0.4	0.4
	5	0.9	1.1	1.2	1.2	1.4	1.6
Environmental hazards	2	0.4	0.5	0.5	0.6	0.6	0.8
	5	1.6	2.0	2.2	2.3	2.6	3.0
Other hazards	2	0.1	0.1	0.1	0.1	0.1	1.0
	5	2.3	2.8	3.1	3.2	3.7	4.3
TOTAL		6.2	7.5	8.3	8.8	9.9	11.5

Table 14b

HEALTH AND SAFETY COMMISSION
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	3.7	3.9	4.3	4.5	5.4	6.8
Research Councils	0.7	0.7	0.8	0.8	0.9	0.9
Other Government departments	0.3	0.3	0.3	0.3	0.3	0.3
Universities	1.1	1.0)				
Private industry	0.9	0.8)				
Public Corporations	..	..)				
Research associations	0.1	0.1)	3.4	3.5	3.7	3.9
Overseas	..	0.2)				
Non-industrial research institutes	0.4	0.9))				
Others	0.1	0.1)				
less Receipts	1.1	0.6	0.4	0.4	0.4	0.4
TOTAL	6.2	7.5	8.3	8.8	9.9	11.5

HOME OFFICE

The Home Office funds research in its Research and Planning Unit and in the Technical Services branch of the Police Department.

The objectives of the Research and Planning Unit relate directly to the policy areas that its work covers, ie criminal justice, criminal policy, police, prisons, community programmes and immigration.

The objectives of the R & D work of the Technical Services branch of the Police Department are:

i. to help the police and fire services to improve their effectiveness, particularly through the use of operational research techniques, the development of new equipment, the application of information technology and the development of improved methods of telecommunications;

ii. to assist the Prison Department in the improvement of prison security systems;

iii. to provide advice on the effects of nuclear and conventional weapons and the protection of the civilian population against such effects, including post-attack recovery;

iv. to develop and improve methods of forensic science and analysis.

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Table 15a

HOME OFFICE
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Rehabilitaion of offenders	2	0.4	0.4	0.3	..	..	..
Equal opportunities	2	0.3	0.3	0.3	0.3	0.3	0.4
Law services	2	2.0	1.9	2.1	2.2	2.2	2.2
Race relations	2	0.0	0.1	0.1	0.1	0.1	0.1
Prison security	2	0.2	0.2	0.3	0.3	0.3	0.3
Civil defence	2	0.5	0.5	0.8	0.8	0.9	0.9
Police research	2	4.3	4.9	4.8	5.3	5.7	5.9
Forensic science	2	1.0	1.1	1.1	1.3	1.6	1.5
Fire research	2	0.5	0.5	0.7	0.9	1.1	1.1
Telecommunications	3	1.5	1.8	1.5	1.9	2.1	2.2
Research into the voluntary sector	6	0.0	0.0	0.0	0.1	0.1	0.1
Sex discrimination and equality	6	0.2	0.2	0.2	0.2	0.2	0.2
Other costs (Total)	9	0.3	0.3	0.4	0.4	0.4	0.4
TOTAL		11.2	12.2	12.6	13.8	15.0	15.3

Table 15b

HOME OFFICE
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	8.0	8.7	9.3	10.5	11.4	11.6
Research Councils	0.1	0.1	0.1	0.1	0.2	0.2
Other Government departments	0.3	0.2	0.2	0.2	0.2	0.2
Universities	0.6	0.7)				
Private industry	1.5	1.8)				
Public Corporations	..	..)				
Research associations	..	..)	3.2	3.2	3.4	3.5
Overseas	..	..)				
Non-industrial research institutes	0.4	0.5))				
Persons	0.1	0.1)				
Others	0.4	0.4)				
less Receipts	0.2	0.2	0.2	0.2	0.2	0.2
TOTAL	11.2	12.2	12.6	13.8	15.0	15.3

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OVERSEAS DEVELOPMENT ADMINISTRATION (ODA)

ODA funds R & D projects as part of its bilateral aid programme to individual developing countries. In addition ODA funds projects at home or overseas, which are not appropriate to funding from other bilaterial aid funds, each of which is expected to benefit several developing countries rather than one.

The main purpose is to sponsor and to support a programme of research aimed at gathering new knowledge and evolving new techniques directly related to the needs of developng countries. The emphasis is on research likely to be of practical use in a reasonable period of time, and special priority is given to R & D of direct relevance to the poorer sectors of the poorer countries with particular reference to the development of the rural sector. The disciplines covered are those related to developing country needs: (i) Agriculture (ii) Fisheries (iii) Veterinary studies (iv) Forestry (v) Medicine and Health (vi) Population studies (vii) Education (viii) Energy (ix) Engineering (x) Building (xi) Transport (xii) Roads (xiii) Hydrology (xiv) Economic and (xv) Social.

Table 16a

OVERSEAS DEVELOPMENT ADMINISTRATION
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Geology	6	0.2	0.3	0.1	..	..	..
Water resources	6	0.8	1.1	1.2	1.3	1.3	1.3
Agriculture environment	6	3.8	4.6	5.1	5.4	5.8	6.1
Animal health and production	6	1.0	1.2	1.1	1.1	1.2	1.3
Tryapnosomiasis (animal)	6	0.6	0.6	0.5	0.5	0.6	0.6
Pest control	6	1.1	1.1	1.3	1.3	1.3	1.3
Forestry	6	0.6	0.5	0.5	0.6	0.6	0.6
Fisheries	6	0.3	0.3	0.3	0.3	0.3	0.3
Post-harvest technology	6	2.5	2.4	2.9	2.8	2.8	2.8
Nutrition	6	0.2	0.2	0.1	0.1	0.1	0.1
Medicine and health	6	1.4	1.4	1.8	1.9	2.0	2.0
Economic and social	6	1.0	1.0	1.2	1.2	1.2	1.2
population	6	1.0	1.3	1.8	2.2	2.6	3.2
Education	6	0.1	0.1	0.1	0.1	0.1	0.1
Engineering	6	0.1	0.1	0.2	0.2	0.2	0.2
Construction	6	0.2	0.2	0.3	0.3	0.3	0.3
Transport	6	1.1	1.9	1.9	2.0	2.1	2.1
Energy	6	0.3	0.4	0.4	0.3	0.4	0.4
TOTAL		16.3	18.6	20.7	21.6	22.8	24.1

Table 16b

OVERSEAS DEVELOPMENT ADMINISTRATION
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	4.3	4.2	5.0	4.8	4.8	4.9
Research Councils	1.3	1.6	1.4	1.5	1.6	1.7
Other Government departments	2.1	2.3	2.0	2.1	2.2	2.2
Universities	3.6	3.5)				
Research associations	..	..)				
Overseas	4.7	5.7)				
Non-industrial research	0.4	1.2)				
institutes		)	13.6	14.6	14.6	15.8
Professional and learned	..	..)				
societies	..	..)				
Persons		)				
Others		)				
<u>less</u> Receipts	0.4	0.3	0.5	0.5	0.5	0.5
TOTAL	16.3	18.6	20.7	21.6	22.8	24.1

DEPARTMENT OF TRADE AND INDUSTRY (DTI)

The general objective of DTI is to encourage, assist and ensure the proper regulation of British trade, industry and commerce; to increase the growth of world trade and the national production of wealth. The three main ways in which this will be achieved are by promoting:

a climate for British industry and commerce which is as conducive to enterprise and competition as that in any other industrial country

the international competitiveness of British firms through increased efficiency and adaptability

innovation to improve the products, processes and services that British industry and commerce can offer to the world.

All three of these involve DTI in R & D activity. This includes programmes carried out in Government laboratories and industry which maintain and enhance the technological base, and work needed for the regulation of industry and for the protection of the consumer. DTI is advised on its R & D expenditure by five Research Requirements Boards (RRBs). Each has a senior industrialist as chairman and strong industrial representation. The main technological areas of support fall into four broad groups namely: Reseach Establishments, General Industrial R & D, Aircraft and Aero-Engines and the Space Technology programme. Each has its own objectives.

1. RESEARCH ESTABLISHMENTS

1.1 DTI runs four laboratories

Laboratory of the Government Chemist (LGC)
National Engineering Laboratory (NEL)
National Physical Laboratory (NPL)
Warren Spring Laboratory (WSL)

The objectives of their R & D programmes are to support

(i) work required by statute eg at the LGC
(ii) the national standards and measurement system

(iii) Government planning and regulatory functions

(iv) Departmental policy initiatives

(v) work of national benefit in new fields and to exploit and enhance mature technology, and to transfer the results to industry

(vi) the provision of specialised expertise and facilities for industry on repayment.

1.2 Consumer Safety

DTI's Consumer Safety R & D Programme is mainly carried out at the LGC. The general objectives are:

(i) To improve the general safety of goods.

(ii) To promote general safety awareness in and around the home.

1.3 Metrology and Standards

DTI's Metrology and Standards programme is primarily carried out at the NPL. The general objectives are:

(i) To support and develop the national measurement system so that all measurements can be made with the appropriate accuracy for the task in hand and can be authentically related to the appropriate national standards. The British Calibration Service network of measurement laboratories is part of this system.

(ii) To help UK industry meet international competition by the establishment of a network of accredited (and subsequently internationally recognised) testing laboratories.

2. GENERAL INDUSTRIAL R & D

2.1 Electronics and Information Technology (IT)

The general objectives are:

(i) To assist the long term growth of components and systems manufactured in the UK electronics and IT industries.

(ii) To increase the international competitiveness of companies, particularly in the telecommunications automation, process control and instrumentation sectors, by helping them to apply advanced electronics effectively to their products and manufacturing processes.

The specific objectives include:

(i) The establishment of the basic technology and the development of a manufacturing base for optical fibres and opto-electronic components.

(ii) The maintenance of a state-of-the-art (manufacturing) capability for integrated circuits.

(iii) The development of advanced industrial, scientific and medical measuring instruments, with particular emphasis on automatic test equipment, automatic control of production and computer aids for design, test and manfacture.

(iv) To encourage development of new telecommunications equipment, such as feature or intelligent telephones, particularly by small and medium-sized firms.

(v) To stimulate the creation and development of new ranges of interactive services and products, such as teletex and in office automation.

(vi) To encourage further development of micro-electronics based products and processes in all sectors.

(vii) To support the development and international competitiveness of the computer and software industries, in particular by developing and using state-of-the-art tools and techniques.

(viii) To encourage further spin-off from MOD R & D.

(ix) To promote studies of improved radio system design and of the utilisation of the radio frequency spectrum.

The Alvey programme of pre-competitive collaborative reseach into advanced IT is complementary to the Electronics Programme. It is co-ordinated by DTI but also involves SERC and MOD. The general objective is to promote research in the underlying technologies of IT through the collaboration of teams in industrial, national and academic research laboratories. The specific objectives are:

(i) To build up UK expertise in very large scale integration (VSLI), including a capability to design and make economically 1 micron metal oxide semi-conductors (MOS) and bipolar ICs and to provide secure access to the technology for UK systems companies.

(ii) To create and maintain in the UK tools and methodologies to produce high quality cost effective software.

(iii) To build up UK expertise in intelligent knowledge based systems (IKBS), with a target to double the number of UK researchers in this area.

(iv) To build up UK expertise in the man-machine interface, including flat panel displays and speech and image processing.

(v) To build up infrastructure and communications technology, including the establishment and operation of an advanced network to link the UK IT community.

2.2 <u>Mechanical and Electrical Engineering</u>

The general objective is to promote UK competitiveness by developing advanced manufacturing technology and assisting its introduction into UK industry.

The specific objectives include:

(i) To raise the level of technology in computer aided engineering, flexible manufacturing systems and robotics, production machine design and development, welding and assembly.

(ii) To enhance the capability of the process plant industry, especially with regard to hardware manufacturing and in the field of biotechnology.

(iii) To develop better manufacturing processes and commercially successful new products in the 'heavy' electrical engineering sector.

(iv) To encourage the application of new technology in the hydraulics industry and those industries providing machinery for the construction, food, drink, packaging, tobacco, plastics, rubber, printing and textile industries.

(v) To enhance the technical quality of British Standards in engineering.

(vi) To assist the UK marine industries to obtain a significant share of the world market by making full use of modern technology, particularly of recent developments in data and information handling, combined with satellite communications systems.

2.3 Materials and Chemicals

The general objectives are:

(i) to strengthen the technological and industrial base of the private sector steel industry and the ferrous castings sector - by enhancing manufacturing efficiency, material quality, technology transfer and product innovation.

(ii) To enhance the competitiveness of the non-ferrous metals sector - by reducing processing costs, improving properties for end use and by encouraging the use of these metals in high added-value sectors.

(iii) To enable UK mining houses to compete in world markets.

(iv) To enhance the industrial exploitation of polymers and ceramics.

(v) To help the UK chemical industry to cope with toxicity and environmental restrictions and generally to maintain the competitiveness of the industry with particular emphasis on the needs of smaller companies.

(vi) To stimulate UK industry to spend more on biotechnology R & D, for new products and processes.

2.4 Vehicles

The general objective is to help the UK automotive industry to meet international competition, and the requirements of pollution, energy consumption and conservation legislation.

2.5 Textiles and Other Manufactures

The general objective is to help the UK carpets, clothing, fibres, footwear, furniture, leather, packaging, paper, printing, textiles and machinery industries improve their competitiveness by raising quality and lowering production costs with existing product types and by encouraging transfer of technology from outside these traditionally based labour intensive industries.

3. AERONAUTICS

The general objectives are:

(i) To assist the UK aircraft, aero-engine and aircraft equipment industry to maintain a technological capability that enables it to compete successfully in world markets.

(ii) To maximise the benefit to the civil sector of the defence R & D programmes

and more specifically

(iii) To increase the civil aircraft manufacturing business in the UK, particularly in exports during the later years of this decade and the early nineties.

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These objectives demand the maintenance of a very high level of technological excellence both for international competitiveness and to ensure a continuing demand for UK involvement as partners in international collaborative projects.

Launch aid for the aerospace industry

Launch aid is a form of assistance provided under the Civil Aviation Act 1982 for specific projects in the aerospace industry. It is provided in recognition of the fact that the high cost, long timescales, and high technical and market risks of major aerospace projects reduce their attraction to commercial investors. It takes the form of a contribution, fixed by contract, towards the cost of launching the product in question, and is recoverable by a levy on sales. Most, but not all, of the costs assisted are R & D costs. Launch aid is thus an instrument of industrial sponsorship, aimed at encouraging industry to undertake specific projects which are judged after thorough appraisal to have good prospects of commercial viability. Each case is the subject of colective decision by Ministers. Launch aid provision is made in the PES only for projects already approved.

4. SPACE

The general objective is to help the development of UK companies that can provide hardware (both satellites and ground stations), software and services in the fields in which the UK has chosen to specialise. The specific objectives include:

(i) The promotion of UK spacecraft capabilities and so to increase the proportion of UK components in UK spacecraft.

(ii) To keep UK companies abreast of developments in new space applications of potential commercial and technological interest.

Most of the expenditure is with the European Space Agency, which places development contracts with UK industry. There is a small national research programme managed for DTI by the Royal Aircraft Establishment, Farnborough.

PUBLIC PURCHASING

Funds are earmarked within DTI's R & D budget for public purchasing projects.

The general objectives are:

(i) To enable innovatory products and processes to be demonstrated specifically in the public sector

(ii) (and thus) To help industry establish international market credibility and competitiveness.

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Table 17a

DEPARTMENT OF TRADE AND INDUSTRY
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
I RESEARCH ESTABLISHMENTS							
COMPUTER AIDED DESIGN CENTRE							
Industrial production and technology	6	3.3	3.3))	Privatisation			
Other costs	6	0.6	0.8)				
LABORATORY OF THE GOVERNMENT CHEMIST							
Environmental and materials science	2	0.0	0.0	0.1	0.1	0.2	0.2
Methods of analysing chemicals	2	0.0	0.0	0.4	0.4	0.4	0.4
Food and nutrition	5	..	..	0.1	0.1	0.1	0.1
Other R & D	6	0.3	0.4	0.1	0.1	0.1	0.1
Other costs	6	..	0.1	0.2	0.2	0.1	0.1
NATIONAL ENGINEERING LABORATORY							
Applied fliud mechanics	3	2.7	3.2	3.5	3.0	3.5	4.0
Heat transfer	3	1.4	1.5	1.9	2.5	2.6	1.2
Fluid power engineering	3	1.0	0.9	0.5	1.2	1.2	1.2
Manufacturing systems and metrology	3	3.3	3.3	4.1	6.4	6.6	7.8
Materials and structures	3	3.5	3.2	4.0	3.8	4.4	4.2
Other R & D	3	1.8	1.0	1.0	0.5	0.5	0.6
NATIONAL MARITIME INSTITUTE							
Industrial production technology	3	0.5	0.3))				
Aerospace equipment manufacturing	3	0.9	0.5))	Privatisation			
Shipbuilding & repairing	3	1.9	1.2)				
Other costs	6	0.5	0.3)				
NATIONAL PHYSICAL LABORATORY							
Metrology and standards	2	12.7	14.4	15.8	17.4	19.2	21.1
Materials technology	3	2.3	2.8	3.1	3.3	3.4	3.5
Information technology	3	1.5	1.6	1.5	1.6	1.6	1.6
Other R & D	6	1.5	1.6	1.7	2.1	2.1	2.2
Other Costs	6	0.6	0.6	0.6	0.8	0.8	0.8
WARREN SPRING LABORATORY							
Support for process ind & envmtl matters	3	1.4	1.9	2.2	3.0	2.9	2.9
Other costs	6	0.5	0.6	0.6	0.7	0.7	0.7
TOTAL RESEARCH ESTABLISHMENTS		42.2	43.3	41.4	47.2	50.4	52.6

Table 17a (Cont)

DEPARTMENT OF TRADE AND INDUSTRY
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
II INDUSTRIAL R & D							
Aircraft equipment	3	1.0	1.0	0.5	1.8	2.2	1.9
Alvey programme	3	0.0	0.0	1.5	7.0	15.4	20.4
Biotechnology	3	0.0	0.4	0.7	2.8	5.1	6.4
Chemicals, textiles and paper							
Polymers and ceramics	3	3.5	2.6	4.0	4.9	5.9	7.2
Biotechnology	3	0.8	1.1	3.3	2.6	1.7	1.3
Chemical manufacture	3	1.3	1.3	1.9	2.5	4.1	4.2
Spinning	3	0.4	0.5	0.5	0.9	0.9	0.8
Other textiles	3	0.6	0.8	0.6	1.0	0.9	0.6
Footwear	3	0.8	0.6	0.6	1.2	0.8	0.7
Paper and board	3	0.4	0.4	0.5	0.7	0.7	0.6
Other R & D	3	2.5	1.9	2.3	5.1	4.9	4.3
Electronics	3	11.1	13.0	21.8	32.3	40.0	39.6
Information technology	3	12.1	27.1	27.7	39.4	38.0	36.8
Maritime technology	3	3.9	5.3	7.0	8.4	8.3	8.3
Mechanical and electrical engineering	3	3.9	10.8	13.8	32.8	25.1	40.1
Minerals metals							
Ferrous metals	3	4.1	3.2	4.3	5.4	5.4	5.6
Non-ferrous metals	3	1.9	1.0	1.4	1.9	1.8	1.9
Other R & D	3	0.3	0.1	0.2	0.2	0.2	0.2
Public purchasing	3	2.2	7.3	15.0	16.5	14.0	14.0
Shipbuilding	3	0.0	0.1	0.1	0.5	0.5	0.5
Vehicles	3	7.7	8.1	11.1	14.4	11.4	12.4
Telecommunications	6	0.0	0.0	0.0	0.3	1.0	1.1
Other industrial R&D sponsorship							
Energy efficiency	3	0.1	0.1	0.1	..	..	0.0
Metrology and standards	2	0.2	0.6	1.8	1.8	1.8	1.9
Food & drug manf, bldg mats & constr ind	3	0.0	0.0	0.5	0.9	1.0	1.3
Other R & D	6	0.9	1.6	3.0	3.5	3.5	3.6
TOTAL INDUSTRIAL R&D		59.9	88.4	122.4	187.1	192.8	213.8

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Table 17a (Cont)

DEPARTMENT OF TRADE AND INDUSTRY
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
III AERONAUTICS							
Aircraft and aeroengines							
Airframes	3	6.0	7.5	8.6	10.0	10.3	11.0
Aircraft equipment	3	4.2	5.9	6.0	6.3	6.5	6.6
Aero-engines	3	15.3	15.3	19.0	20.1	28.9	29.8
Other R & D	3	0.2	0.2	0.2	0.2	0.2	0.2
Launch Aid & Other Aid							
Concorde performance enhancement	3	0.4	0.0	0.4	0.0	0.0	0.0
Launch aid for Rolls Royce	3	88.9	45.1	65.6	10.4	6.0	-17.0
Launch aid for helicopter projects	3	0.0	10.0	11.0	18.0	14.0	12.0
A320 Launch aid (Airbus)	3	0.0	0.0	0.0	62.0	73.0	86.0
TOTAL AERONAUTICS		115.0	84.1	110.9	127.0	138.9	128.6
IV SPACE							
ESA (Telecommunications)	3			(41.9	38.5)		
ESA (Transport systems)	3	53.3	54.7	(4.9	8.7)	66.3	51.3
ESA (Remote sensing)	3			(1.5	11.9)		
Other ESA activities	3			(2.7	7.4)		
National space programme	3	5.4	7.2	10.3	12.1	13.5	13.5
TOTAL SPACE		58.7	61.9	61.3	78.7	79.8	64.8
V REGULATION							
Future radio systems	2	0.3	0.4	0.5	0.5	0.6	0.8
Contr to Int Bureau of Weights & Measures	5	0.1	0.1	0.2	0.2	0.2	0.3
Consumer safety	6	0.5	0.5	0.4	0.5	0.5	0.5
Office of Fair Trading	2	0.1	0.1	0.1	0.1	0.1	0.1
Marine Directorate		1.9	2.5)				
Civil Aviation Policy		0.1	0.1)	Transferred to DTp			
TOTAL REGULATION		2.9	3.7	1.3	1.4	1.5	1.6
VI OTHER INDUSTRIAL SPONSORSHIP							
Sponsorship(mainly manufacturing)	3	6.2	2.7	6.0	8.6	4.9	0.8
TOTAL OTHER		6.2	2.7	6.0	8.6	4.9	0.8
TOTAL (1)(2)		284.9	284.0	343.3	449.9	468.2	462.3

Table 17b

DEPARTMENT OF TRADE AND INDUSTRY
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	55.6	57.5	52.3	56.7	60.1	64.2
Research Councils	0.4	0.3	0.3	0.4	0.4	0.4
Other Government departments	21.7	27.9	31.0	29.5	29.3	29.7
Universities	2.0	1.8)				
Private industry	177.8	169.8)				
Public Corporations	15.7	18.0)				
Research associations	5.3	12.1)				
Overseas	59.7	54.7)	318.9	424.6	456.6	455.3
Non-industrial research institutes	0.3	0.4)				
Persons	..	..)				
Others	0.4	2.5)				
<u>less</u> Receipts	53.4	62.5	61.0	64.1	80.0	87.8
TOTAL	285.6	282.5	341.4	447.0	456.4	461.9

(1) The R & D expenditure reported in this review is that which falls strictly within the Frascati definition. The Department of Trade and Industry responsibilities for technology and innovation range more widely than this. A detailed review of the Department's support for technology and innovation is given in the Department of Trade and Industry report "Technology and Innovation 1983-84", published in October 1984.

(2) The differences in the totals between Tables 17a and 17b are mainly due to some data having been provided rounded to the nearest £million for Table 17a and to the nearest £thousand for Table 17b.

DEPARTMENT OF TRANSPORT (DTp)

DTp's research programme contributes to the formation of policy, the framing of national and international standards and regulations and the technical maintenance and efficiency in road, rail, sea and air transport. The main contractor for road transport systems research is the Department's Transport and Road Research Laboratory (TRRL). DTp also supports research commissioned by British Rail and London Transport through joint programmes.

The objectives and purposes of the research undertaken in the subject areas covered by DTp are as follows:

Bridges - primary purpose: purchasing

i. to improve design standards taking advantage of current knowledge and materials;

ii. to find the best ways of dealing with ageing and deterioration;

iii. to improve ability to assess capacity for carrying heavy loads.

Ground engineering - primary purpose: purchasing

iv. to reduce the whole life costs by optimising the use of in-situ materials in both new construction and maintenance work by means of more effective site investigation, site control and improvements in soil-strengthening techniques;

v. to improve assessment, design and maintenance methods in areas where soil behaviour forms an integral part of the construction process and is of paramount importance in the interactive support to and long-term performance of structures, earthworks, tunnels, pipes and pavements.

Pavement design, materials and maintenance - primary purpose: purchasing

vi. to develop and test new pavement design formulations of concrete and bituminous materials;

vii. to develop methods for the assessment of road pavement strength and conditions;

viii. to develop techniques for assessing optimal timing and nature of road maintenance works;

ix. to develop recommended construction techniques for minimal whole-life costs (construction, maintenance and user costs).

<u>Highway planning and evaluation</u> - primary purpose: policy

x. to develop improved techniques for the design and economic evaluation of highway schemes and road junctions, and for predicting traffic flows and speeds;

xi. to develop techniques for environmental appraisal and the development of special instrumentation.

<u>Traffic management, communications and control</u> - primary purpose: obligations

xii. to make safer and more efficient use of existing road systems by improvement in traffic management and associated signals and communication equipment;

xiii. to design and appraise traffic management measures at roadworks.

<u>Road user safety</u> - primary purpose: policy

xiv. To save lives and reduce injuries.

<u>Vehicle design and safety</u> - primary purpose: obligations

xv. to ameliorate the environmental effects (noise, vibration damage and air pollution) arising from road vehicles;

xvi. to provide an adequate basis of technical advice to enable policies, regulations, standards and legislation to be framed to take full account of changes in technology and economics which will affect the design, construction, mechanical and fuel efficiency of vehicles.

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Transport and disabled people - primary purpose: policy

xvii. to develop systems of transport that enhance the mobility of the disabled, through improvements in the design of public service vehicles, taxis and cars, the improvement of infrastructure and the development of new services.

Public Transport and Transport Planning - primary purpose: policy

xviii. to provide information on the demand for travel, public transport provision (subsidy, efficiency, organisation, alternative services, infra-structure investment) and energy use, so far as required for policy decisions.

Freight - primary purpose: policy

xix. to encourage the development of freight transport that is more efficient, safer and less damaging environmentally by gathering and interpreting information on UK freight transport and its effects on society;

xx. to assist in the formulation and implementation of policies, fostering new technology as appropriate.

Ports - primary purpose: policy

xxi. to provide information and statistics that will help to improve efficiency in the ports industry.

Joint DTp/British Rail programme - primary purpose: sponsorship

xxii. to improve the operational efficiency of the railway system;

xxiii. to reduce capital and maintenance cost;

xxiv. to achieve the maximum utilisation of investment resources to the long term benefit of the railway;

xxv. to reduce manpower and increase productivity;

xxvi. to achieve economy in the use of energy consistent with the Board's commercial and financial policies and with the need to adopt a flexible strategy so that options are available;

xxvii. to enhance the export prospects of the UK railway manufacturing industry.

Joint DTp/London Transport Executive Programme - primary purpose: sponsorship

xxviii. to reduce the capital, operating and maintenance costs fo the LT rail system, and the improvement of performance, reliability and passenger environment in service so as to attract increased patronage.

Marine and Shipping - primary purpose: obligations, sponsorship and policy

xxix. to help discharge responsibilities in a national and international context for

a. the safety of merchant ships and fishing vessels;
b. the health and safety of persons on ships;
c. the prevention of pollution of the sea from ships and
d. the clearing up of marine pollution.

xxx. to promote, where appropriate in partnership with the General Council of British Shipping, the efficiency and international competitiveness of the British shipping industry.

Aviation - primary purpose: obligations

xxxi. to investigate the effects of various parameters on measurements of noise from aircraft in flight for purposes of noise certification.

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Table 18a

DEPARTMENT OF TRANSPORT
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Highway Planning	2	2.4	1.6	1.3	2.2	2.2	2.3
Road user safety	2	2.7	2.4	2.8	3.2	3.2	3.3
Transport and disabled people	2	..	..	..	..	0.2	0.3
Public transport and transport planning	2	2.2	1.8	2.3	2.5	2.2	2.3
Freight	2	0.6	0.3	0.5	0.5	0.5	0.5
Ports	2	1.1	0.1	0.5	0.2	0.2	0.3
Joint R & D with BR	3	3.5	4.1	4.3	4.5	4.7	4.9
Joint R & D with LT	3	1.6	1.9	2.4	5.6	9.7	5.9
Bridges	4	2.1	2.8	2.3	3.9	3.9	4.0
Ground engineering	4	1.8	1.5	1.3	2.0	2.0	2.0
Pavement design	4	2.6	2.4	2.2	3.2	3.2	3.3
Traffic management	5	2.0	2.6	3.1	3.4	3.4	3.5
Vehicle design and safety	5	1.9	1.5	2.1	2.0	2.0	2.0
Aircraft noise measurement	5			(0.1	0.1	0.1	0.1
Technology (NPL)	Transferred from DTI(						
Marine safety (General)	5			(2.1	2.3	2.4	2.6
Pollution control and prevention	5	0.8	0.7	1.0	1.1	1.1	1.2
Support of ODA	6	1.6	1.1	1.4	1.5	1.5	1.5
Other costs (Total)	6	1.6	1.8	2.0	2.2	2.1	2.2
TOTAL		27.5	25.9	31.7	40.4	44.5	42.0

Table 18b

DEPARTMENT OF TRANSPORT
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	18.1	16.6	17.3	20.9	20.4	21.1
Research Councils	..	..	..	..	..	..
Other Government departments	0.3	0.4	1.9	2.0	2.1	2.1
Universities	1.6	1.6)				
Private industry	3.4	3.2)				
Public Corporations	3.5	4.1)	12.5	17.5	22.0	18.8
Research associations	0.1	0.1)				
Others	1.8	2.2)				
less Receipts	1.3	2.2	..	..	..	..
TOTAL	27.5	25.9	31.7	40.4	44.5	42.0

NORTHERN IRELAND DEPARTMENTS

DEPARTMENT OF AGRICULTURE FOR NORTHERN IRELAND

The largest proportion of R & D expenditure in Northern Ireland is in the agriculture and food sectors. Research and specialist scientific, advisory and diagnostic work is designed to develop methods which increase the efficiency of production of and improve the quality of food. R & D work in this area is also designed to minimise environmental disturbance while maximising agricultural benefits.

DEPARTMENT OF HEALTH AND SOCIAL SECURITY NORTHERN IRELAND

Research in the general field of health and social services is funded by the Department of Health and Social Services, Northern Ireland, through its Clinical Research Advisory Award Committee. This aims to support research projects over a maximal period of 3 years, provided there is a clear potential benefit either in improvement of the quality of clinical care or in the acquisition of information capable of improving the delivery of social services.

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Table 19a

NORTHERN IRELAND DEPARTMENTS
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Economic and social sciences	1	0.1	0.2	0.2	0.2	0.2	0.2
	2	0.2	0.2	0.2	0.2	0.2	0.2
Water research	2	0.3	0.3	0.4	0.4	0.4	0.4
Public expenditure Priorities	2	0.1	0.1	0.1	0.1	0.1	0.1
Energy	2	..	..	..	0.1	0.1	0.1
Environment (roads service/finance)	2	0.1	0.1	0.1	0.1	0.1	0.1
	5	0.1	0.1	0.1	0.1	0.1	0.1
Industrial development and production	2	0.1	0.1	0.1	0.1	0.1	0.1
Industrial development Board R & D	3	2.3	2.1	3.1	4.6	5.1	5.1
Agriculture and food R & D	3	6.6	6.3	6.8	7.2	7.5	7.7
TOTAL		9.7	9.4	11.1	12.9	13.8	14.1

Table 19b

NORTHERN IRELAND DEPARTMENTS
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	6.6	6.5	6.9	7.2	7.5	7.8
Other Government departments	..	..	..	..	..	..
Universities	..	..)				
Private industry	2.2	2.0)				
Research associations	0.1	0.1)				
Non-industrial research institutes	1.4	1.5)	4.8	6.4	6.9	7.0
Persons	..	..)				
Others	..	..)				
<u>less</u> Receipts	0.6	0.7	0.7	0.7	0.7	0.7
TOTAL	9.7	9.4	11.1	12.9	13.8	14.1

SCOTTISH DEPARTMENTS

DEPARTMENT OF AGRICULTURE AND FISHERIES FOR SCOTLAND (DAFS)

DAFS commissions programmes of agricultural R & D work at the seven Scottish Agricultural Research Institutes and three Scottish Agricultural Colleges, all of which it funds and administers. The Institute programmes consist of basic and applied research which aim to extend scientific knowledge and to identify options which could be used to improve the efficiency of the agricultural and related industries. This research makes a distinctive contribution to the overall programme of the Agricultural and Food Research Service and also includes work of specific relevance to the soils, climate, crops and livestock of northern Britain. The Colleges concentrate on development work, including systems of production, and this is undertaken in close association with their advisory and educational activities. The aim is to develop and demonstrate how new knowledge can be used to improve the technical and economic efficiency of agriculture (including horticulture), particularly in Scotland, and such development work accounts for about one quarter of the total cost of the comissioned R & D work. Within its overall aims DAFS's main objectives are:

a. to classify, characterise and map the distribution of differing soil types in Scotland to provide a sound base of soil information for agriculture and other land-use requirements and to encourage the use of this information;

b. to improve knowledge of soil and crop nutrition so as to maintain and improve soil fertility and structure and, through a programme of the relevant plant sciences, to devise crop and soil management strategies to improve crop production;

c. to develop greater unerstanding of the soil, plant and engineering factors affecting the cost-effective production of high quality, fresh and conserved forages and their utilisation in cost-effective milk, beef and sheep production, with particular attention given to hill and upland conditions;

d. to study the science of animal production and to encourage the synthesis of research findings into farming systems which offer farmers flexibility to adapt to changing market conditions and costs;

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e. to control and, as far as possible, eliminate the wide spectrum of disease and parasitic organisms which affect farm animals and which currently constrain the achievement of high yields;

f. to seek further knowledge of factors affecting the efficiency of digestion of feedstuffs, absorption of nutrients and their metabolism in ruminant and non-ruminant animals (including work of relevance to human nutrition);

g. to promote increased efficiency in economic terms through better understanding of production economics, market requirements and price/supply outlook; and

h. to investigate aspects of the utilisation of plant and animal products with a view to maximising quality and marketability as traditional or novel foods.

The commissioned R & D work includes work on both new research opportunities and on industry needs. So far as new opportunities are concerned it is not feasible to specify target benefits in advance of the work, but it is sometimes possible to do so in the case of some industry problems, such as the incidence of a particular disease of crops or animals. DAFS endeavours to meet the need to establish targets, as far as is practicable, by carrying out systematic reviews of each sector of its commissioned work every four years, on a rolling basis. These reviews include the assessment of progress achieved and the establishment of priority objectives for the next four years. In setting these objectives consideration is given not only to scientific criteria but also to other factors such as the recommendations of the industry and of relevant organisations in the agricultural field and the R & D programmes of MAFF and the AFRC.

R & D undertaken by DAFS' Agricultural Scientific Services arises almost entirely from its statutory and regulatory functions concerning crop protection and improvements, pest control and pesticide residues. The R & D objectives fall into the following categories - improvement of seed testing methods and identification of plant varieties; development of pest and disease

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control in potatoes and other crops especially through official certification (classification) schemes; protection of crops and imported foodstuffs against non-indigenous and important indigenous pests, and improvements of regulation of pesticide use and pesticide residues.

The Royal Botanic Garden's R & D work is almost exclusively basic research in plant taxonomy, and is closely interwoven with other activities involved in running gardens of scientific/amenity interest and in providing training schemes for horticultural students.

A large part of the R & D on fisheries is to fulfil statutory responsibilities and, in co-ordination with MAFF, to aid the formulation of policy and the provision of advice. Examples are the assessment of fish stocks; the setting of catch limits and quotas, and development of appropriate gear, with a view to conserving stocks; licensing the dumping of material at sea consistent with protecting the environment; and the diagnosis of notifiable fish diseases.

INDUSTRY DEPARTMENT FOR SCOTLAND (IDS)

The objective of research funded by IDS is to assist in improving understanding of the influences affecting industrial and economic development in Scotland, including the effects of policy measures. The programme complements work commissioned by UK departments and by the Scottish Development Agency.

SCOTTISH DEVELOPMENT DEPARTMENT (SDD)

Only applied research is commissioned by SDD and this provides information on those issues or developments particular to Scotland, which are not dealt with by the larger research programmes of UK Departments. Reflecting the Department's responsiblities, the main areas of research are water and waste disposal, pollution, housing, planning and local transport. The objectives of research are related to (a) broad policy and decision making issues where there is a need to define the scope and content of possible new initiatives or review the impact of past decisions, particularly were decisions on capital expenditure are involved and (b) providing the detailed information upon which advice and guidance is offered to local authorities and statutory undertakers in pursuance of SDD's regulatory role, including matters of public health and safety.

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SCOTTISH EDUCATION DEPARTMENT (SED)

Two separate research programmes are administered by SED, the objectives of which are (1) to encourage research and related development into all fields of education so as to maximise the effectiveness of education in Scotland, and (2) to promote the effective and efficient use of social work services by supporting studies which examine areas of policy and practice of particular significance.

SCOTTISH HOME AND HEALTH DEPARTMENT (SHHD)

The Chief Scientist Organisation (CSO), on the Health side of SHHD, has responsibilities to identify, encourage, promote and support R & D relevant to improvement of the NHS in Scotland. An overall policy committee (the Chief Scientist's Committee) and four specialist committees deal with R & D issues and assess applications in the broad fields of health services and biomedical research, equipment for the disabled, and innovative scientific and medical equipment. In addition, reviews of topics, problems and research needs are undertaken by Working Groups established for specific tasks and disbanded on completion of their work. Research is not conducted "in house" but funded through grants to universities and other institutions which provide for the support of long term research units, major research programmes and shorter term projects. Close liaison, on occasion involving jointly funded research, is maintained with the DHSS and relevant Research Councils, in particular MRC.

From the outset (in 1973) the CSO has developed objectives and research policies by identifying major health problems affecting Scotland and health burdens imposed upon the NHS with the purpose of developing relevant research initiatives. For example, major research initiatives (usually stemming from a review by a Working Group and often promoted through the establishment of a research unit) have been taken in the fields of health care of the elderly; coronary heart disease; mental health; dentistry; health economics; and health and behavioural change. Smaller, but nevertheless important initiatives, often arising opportunistically have also been taken in areas such as head injuries; monitoring of perinatal mortality; computerisation of electrocardiograms; the evaluation of new services and screening; and nuclear magnetic resonance. Against this background an increasing and substantial proportion of the CSO's resources is being devoted to the maintenance and development of longer term units and programmes. However, the CSO continues actively to encourage the submission of spontaneous applications for research relevant to the broad objectives of the Organisation. The majority of these are for shorter term projects.

As far as the Home side of the SHHD is concerned, the research covers crime and allied social problems, the criminal justice process and the treatment of

offenders. By funding research of this kind it is hoped to achieve a better insight into the causes of crime. Recommendations arising from reports of the findings of these research projects are often incorporated into the criminal justice system.

Table 20a

SCOTTISH DEPARTMENTS
SUBJECT AREAS AND PRIMARY PURPOSES
£millions

SUBJECT AREA	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Agriculture							
Animal products	3	11.4	13.1	13.8	13.8	14.5	14.9
General agricultural research	3	4.2	4.6	4.9	5.1	5.3	5.4
Veterinary medicine	3	4.2	2.7	2.9	2.9	2.8	2.9
Crops		7.6	8.2	9.2	11.2	11.6	12.0
General planning of land use	3	0.3	0.2	0.3	0.3	0.4	0.4
Construction and planning of buildings	3	0.5	0.6	0.6	0.7	0.7	0.7
Other agricultural research	5	0.6	0.5	1.3	1.4	1.4	1.4
Fisheries	1	7.4	8.2	8.6	8.8	9.8	9.9
Education	2	0.2	0.2	0.2	0.3	0.3	0.3
Health	5	2.9	3.0	3.6	4.3	4.5	4.7
Other research	2	1.5	1.5	1.9	2.0	2.1	2.1
TOTAL		40.8	42.8	47.3	50.7	53.3	54.8

Table 20b

SCOTTISH DEPARTMENTS
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	9.4	10.0	11.6	11.9	13.1	13.3
Research Councils	0.1	0.1	0.1	0.1	0.1	0.1
Other Government departments	0.1	0.1	0.1	0.1	0.1	0.1
Universities	0.4	4.0)				
Private industry	0.1	0.1)				
Public Corporations	..	..)				
Research associations	..	..)	35.5	38.5	40.0	41.2
Non-industrial research institutes	20.4	21.6)				
Persons	..	..)				
Others	10.3	10.4)				
TOTAL	40.8	42.8	47.3	50.7	53.3	54.8

OTHER DEPARTMENTS

THE BRITISH LIBRARY

The British Library Research and Development Department's remit is to support library and information research in order to improve the transfer and use of information.

The specific objectives of the research are to:-

i. facilitate the improvement of library and information services
ii. encourage the development of information-handling skills
iii. stimulate awareness and use of information sources
iv. encourage and evaluate the application of new information technologies
v. stimulate modern education and training of library and information personnel
vi. effect co-ordination throughout the information community.

HM CUSTOMS AND EXCISE

The objective of the research undertaken by HM Customs and Excise is to aid the investigation and detection of smuggling and other offences connected with the Department's value added tax and revenue duties.

DEPARTMENT OF EMPLOYMENT (D Emp)

The objectives of D Emp's research programme are:

a. to assist Government policy-making and decision making on questions of employment, industrial relations, pay and prices, in furtherance of the strategic objective of improving the efficiency of the labour market;

b. to assist D Emp in carrying out its statutory executive functions, which include investigations of the costs and effectiveness of individual Departmental measures and activities.

The disciplines employed in the programme are mainly those of economics and applied sociology. The methodologies include the design, conduct and analysis of surveys of behaviour and attitudes, or alternatively the analysis (often econometric) of the results of existing data from surveys and administrative records. Individual research projects may be designed to identify or clarify policy problems, to establish behavioural relationships which are relevant to the assessment of the probable consequences of alternative policy options, or to estimate the economic and social effect of existing policies. Exceptionally, a large scale project may have multiple objectives because of the economies of including multiple questions in a single survey.

Research priorities are determined mainly by perceived policy needs, taking account of the needs of other Government Departments as well as those of the D Emp Group. Results are normally published and the contribution which they may be expected to make to users outside govermment, and their likely contribution to informed public debate, are also taken into account.

<u>FOREIGN AND COMMONWEALTH OFFICE</u> (FCO)

The objectives of FCO's research programme are the improvement of telecommunications systems. Currently research is concentrated on the development of equipment for the automatic control of radio systems.

<u>FORESTRY COMMISSION</u>

The Forestry Commission's objectives are twofold, reflecting its normal departmental role as the country's Forestry Authority as well as its direct involvement in forestry as owner of the national forest estate or Forestry Enterprise. The Commission's R & D objectives flow directly from its Authority roles which are:

i. To advance knowledge and understanding of forestry and trees in the countryside.

ii. To develop and ensure the best use of the country's forest resources; and to promote the development of the wood-using industry and its efficiency.

iii. To undertake research relevant to the needs of forestry.

iv. To combat forest and tree pests and diseases.

v. To advise and assist with safety and training in forestry.

vi. To encourage good forestry practice in private woodlands through advice and schemes of financial assistance and by controls on felling.

Forestry Commission research is conducted or commissioned by the Research and Development Division which also performs a number of technical services. Objectives of the research programme, which aims to benefit both the Forestry Enterprise and private forestry are as follows:

i. To increase and publish knowledge bearing on the practice of forestry in Britain.

ii. To improve understanding of the way in which management influences the quantity and quality both of wood produced and of environmental benefits.

iii. To develop working methods improving the effectiveness of men and machines in ways compatible with the environment.

The bulk of the Division's work is applied, with objective basic research undertaken where the need exists and circumstances demand. Research tasks can be broadly broken down into four headings all of which combine to move the supply curve for forest products, both goods and services, to the right.

i. enhancing the volume production of wood; including the reduction of losses,

ii. enhancing the quality of wood,

iii. increasing the environmental benefits of forests and trees,

iv. increasing the cost effectiveness of forest operations.

INLAND REVENUE

Inland Revenue supports R & D jointly with Customs and Excise, Treasury and ESRC, with the objective of securing independent advice on the effects of fiscal policy that relate to Inland Revenue's interests.

OFFICE OF POPULATION CENSUSES AND SURVEYS (OPCS)

The objectives of the OPCS R & D programme are to increase knowledge of (a) the structure of the population and the underlying determinants of population change ie mortality, fertility and migration; (b) the incidence of disease and mortality among special high risk groups in the population and (c) the most effective methods for household surveys. OPCS also carried out household surveys, at the request of other government departments, to increase knowledge of the social structure of the population in areas of direct concern to current social policy. During 1983/4 surveys covered such topics as child nutrition, the living standard of the unemployed, the further education of children aged 16 and over, and the drinking habits of adolescents.

ORDNANCE SURVEY (OS)

The R & D programe of OS is directed towards applied research in support of its main activities and the development of new products and production methods, although some "mission oriented" basic research may be necessary from time to time. Applied research is supported in the fields of geodesy, photogrammetry and cartography and projects of direct relevance to the OS are sponsored at British universities and research institutions.

The programme's main objective is the development and introduction of more efficient and cost effective techniques, equipment and systems for the production and dissemination of topographic data in forms best suited to the needs of users.

WELSH OFFICE

Research sponsored by the Welsh Office is aimed at assisting the achievement of its functional policy objectives.

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In the broad context of economic policies, work is directed at a better understanding of the relationship between the Welsh and UK economies; at clarifying the relationship between transport investment and economic development; and at assessing rural areas' transport needs and ways of meeting them.

Research in support of social policies concentrates on three main fields. The objectives of the environmental research programme are to achieve improved understanding of and better methods of controlling the effects of the processes causing pollution, erosion and instability of the Welsh environment, which comprises the atmosphere, land and water, particularly water used for public supplies. Educational research is directed at the development of resources and techniques for determining the nature and extent of learning problems and for assisting the assessment and improvement of pupil performance, and in particular at the preparation of materials for Welsh medium education. In the broad field of health care, research covers the delivery of health and personal social services, aspects of the care of the elderly and mentally handicapped people, and medical research on the development of improved techniques and equipment for diagnosis and treatment.

Table 21a

OTHER DEPARTMENTS
DEPARTMENT AND PRIMARY PURPOSES (1)
£millions

DEPARTMENT	PP	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Government Actuary	2	0.1	0.1	0.1	0.1	0.1	0.1
Office of Arts and Libraries	6	2.0	2.0	1.9	2.2	2.2	2.3
Natural History Museum	1	7.8	8.4	8.9	9.3	9.3	9.3
Royal Society	1	4.2	4.5	5.0	5.3	5.5	5.7
HM Customs & Excise	6	0.1	..	0.1	0.1	0.1	0.1
Department of Employment	2	4.8	5.5	4.0	3.9	4.1	4.1
Foreign and Commonwealth Office	2	0.2	0.1	0.1	0.2	0.2	0.2
Forestry Commission	3	5.1	5.5	5.6	6.0	6.0	6.0
Inland Revenue	2	-	-	..	..	..	..
Ordnance Survey	6	0.6	0.8	1.0	1.1	1.1	1.0
Office of Population Censuses and Surveys	2	3.5	3.5	2.4	2.3	2.4	2.5
Property Services Agency(2)	4	9.1	10.8	-	-	-	-
HM Treasury	2	0.2	0.2	0.3	0.4	0.4	0.4
Welsh Office	2	1.6	1.5	1.9	2.1	2.1	2.3
TOTAL		39.4	42.9	31.4	32.8	33.4	33.8

(1) In this table, several separate sub-programmes have been aggregated for the sake of conciseness, and the primary purpose code shown is that of the largest component. In the summary tables in Part I, however, those sub-programmes have been included in the form in which they were originally submitted.

(2) Expenditure by the PSA on buildings for R & D. These costs were transferred to Departments' own programmes from 1983/84.

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Table 21b

OTHER DEPARTMENTS
DISTRIBUTION OF FUNDING
£millions

SECTOR	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Intra-mural	28.2	31.0	20.2	20.5	20.7	20.6
Research Councils	..	0.1	0.1	0.1	0.1	..
Other Government departments	0.3	0.3	0.3	0.3	0.3	0.3
Universities	3.5	4.0)				
Private industry	0.6	0.7)				
Public Corporations	0.1	0.2)				
Research associations	..	..)	11.2	12.2	12.5	12.9
Overseas	..	..)				
Non-industrial research institutes	1.5	1.7)				
Professional and learned societies	4.4	4.5)				
Persons	0.4	0.5)				
Others	0.3	0.2)				
<u>less</u> Receipts	0.4	0.4	0.2	0.2	0.2	0.2
TOTAL	39.1	42.8	31.7	32.8	33.4	33.7

W.0495 27 July 1984

PRIME MINISTER

ANNUAL REVIEW OF GOVERNMENT-FUNDED RESEARCH AND DEVELOPMENT

Sir Robert Armstrong has sent you a copy of the 1984 Annual Review of Government-Funded Research and Development, together with ACARD's comments on it.

2. Departments were asked to identify their research programmes according to primary aim and I have summarised the current situation and the trend in the Annex. Departments were also asked to describe their objectives at a strategic level in quantitative terms wherever possible. The general standard of these statements was low and ACARD found it almost impossible to relate individual expenditure plans to components of the statements of objectives. This is a thoroughly unsatisfactory situation which the Sub-Committee of Chief Scientists will work on this year with further guidance from ACARD.

3. One of the purposes of the review is to take an overview of the balance of Government-funded R&D. Some Departments still argue that they and they alone can determine the size and scope of their R&D programmes. I disagree with this view: many areas of science and technology range across several Departments and a co-ordinated view of these must be taken, especially in the important area of strategic research which Lord Whitelaw drew to your attention in his minute of 22 February. Further, R&D requires people and one Department can knowingly or unknowingly pre-empt too large a share of the resources available in scarce skills such as micro-electronics.

4. The Annex is one way of looking at the balance of R&D. It shows that last year the Government spent nearly £4 billion on R&D. Fractionally more than half was spent supporting procurement programmes, the vast majority by the Ministry of

Defence. Of the remainder, approximately 17% was spent on each of the advancement of science and the improvement of technology for industry. Most of the rest, 12% of the total, was spent supporting Departmental policy-making and its implementation.

5. On current plans, MoD will spend a further £380 million cash in 1986/87. In so doing, its proportion of the total Government spend on R&D will further increase by 1%. By the same year, expenditure on advancement of science will have declined by 3% in real terms, and by nearly 1% of the Government total. R&D in support of Government policy-making and its implementation will decline by 4% in real terms. These trends seem to me to be in the wrong direction.

6. I support ACARD's view that there is a high opportunity cost associated with pre-empting an ever-increasing fraction of the nation's R&D resources in defence technology. The ratio of £1 spent on R&D for every £3 spent on purchase of equipment is absurdly high. I have the impression that the MoD is feeding a leviathan with an insatiable appetite for R&D resources. As equipment gets more expensive and production orders are more widely spaced and for smaller numbers of units, the defence industry is fed more R&D contracts "to keep development teams together" even though only a fraction of the products thereby developed can ever be manufactured and purchased with the current defence procurement budget. This trend must stop eventually and I think there is a case for examining the consequences of a reduction of the MoD R&D spend to roughly half its present value over a period of 5 years, with corresponding changes in procurement policy and a switch of the R&D resources thereby released to areas with a greater influence on the economic health of the country. These remarks are not, of course, a criticism of the need for strong military defence, rather on the way the MoD chooses to obtain this.

7. These considerations would, I hope, be examined by the inter-Departmental group proposed in Sir Robert Armstrong's minute.

8. In his minute to you of 22 February, Lord Whitelaw drew attention to the widespread concern on the health of basic and strategic research. You then asked how these problems could be solved without spending more money. Although there is still something to be won from improved efficiency and selectivity in basic research, I believe that the answer lies in re-allocating funds from other parts of Government's R&D spend such as defence.

9. There is real damage being done to our University and Research Council research. Although it is true that the past excellence of this research seems to have had little influence on the economic performance of the country, one does not solve that problem by reducing the excellence of basic research. At a time when the Government's policies have led to encouraging progresss in the application of our scientific and technological skills to producing marketable goods and services, it would indeed be ironic if the same Government was to damage irreparably the very source of those skills and so inhibit the development of a strong science- and technology-based industry.

10. I also share the concern on strategic research. Financial constraints have led to some Departments abandoning their longer-term R&D programmes which are a prudent measure for the discharge of their future responsibilities. The results of these actions can already be seen, for example in the area of the environment when policy decisions have to be taken on the basis of an inadequate technical understanding of the problem.

11. In summary I believe that analysis of the annual review of R&D shows that Government-funded R&D is substantially out of balance, a trend which developed over many years as a result of the varying bargaining skills of Departments in the PES round and which previously went unnoticed because of the absence of an overview. In general I think we are over-committed in R&D for defence, agriculture and nuclear energy and under-committed in basic research and in strategic research for areas such as the environment and menufacturing industry.

12. It could be argued that the Government's overall policy demands that any cuts made in the over-committed areas should

revert to the tax-payer rather than to righting the situation in the under-committed areas. I believe this would be a mistake because in most of the under-committed areas Governments in all industrialised countries assume a major funding responsibility because of the effect of research in these areas on long-term economic performance. At the moment Government funding of R&D runs at 2-2.5% of GNP for all major industrialised countries. However the UK figure only gets into this band by virtue of our enormous defence R&D spend. Thus cutting that and not transferring the proceeds to other areas of R&D would leave us well below the norm with, I believe, serious adverse consequences for the development of a strong science- and technology-led industrial economy in the future.

13. The Chief Secretary has asked to be kept informed of the Annual Review so that he may use it in his discussions on Departments' R&D needs during the PES round, and you may wish me to communicate to him the views I have expressed in this minute. His officials have, in any case, asked for guidance on the questions that might be put to Departments and I have prepared a rather detailed note on this which does not cover the overall policy implications I have addressed in this minute but is, of course, consistent with the views I have expressed here. If you take Sir Robert Armstrong's advice on the distribution of the Annual Review to Ministers, I would plan to send my note to Treasury officials at the same time.

14. I am copying this minute to Sir Robert Armstrong.

RBN

ROBIN B NICHOLSON
Chief Scientific Adviser

Cabinet Office
27 July 1984

ANNEX

Total Government Expenditure on R&D by Primary Purpose,
£million cash

	1983/84 Estimated Outturn	1986/87 Plan Cmnd 9143(1) (change in real terms from 1983/84)
Advancement of Science	675	740 (- 3%)
Support for Policy Making	485	525 (- 4%)
Improvement of Technology	655	810 (+ 9%)
Support for Procurement Decisions	2005	2380 (+ 4%)
Support for Statutory Duties	65	75 (- 2%)
Support for Other Activities	65	75 (- 1%)
TOTAL	3950	4605 (+ 3%)

These figures are consistent with the Government's expenditure plans to be found in Cmnd 9143: the details in this table are not to be found in that White Paper.

Stkupe

ADVISORY COUNCIL FOR APPLIED RESEARCH AND DEVELOPMENT

70 Whitehall, London SW1A 2AS Telephone: 01-233

CABINET OFFICE
A 5176
12 JUL 1984
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FILE No. ....

CONFIDENTIAL

Sir Robert Armstrong
The Cabinet Office
70 Whitehall
London SW1A 2AS

11 July 1984

c- Dr Nicholson -
Advice & draft
for Prime Minister
please
Carol
12/7

Dear Sir Robert

Annual Review of Government Funded Research and Development

You will recall there was opportunity last year for ACARD to make only brief comments on the first of the Annual Review of R & D expenditures announced in Cmnd 8591. The Council considered then that the Review process had made a highly promising start and looked forward to contributing to the 1984 Review.

That promise has been maintained. The Science and Technology Secretariat have assembled a comprehensive set of expenditure figures and some illuminating analyses which I very much hope will be published, following the example of last year's Review. In recognition of the Annual Review as a valuable tool for examining issues in R & D policy, the Council at its last meeting decided to establish a standing sub-committee to consider further aspects of the 1984 Review and to advise upon the 1985 exercise.

This year, the Council were able to appoint a sub-group to consider the data in detail. I attach a note prepared by the sub-group and endorsed by the full Council giving ACARD's observations on the distribution of expenditures shown by the Review. Our main conclusions are summarised in paragraph 30. Briefly, there are:

1. By international standards, the UK spends a comparatively high proportion of its GNP on defence R & D. There would appear to be significant opportunity costs associated with R & D, notably because of its demands on skilled manpower. The justification for conducting so much defence R & D in the UK should be closely examined.

2. The balance between the support provided for R & D in the agriculture, fisheries and food industries, and for R & D in other industries, should be examined.

3. The distribution of expenditures in support of manufacturing industry requires further examination, which the Council intend to set in hand through the new sub-committee.

The Council have also suggested some new lines of approach to improve next year's Annual Review and look forward to entering into dialogue with the Cabinet Office and Departments over both the 1985 Review and their comments on the 1984 Review.

Finally, I should make it clear that ACARD regard their comments on the Annual Review as confidential advice to Government and do not intend to seek permission for their publication.

I should be grateful if you would convey this letter and the attached note to the Prime Minister.

Yours sincerely
Henry Chilver

Sir Henry Chilver
Chairman

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10 DOWNING STREET

From the Private Secretary

Mr. Courtney
7478.

DR. NICHOLSON (on return)
CABINET OFFICE

Maintaining the Strength of the Science Base

We have now received minutes from both the Defence Secretary and the Education Secretary, which I understand have been copied to you separately, in response to my letter to their Private Secretaries of 23 May about maintaining the strength of the science base.

I should be grateful if you could provide advice for the Prime Minister on these responses.

David Barclay

2 July 1984

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cc/10.

PRIME MINISTER

MAINTAINING THE STRENGTH OF THE SCIENCE BASE

As recorded in David Barclay's letter of 23 May to Richard Mottram, you asked Michael Heseltine and me to let you have by the end of June separate notes on the implications of transferring to the university-Research Council system £20M presently intended for intra-mural research in MOD.

2. What we are examining, I take it, is the net effect for the national interest of stopping £20Ms' worth p.a. of MOD intra-mural research to transfer that sum to my PES block for work in the university-Research Council research base. The aim would be to strengthen those disciplines of at least potential interest to long-term defence needs - both for knowledge and for trained manpower. (In this connection it is worth noting that we spend about four times as much on defence research as the figure in the science budget whereas in France the two sums are about the same.) It would be a distinct and different exercise from the modest (but welcome) expansion MOD have proposed in their "research agreements" with universities where relevance to defence needs is quite properly a major criterion. The exercise we are considering would widen but not abandon the concept of relevance; that is the money should be used to strengthen say chemistry but not anthropology.

3. You ask what research areas might best be supported. I would want to use the money to reinforce current excellence - whether in a university department or Research Council unit - where the wider interests of MOD, and Councils' judgement of scientific quality and opportunity, coincide. It would not be sensible for me to try here to offer a definitive list - that would require joint work by the Councils with MOD. A starting point could be the areas where MOD currently have research agreements

with the universities; I attach that list annotated to show which Research Councils are also supporting work in the field. You will see that the extent of shared interest is so remarkable as to make this further analysis which you have set in hand even more necessary.

4. My starting point for the use of this additional money would be those scientific opportunities that on our present expenditure plans will have to be forgone. The disciplines of interest to MOD are probably mainly within the scope of the SERC who would give high priority to:

- low dimensional structures, including molecular electronics (where novel physics confers some remarkable properties, as I think we shall hear at our seminar on 8 July)

- development of bio-sensors for specified chemical species

- protein engineering

- systems design and control, specifically in the application of computers to mechanical engineering

- development of laser applications

- information technology, and in particular strengthening their contribution to IKBS and the Alvey programme more generally

- a UK-led space science mission.

There are areas in the medical field, too, where there is exciting science to be done likely to be of long term interest to MOD as well as more widely. The Anatomical Neuropharmacology Unit at Oxford is developing work on the organisation of neural circuits in the brain and their relation to information processing and behaviour. More generally in molecular neurobiology the Council sees great opportunity which at present it cannot grasp. MRC are also working in co-ordination with SERC on protein engineering, particularly the design and construction of novel enzymes and hormones. Other areas of possible interest where they would like to expand include the molecular basis of medicine, work on addiction and possible therapies, depression and the possibility of intervention therapy, and work on man-machine interactions in relation to the Alvey programme.

5. I stress that these are only examples of starting points, illustrative of the extent of common interest. I would want to see close collaboration between MOD and the Councils in defining the precise disciplines and places where the funds should be applied to bring about the strengthening of present excellence. This would accord well with the plans on which I am working with the UGC, the ABRC, and the Research Councils, to bring about greater selectivity in the UGC funding of research. Much of the transferred money would go to the universities, but not necessarily all because there are areas of MOD interest where the country's expertise might be in a Research Council unit or institute.

6. Michael will be able of course to assess the implications for MOD of terminating certain programmes and, obviously, there is room to spell out more fully the advantages to MOD of developing work in particular Council areas. I would expect defence interests to benefit over the longer term from a science base that is not only stronger but more aware of,and alert for, novel science having defence potential; from closer working relations with the Research Councils and the universities, and particularly from the indirect benefits in teaching and postgraduate training in the basic science and engineering disciplines that would follow from the strengthened science base. I would expect there to be strong reinforcement of highly qualified manpower in just those skills that MOD most need. But these benefits would of course be felt more widely than defence, throughout all parts

of employment and over and above the exploitation of any particular pieces of work. I believe the transfer could on balance be a net gain for the national interest as a whole.

7. I favour an addition to the Science Vote, albeit one that is applied to agreed disciplines, rather than specific contracts. The latter have their place and should continue but they are by nature limited in period and purpose and rightly tend to be judged primarily against the specific needs of the contractor and demonstrable defence potential. As I see it we are seeking something rather different - a reinforcement of the science base that can be expected to benefit defence, and other industry more widely, in ways that cannot be explicitly foreseen at the outset. I think this requires giving primacy to the criterion of scientific distinction and promise, as applied in decisions about the Science Budget. It does not necessarily mean, of course, that we are talking just about blue-sky basic research; interest may well focus more on strategic research, to which a good part of the Science Vote is directed.

8. On application I think the SERC have a good record and one that is steadily improving. I have in mind for example the success of their Teaching Company Scheme (which might be developed to cover areas funded by the transfer) and their use of special Directorates where they have brought about a sea change in a number of areas as for example in polymer engineering and marine technology. Similarly MRC have been developing their exploitation policy, as for example through Celltech and NMR imaging. Both Councils would, I believe, be ready and efficient in responding to the request that I would want to attach to this transfer that application should receive particular attention.

9. We are talking, I judge, about relatively small sums - perhaps 3.5% of MOD's intra-mural R and D spend or perhaps about twice that percentage if we discount development expenditure. And we would increase the Science Budget by about 3.5%. These small percentage figures convey little impression of the very

considerable impact and benefit that I believe the PES transfer would secure. I hope you will agree that the proposal should be developed, jointly by DES with MOD with Dr Nicholson's help and oversight, to produce a more detailed note on the basis of which we and our colleagues could reach a decision in the course of our public expenditure discussions in the autumn.

10. I am sending copies of this minute to Michael Heseltine, Robert Armstrong and Robin Nicholson.

KJ

2 July 1984

AREA OF MOD INTEREST FOR RESEARCH AGREEMENTS	COUNCIL SUPPORTING WORK IN THE AREA
Aerodynamics	SERC
Aircraft structures	
Materials eg novel semi-conductors	SERC
Electronics	SERC
Information technology	SERC, MRC, ESRC
Opto-electronics	SERC
Space eg satellite instrumentation, remote sensing	SERC, NERC
Acoustics	SERC, MRC
Physics eg semi-conductor behaviour	SERC
Chemistry	SERC
Medicine and behavioural sciences	MRC, ESRC
Biochemistry	SERC, MRC
Hydrodynamics	SERC
Propulsion	
Control systems	SERC
Mathematics	SERC
Operations analysis	SERC
Marine technology	SERC, NERC
Oceanography	NERC
Meteorology	NERC
Systems design	SERC

Science & Tech

Sept 83

Budget

Await DES

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PRIME MINISTER

MAINTAINING THE STRENGTH OF THE SCIENCE BASE

I am responding to the questions posed in your Private Secretary's letter of 23rd May.

2. Of the annual in-house expenditure of some £200M at the Defence Research and Development Establishments, 5% (£10M) goes to basic or "seed-corn" research directed at defence applications; the remaining £190M is devoted to applied research. About the same amount again is spent on basic research with the Universities and Research Councils (£9M last year, rising to £11M over the next two years). To put this total of £20M in perspective, the DES spends a sum approaching £½ billion on research with the University Grants Committee and the Science and Engineering Research Council alone.

3. The main factors determining whether basic research is undertaken in-house or placed outside are whether the most appropriate centres of expertise in the fields concerned lie inside or outside Defence Establishments, and its defence application. The stronger the defence orientation, the more appropriate it is for innovative work to be done by defence scientists who, by direct experience and close day-to-day contact with the Service "customer", understand defence needs. The availability of infrastructure (required at Defence Establishments to support applied research and current procurement) and security constraints is also an important consideration.

4. The quality of research conducted within MOD Establishments is monitored at a number of independent levels: by senior management audit, by peer review by university scientists serving on the Defence Scientific Advisory Council (DSAC) and its Boards and Committees and, in the case of seed-corn research, by scrutiny by the MOD Basic Research Advisory Committee whose membership includes independent scientists from the DSAC. It has to stand up to exposure to university and industrial scientists working closely with the Establishments in specialised fields. Our scientists publish their work in the open literature with little security constraint in the more basic areas and their papers are always subject to refereeing by national and international experts. There is every indication from these sources that basic research undertaken by the Establishments attracts and deserves a high reputation.

5. You sought my views specifically on the implications of switching £20M from defence intramural research to the university and research council system. I would be against this for a number of reasons. First I am advised that, although we could, in principle, make increased use of external capabilities (assuming these were available and willing to be involved with defence) in computing science and software, electronics, material/composites, marine technology, acoustics and behavioural sciences, there would be advantages only if sufficient good people with good ideas were readily available at universities and other academic institutions. We are already drawing substantially on these capabilities in our existing university research programme and will be increasing our demands on them. Furthermore, an increase of £20M in our expenditure with the universities could not be funded in addition to our present level of intramural basic research, which would have to cease. This would be very damaging since a modest long-term innovative intramural programme is essential to the scientific health and motivation of our Research Establishments. The 5% level we set for basic research is well within the 10% allowance recommended in the 1971 Rothschild report "A Framework for Government Research and Development" (Cmnd 4814).

6. The consequence would be that all basic defence research would be decoupled from the environment of applied research. This would inevitably result in the loss of applications to weapons projects and of the benefits which flow from team efforts directed to particular defence objectives. The decoupling effect would be all the more marked if the transferred funds were added to the Science Vote rather than sub-contracted specifically by the MOD. The former course would be detrimental to defence applications of the research, including exploitation by the defence industries, for example, in the export market. In this connection I would not foresee any significant enhancement of spin-off from the transfer of funds from the Defence Establishments. Industry can already draw on some 100-150 patents each year arising from the work of these Establishments and they have an intrinsic need to stay close to that work. As you are aware we have been following through the themes which I set out in my address to your Lancaster House Seminar last year and we are about to announce new arrangements, engaging private venture capital, to enhance spin off of ideas and technology generated in the Establishments.

7. For these reasons I would not wish to see any change in the present balance between intra- and extramural basic defence research. We are already planning a modest increase over the next two years in our expenditure with the universities and research councils and I propose to keep the return we get from this programme under my personal review. But I would not wish to go further. In particular I would resist any suggestion that funds voted for Defence purposes should be used to substitute for the DES Budget.

Ministry of Defence
25th June 1984

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CONFIDENTIAL BF 5/6

Department of Education and Science
Elizabeth House York Road
London SE1 7PH
Telegrams Aristides London SE1
Telephone 01-928 9222 ext

1 June 1984

Our ref GS 1016/393

Andrew Turnbull Esq
Private Secretary
10 Downing Street
LONDON SW1

CF: PPS pre.
5/6

Dear Andrew,

SCIENCE BUDGET: 8 JULY SEMINAR: INTERIM REPORT

1. This is just to let you know that yesterday Sir David Phillips, Dr Robin Nicholson and I discussed and short-listed names and themes for this seminar with the Prime Minister. We need a few more days for some further enquiries but by about the middle of next week we should be ready to make firm proposals for you to look at with Robin Nicholson or me or both of us. I suggest that the next step would then be for Sir David and Robin between them to telephone participants to establish their willingness and availability. More formal invitations would follow; and Sir David and Robin would both want to offer (probably jointly) further briefing in part on paper and in part oral.

2. In accordance with your letter of 13 April the programme put to participants would be for a 5.00 pm start followed by two and a half hours of presentations and discussion, then by supper. It may also be helpful to indicate a likely finishing time.

3. Experience suggests that presenters will want to use 35 millimetre slides and probably an overhead projector for free hand illustration. I hope you can arrange for the necessary equipment to be available.

4. I am copying this letter to Elizabeth Hodkinson, Robin Nicholson and David Phillips.

Yours sincerely

David

D W TANNER

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10 DOWNING STREET

From the Private Secretary

23 May, 1984

CONFIDENTIAL

MAINTAINING THE STRENGTH OF THE SCIENCE BASE

The Prime Minister held a meeting on 26 October last year to discuss the quality of the science base. It was agreed that the Chairman of the ABRC, Sir David Phillips, should discuss with your Chief Scientist the terms on which universities could secure additional defence research work. The Prime Minister has recently held a further meeting with the Secretary of State for Education and his scientific advisers to review the condition of the country's science base. I enclose a copy of the record of that meeting. The Prime Minister would be grateful if the issues raised could now be explored further.

The Prime Minister is aware, of course, that most of the R&D expenditure of MOD is connected with the development of specific weapons system or other items of defence equipment, and that your Secretary of State has recently stated his intention of obtaining the maximum commercial benefit from this expenditure. The meeting with the Education Secretary was relevant to the other part of the R&D budget, the £330 million or so devoted to research, and specifically that portion which supports longer-term work in MOD research establishments.

It has been put to the Prime Minister that some of the more basic and strategic research currently carried out in Government establishments - both civil and defence - would, security considerations permitting, be better conducted through universities and Research Councils, not only because of the high calibre of their staff but because the routes to eventual exploitation would be more numerous and effective. In view of the Government's concern to gain the maximum scientific, defence and industrial benefit from the substantial sums involved, and the clear overlap between many areas of MOD research interest and university research, the Prime Minister would like these assertions investigated. Specifically, she would be grateful for your Secretary of State's view on the effectiveness of the arrangements in his

RAMAAU

RM

Department for monitoring the scientific quality of the work undertaken at research establishments and for judging whether a particular research programme would be carried out more effectively in these or elsewhere, both in respect of the quality of the work and its exploitation.

The Prime Minister has asked me to emphasise that she has yet to be persuaded of the strength of the argument put forward on behalf of the universities and Research Councils. But she thinks it would be helpful if both your Secretary of State and the Secretary of State for Education and Science were to take a specific sum, say £20 million, presently intended for intra-mural research in MOD and consider:-

(i) the research areas that might best be supported with such a sum in the university and Research Council system;

(ii) the advantages and disadvantages to MOD;

(iii) whether specific contracts or an addition to the Science Vote would produce results of the highest quality and the widest applicability; and

(iv) how such application would be secured.

The Prime Minister would be grateful for notes from your Secretary of State and from the Education Secretary by the end of June.

I am sending copies of this letter to Elizabeth Hodkinson (Department of Education and Science), and to Richard Hatfield and Robin Nicholson (Cabinet Office)

(David Barclay)

R. Mottram, Esq.,
Ministry of Defence

RAMAAU

W.0387

23 May 1984

MR DAVID BARCLAY

n.b. pm
Spoke to RN and explained that the letter had already gone.
DMB 23/5

SCIENCE BUDGET

I am not sure what the position is on the minute and draft letter to Mr Heseltine which Sir Keith Joseph sent to the Prime Minister last week and which I commented on for her weekend box. In the event that she does intend to send the letter to Mr Heseltine and that it hasn't yet gone off, can I point out that there was a small ambiguity in my suggested text where in paragraph 4 it is not clear whether the figure of £20m is a total sum or a per annum sum. The latter was the intention, and if it is not too late I suggest that that is made clear.

If the minute, or something like it, has already gone, I would propose to clarify the point in discussions with the MOD Chief Scientist which I am sure would be the next stage after Mr Heseltine had received the letter.

RBN.

ROBIN B NICHOLSON

Science & Technology : Science Budget 9/83

File

VC

CC Dr Nicholson

10 DOWNING STREET

THE PRIME MINISTER

21 May, 1984

Dear Sir Alec,

Many thanks for sending me your note on CERN and the UK. I understand that you met Sir John Kendrew and his Committee last week when you were able to give them a copy of your note and speak to it. I have read your note with interest and look forward to seeing the report from the Kendrew Committee which will address the critical issues which you raise.

Yours sincerely

Margaret Thatcher

Sir Alec Merrison, D.L., F.R.S.

ECL

10 DOWNING STREET

From the Private Secretary

GR

Pse type flag B as minute for PM's sig.

DMB 21/5

~~Prime Minister~~ (1)

SCIENCE BUDGET

You were minded to write to Mr Heseltine about getting better value from defence research expenditure.

Attached are two drafts: one prepared by DES (flag A), and the other by Dr Nicholson (flag B). I think Dr Nicholson's is better, since it is less likely to provoke a hostile response.

Agree draft minute at flag B?

Yes mr

DMB
18/5

W.0382 18 May 1984

PRIME MINISTER

SCIENCE BUDGET

I have seen a copy of Sir Keith Joseph's minute to you of 17 May and his draft letter for you to send to the Secretary of State for Defence.

2. I support Sir Keith's comments in his minute to you. In my judgement they accurately reflect the current science and technology scene in the UK.

3. I am much less happy with his draft letter for you to send Mr Heseltine. The draft fails to distinguish between the very large, mainly extramural, development expenditure in MOD which has little relevance to the science budget and the smaller (but still £330 m) mainly intramural, research budget which does have relevance. It also makes a number of unsupported allegations against MOD research which will be countered by similarly unsupported rebuttals.

4. An objection of a different sort is that I am quoted in support of the DES position in paragraph 2 and, in paragraph 4, am apparently expected to bat on behalf of the Research Councils against MOD. I hope I have shown you that I do not shrink from giving you frank, and sometimes controversial, advice on a confidential basis or from supporting this at meetings you may have with colleagues. However I do think I need to preserve an element of neutrality between Departments and Sir Keith's draft seems to me to go beyond this.

5. In the light of this assessment, I have taken the liberty of preparing a substantially revised draft for you to send to

Mr Heseltine. It places an onus on MOD (and DES to a lesser extent) to justify their present research expenditures and their future aspirations. It calls initially for a written response although I envisage that later you you will wish to have another meeting since it is virtually certain that the Departments will not agree on the right way ahead in the future.

6. By the time the meeting is held, you will have some further advice to hand on this matter. First, my Secretariat's 1984 Annual Review of Research, which takes an across-the-board view of Government R&D expenditure, will be complete, together with comments on the review from ACARD.

7. Secondly, the review which you agreed I should undertake on Government Research Capability, which takes a long-term view of Government Research Establishments,will be with you in draft form. I was, I regret to say, over-optimistic on the time needed to conduct a review on this difficult subject but I shall have completed the draft early in June. I can say now that the review will recommend that Departments should develop long-term plans for putting <u>all</u> their research establishments into the private sector with the sole exception of MOD establishments covering chemical and biological defence and nuclear weapons. The onus would be on Departments to produce convincing arguments <u>against</u> this general privatisation rather than, as at present, simply requiring them to defend the status quo.

8. I am copying this minute to Sir Robert Armstrong.

RBN

ROBIN B NICHOLSON
Chief Scientific Adviser

Cabinet Office
18 May 1984

CONFIDENTIAL

M4/84

DRAFT MINUTE FROM PRIME MINISTER TO SECRETARY OF STATE FOR DEFENCE

MAINTAINING THE STRENGTH OF THE SCIENCE BASE

1. At our meeting to discuss the quality of the science base on 26 October last year, it was agreed that the Chairman of the ABRC, Sir David Phillips, should discuss with your Chief Scientist the terms on which universities could secure additional defence research work. I have recently held a meeting with Keith Joseph and his scientific advisers to review the condition of the country's science base. I enclose a copy of the record of that meeting. In the light of what was said, ~~In the light of what I heard,~~ I should now like to look into the matter further.

2. I am aware, of course, that most of the R&D expenditure of MOD is connected with the development of specific weapons system or other items of defence equipment and you have recently stated your intention of obtaining the maximum commercial benefit from this expenditure. My discussion with Keith Joseph was relevant to the other part of the R&D budget, the £330 million or so devoted to research, and specifically that portion which supports longer-term work in MOD research establishments.

3. It has been put to me that some of the more basic and strategic research currently carried out in Government establishments - both civil and defence - would, security considerations permitting, be better conducted through universities and Research

Councils, not only because of the high calibre of their staff but because the routes to eventual exploitation would be more numerous and effective. In view of our joint concern to gain the maximum scientific, defence and industrial benefit from the substantial sums involved, and the clear overlap between many areas of MOD research interest and university research, I would like these assertions to be thoroughly investigated. Specifically, I would like to have your view on the effectiveness of the arrangements that you have for monitoring the scientific quality of the work undertaken at your research establishments and for judging whether a particular research programme would be carried out more effectively in these or elsewhere, both in respect of the quality of the work and its exploitation.

4. Let me make clear that I have yet to be persuaded of the strength of the argument put forward on behalf of the universities and Research Councils. But I think it would be helpful if both you and Keith Joseph were to take a specific sum, say £20 million, presently intended for intra-mural research in MOD and consider:

i. the research areas that might best be supported with such a sum in the university and Research Council system;

ii. the advantages and disadvantages to MOD;

iii. whether specific contracts or an addition to the Science Vote would produce results of the highest quality and the widest applicability; and

iv. how such application would be secured.

I should be grateful for notes from you and Keith Joseph by ~~[30 June]~~ the end of June.

I am sending copies of this minute to Keith Joseph, Sir Robert Armstrong and Dr Nicholson.

W.0380 18 May 1984

PRIME MINISTER

LETTER FROM SIR ALEC MERRISON ON CERN

Sir Alec Merrison is now President of the Council of CERN and it is natural that he should be concerned about the review being carried out by Sir John Kendrew and his Committee on High Energy Particle Physics (HEPP).

2. The Kendrew Committee had a formal meeting with Merrison earlier this week at which he gave them the same document that he has sent you. The Committee will be seeing him again when they visit CERN in October.

3. Much of Merrison's document would be common ground between him and the Committee but I think they will question the logic of his arguments in paragraphs 9 and 10 which, in effect, propose the view that HEPP research should be done regardless of cost.

4. On Merrison's paragraph 11, present evidence suggests that many European countries secretly admire our decision to review our HEPP activities although they may publicly say otherwise. There are currently no consequential problems with our discussions in Europe on scientific collaboration.

5. My advice is that you should take a neutral stance on the issue until the Kendrew report is available at the end of the year. I have drafted your reply accordingly.

RBN

ROBIN B NICHOLSON
Chief Scientific Adviser

ORD

file

W.0379 18 May 1984

MR TURNBULL, NO 10

CERN AND THE UK

- Attached are a minute for the Prime Minister and a draft
- reply to Sir Alan Merrison prepared after consultation with the Secretariat of the Kendrew Committee in DES.

with AT?

I am copying this and the attachments to Elizabeth Hodkinson (DES).

RBN

ROBIN B NICHOLSON
Chief Scientific Adviser

GR pl type for signature

DRAFT LETTER FROM THE PRIME MINISTER TO SIR ALEC MERRISON

Many thanks for sending me your note on CERN and the UK.

[As you know, I have always enjoyed my visits to CERN and admire the research which is carried out there.]

I understand that you met Sir John Kendrew and his Committee last week when you were able to give them a copy of your note and speak to it.

I have read your note with interest and look forward to seeing the report from the Kendrew Committee which will address the critical issues which you raise.

1) Mr Coles
2) Prime Minister (1)
Agree attached minute to the Defence Secretary?
8/5

PRIME MINISTER

SCIENCE BUDGET

At our meeting on 3 May with Sir David Phillips, Professor Kingman and Dr Nicholson, you asked me to let you have a note about what might be done to get better value for money from civil and military research programmes - your Private Secretary's letter of 4 May refers.

2. My concern is that we are missing opportunities in scientific research and allowing our once exceptionally good science base to fall below the standards of our major competitors. Preserving the quality of our science base requires the Research Councils to be in a position to finance a spectrum of basic, strategic and some applied research. I am advised that the best research of this type in this country, with one or two distinguished exceptions like the Royal Signals and Radar Establishment at Malvern, is done either at universities (often with Research Council funding) or in Research Council institutions like the Laboratory of Molecular Biology at Cambridge. (Dr Nicholson would, I think, agree with this generalisation.) The Research Councils are in very close touch with industry, having industrialists as Council members and on their advisory committees; and the universities are now making real efforts (even though belatedly) to get closer to industry in the form of numerous initiatives including teaching companies, science parks and industrial professorships.

3. Leading scientists have told me of their concern about the quality and value of some of the work done in Government research establishments funded by the civil departments. They also question whether the country is getting full value from the scientific research financed by the Ministry of Defence. It has been suggested to me that, if some of this

finance were transferred to the Research Councils, there would be a gain to science and to industry without loss to the nation's defence. Another important question is whether the results of research carried out in defence establishments could be made more widely available to the rest of the scientific community and to industry. (The general flavour is illustrated by Sir Hermann Bondi's remark that the NERC's oceanographers get more help from the US Navy than from the Royal Navy! They were more helpful in the nineteenth century - HMS Beagle took Darwin round the world.)

4. At your meeting to discuss the strength of the science base on 19 October last year, Sir David Phillips was asked to pursue with the Chief Scientist at MOD the terms on which universities could secure additional defence research work. Sir David Phillips told you on 3rd May that, in his view, things were moving rather slowly. Since then he has received from the Ministry a draft paper which they intend to circulate to Universities and polytechnics to inform them about the areas of research in which the Ministry are interested. Their list of research areas includes very little which is not also on the list of research areas supported by the SERC, the NERC and the MRC. Because the ABRC are not informed about what the Ministry are doing, they cannot ensure that government research money is being spent to best effect. My Permanent Secretary has now spoken to Sir Clive Whitmore about this whole question, as you asked him to do, and the Ministry are looking into the matter.

5. I am, as you requested, sending you with this Minute (copies of which go to Sir Robert Armstrong and Dr Nicholson) a draft Minute for you to send to the Secretary of State for Defence.

KJ

17 May 1984

DRAFT MINUTE FOR THE PRIME MINISTER TO SEND TO THE SECRETARY OF STATE FOR DEFENCE

MAINTAINING THE STRENGTH OF THE SCIENCE BASE

1. At our meeting to discuss the quality of the science base on 26 October last year, it was agreed that the Chairman of the ABRC, Sir David Phillips, should discuss with your Chief Scientist the terms on which universities could secure additional defence research work. I have recently held a meeting with Keith Joseph and his scientific advisers to review the condition of the country's science base. I enclose a copy of the record of that meeting. In the light of what was said, ~~In the light of what I heard,~~ I should now like to look into the matter further.

2. The Research Councils, Sir David Phillips and Dr Nicholson are concerned that government money allocated to scientific research may not always be used to best effect. Their fear is that Universities and Research Council institutes ~~are~~ may be denied funds to do potentially very high quality research (both strategic and to some extent applied) while less good work of the same sort goes ahead in Government establishments - both civil and military. It has also been put to me that there may be duplication because the rest of the scientific community and industry are not aware of the results of work done in defence establishments. It may be, for example, that our work on remote sensing would be more profitable if there were better contact, and a different balance of effort, between the Royal Aircraft Establishment and the Rutherford Appleton Laboratory. Many areas of research supported by the Ministry of Defence are also supported by the Research Councils - so that this may be a pervasive, not an isolated, problem.

3. I know that you are anxious to ensure that the results of defence research and development are widely disseminated whenever security considerations permit. But I wonder whether that really gets to the heart of the problem. Is it

true, do you think, that quite a lot of the large sums of money spent on defence r. and d. produces a low scientific and industrial return by comparison with research supported by the Research Councils? Do you believe that the similarity of interest between the Ministry of Defence and the Research Councils results in duplication?

4. I am asking my office to arrange a discussion of these questions with you and Sir Clive Whitmore, Professor Norman and Dr Nicholson.

5. I am sending copies of this minute for information to Keith Joseph, Sir Robert Armstrong and Dr Nicholson.

SCIENCE & TECH: Science Budget
Sept 83

18/5 √

10 DOWNING STREET

From the Private Secretary

DR. NICHOLSON

CERN AND THE UK

Professor Merrison has sent the Prime Minister the attached note on CERN and the UK. I propose to put this in the weekend box. Could you let me have comments on the paper and advice on the terms in which the Prime Minister could reply, by Friday.

I am sending a copy of the note to Elizabeth Hodkinson (Department of Education and Science).

AT

15 May 1984

√

TELEPHONE: BRISTOL 24161

THE UNIVERSITY,
SENATE HOUSE,
BRISTOL,
BS8 1TH.

VICE-CHANCELLOR:
SIR ALEC MERRISON, D.L., F.R.S.

14th May 1984

Dear Prime Minister,

Here is the short note on CERN and the U.K. which I said I would send to you.

It is, of course, partisan but as I said in my previous letter it is a matter on which I feel deeply.

With all good wishes

Yours sincerely

Alec Merrison

The Rt. Hon Mrs Margaret Thatcher M.P.
10 Downing Street
London SW1

CERN AND THE UK

A new view of the universe

1. Between them the nuclear physicists* and the astronomers have provided us in this century with an entirely new view of the physical universe, a revolution in the way man looks at the world which has no parallel in history.

2. Apart from its intellectual and cultural significance the practical consequences of this revolution for the way we live could not have been more profound. The development of the idea of the nuclear atom, with electrons in well ordered and definable orbits, has provided the basis for virtually the whole of modern technology both in the physical and biological fields. It has provided us with a new source of energy and with weapons of hitherto unimaginable destructive force, with profound consequences for the whole of mankind.

3. Nor is there the slightest reason to believe that we have passed some turning point and that we now stand on some sort of plateau in our knowledge and the way we apply it. Arguments of this kind were invented at the end of the nineteenth century for the situation in science as it then was and proved, of course, entirely specious. There is no reason for believing that we have become any better at foreseeing the unforeseeable.

4. The speed of the development of new science and its applications has been breathtaking. In the late 1920s and early 1930s Rutherford was severely criticised by his fellow scientists for leading the Cavendish Laboratory into nuclear physics which 'was disconnected from the mainstream of physics and had no practical consequences'.** It was just 13 years between the discovery of the neutron in 1932 and the use of the first nuclear weapon at Hiroshima.

Nuclear Physics in the UK since World War II

5. After the second world war the instruments required to do nuclear physics, though expensive, were on a scale which enabled them to be housed in universities. It gradually became apparent that nuclear accelerators with the capacity to do physics at an international level, were beyond this scale and so in the 1950s and 1960s accelerators accessible to university users on a national basis were built at the Rutherford Laboratory at Harwell and at Daresbury. In the early 1970s it

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* Shorthand for nuclear physicists and elementary particle physicists, just as 'nuclear physics' will be used throughout as shorthand for nuclear physics and elementary particle physics.

** I was told this by the lat Sir James Chadwick, Rutherford's principal lieutenant, the discoverer of the neutron, and the man as responsible as anyone for the UK development of nuclear energy and weapons.

again became apparent that elementary particle physics at the highest international level required something more and it was decided to concentrate our efforts almost entirely at CERN, which had been set up in the mid-1950s. Although painful that was certainly, particularly in the light of major developments at CERN since then, a correct decision.

The present position at CERN

6. By a series of bold and imaginative decisions CERN is now as well equipped to do the physics of the late twentieth and early twenty-first century as any laboratory in the world. UK physicists and engineers have played a critical part in bringing CERN to its present world eminence.

7. Over the years CERN has become much more than simply a European laboratory. It is significant that when the new accelerator LEP begins work in 1988 one of the first four experimental groups, altogether about 150 physicists, will be made up of Europeans, Russians, Americans and Chinese, led by an American, Sam Ting, born in mainland China.

The UK and its withdrawal from CERN

8. Having seen none of the arguments which have led the ABRC and the SERC to set up their joint enquiry into this possibility I can only speculate about the reason for their decision to do so. But let me assume that the arguments run along the lines that it is too expensive and the money could be better used to support other kinds of scientists.

9. Unquestionably it is expensive to do elementary particle physics, though not that much more expensive than doing biology, for example, as one might immediately suppose. So one is driven to ask questions, if one follows this line, which have not and cannot have an answer; such as, will we do more and better science if we stop doing elementary particle physics.

10. All one can say is that elementary particle physics is fundamental to our building up a view of the physical universe, and that there is absolutely no reason to suppose that the next 50 years will be less surprising in this respect than the last 50 years.

11. The one certain consequence that would follow from our withdrawal from what is commonly acknowledged to be one of the world's finest laboratories would be to cast doubt upon our reliability as partners in any international scientific or technological enterprise at a time when we need the rest of the world at least as much as it needs us. To my mind it would be a simple assertion of the UK's unwillingness to maintain, let alone extend, its position as a world leader in science.

A.W. Merrison
14.5.84

The Times Higher Education Supplement May 4, 1984.

File

Scientists called to Downing St

by Paul Flather

Mrs Margaret Thatcher, the Prime Minister, called a private meeting of top science policy advisers and officials at Downing Street yesterday to discuss, among other matters, the future funding of science research and reforms of how science is organized.

Details have been kept highly secret, with participants even trying to deny the existence of the meeting. But it is understood the Prime Minister is keen to hear exactly what major concerns and requests scientists have before next year's science budget is fixed in the annual expenditure round.

At the meeting were Professor John Kingman, chairman of the Science and Engineering Research Council, also chairman of the Heads of Research Councils committee, Sir David Phillips, chairman of the Advisory Board for the Research Councils, Dr Robin Nicholson, chief scientist to the Cabinet Office, Mr Peter Brooke, under secretary for higher education, and Mr David Hancock, permanent secretary at the Department of Education and Science.

A key issue was to try and unscramble the crossed wires that seem to have followed last September's highly public "science seminar", hosted at Lancaster House by the Prime Minister, which left many scientists believing they had now won Mrs Thatcher's personal backing for more research fundings.

The Prime Minister never meant to imply more money would be there for the taking. She does however accept that the total £3.8 billion Whitehall research and development budget may not be being spent in the best way.

She was expected to reaffirm her view that if the case for increasing the science vote was well made, then the total research and development budget could well be altered. She was also expected to tell the group she is keen to pursue reforms in the way science is organized and funded.

Professor Kingman and Sir David were expected to raise the question of how much more money is needed if Britain is to continue its participation in CERN, the European Nuclear Research Centre. Mrs Thatcher is not convinced about the value of Britain's continued involvement.

A new document, *Scientific Opportunities*, for this year's science budget has just been prepared by the ABRC, and Sir David and Professor Kingman, backed by Mr Brooke and Mr Hancock, were expected to talk the Prime Minister through the report.

SUBJECT cc Master

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c. ENVIRONMENTAL AFFAIRS: Acid Rain Sept. 1979.

FILE da

10 DOWNING STREET

From the Private Secretary

4 May 1984

Dear Elizabeth,

SCIENCE BUDGET

The Prime Minister held a meeting yesterday to discuss the science budget and the way in which priorities within it were determined. Present were your Secretary of State, Mr. Brooke, Mr. Hancock, Dr. Nicholson, Sir David Phillips (Chairman of the Advisory Board for the Research Councils) and Professor John Kingman (Chairman of the Science and Engineering Research Council).

The Prime Minister invited Professor Kingman and Sir David Phillips to report on the opportunities for scientific research and the way in which the science budget was able to respond to them. She asked whether the system of interlocking committees was the best way of making the difficult choices necessary.

Professor Kingman said there was a spectrum of research - basic, strategic and applied. It was important for the UK to maintain an effort over the whole spectrum. The most difficult choices were in basic science where the final application could not be predicted. It could not have been known, for example, how far basic work in solid state physics would lead to productive applications in semiconductors and microelectronics. The UK was fortunate in having an active system of university research. This enabled the Government to conduct research in a cost-effective way by providing the additional costs which university centres needed.

On the way in which decisions were taken, he said many committees were necessary to cover all the fields which a research council like SERC was seeking to cover. Such committees were inevitably conservative but he nevertheless thought the system was the best available. The cost of administering the system of peer review was around 2-3%, a reasonable price to pay for good choices. Research projects submitted for support were graded into alpha and beta but at present support was given for only about 70% of the alpha

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/ projects

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projects. This meant that 30% of good projects, and good people, were being turned down and significant opportunities were thereby being refused.

The Prime Minister said it was unsatisfactory that Britain had made such advances in basic science but had failed to develop profitable applications. Japan had followed the opposite course, though it was noted that it was now moving towards more basic research. In discussion, it was argued that a greater link between industry and research centres, particularly the universities, was necessary. The development of teaching companies, now numbering 127, was most promising. The larger British companies should undertake more research though it was recognised that the pressures of inadequate profitability had forced them to take a short term view. It was to be hoped that, as profits recovered, this situation would improve.

Your Secretary of State said that those responsible for managing the science budget were to be congratulated on having taken a number of tough decisions. In some research councils there had been very significant redundancies, the cost of which had to be borne on their budgets, in contrast to departments, where such costs were borne centrally.

Your Secretary of State said the Secretary of State for Defence had offered to improve co-operation between the science budget and research in the defence field. It was essential to follow this up urgently. Sir David Phillips said the Ministry of Defence was about to produce a booklet guiding the universities on how they could bid for defence research work. A mechanism was needed for ensuring that duplication was eliminated and that priorities between the civil and military research programmes were co-ordinated. Within the science budget there were mechanisms for ensuring that institutions that had passed their peak were scaled down or closed. Was this equally true for defence and other departmental programmes? Your Secretary of State offered to minute the Prime Minister setting out what might be done in this area, with a draft of a letter which could be sent to the Secretary of State for Defence. The Prime Minister accepted his offer and pointed out that she was still waiting for a paper from the Ministry of Defence on the military applications of space technology. She would be happy to hold a meeting with Professor Norman, MOD's Scientific Adviser. Mr. Hancock agreed to remind Sir Clive Whitmore of this.

The Prime Minister said she doubted whether Departments were able to spend their research funds effectively. Dr. Nicholson said the Rothschild contractor/customer principle had many advantages but to work effectively, it called for

RESTRICTED

expertise on the part of the customer which was not always to be found. He pointed out that the amount of research being commissioned directly by Departments was declining.

The Prime Minister asked about the fields in which the most exciting scientific prospects were to be found. Professor Kingman suggested new materials and low dimensional structures whose electrical properties would create opportunities for microelectronics. Sir David Phillips suggested applications of molecular biology to neurology, which could open the way to understanding about the organisation of the brain; and nuclear magnetic resonance where it might soon be possible to develop scanners capable of displaying real time pictures. The Prime Minister looked forward to continuing this discussion at the Seminar on 8 July.

The Prime Minister was disturbed about inadequate public understanding of the problem of acid rain. Dr. Nicholson said the priority was better understanding of the scientific processes involved. This was difficult to achieve as the problem straddled a number of scientific disciplines. Work had not kept pace with growing public sensitivity on the issue. It was originally thought that the problem lay principally in sulphur emissions but there was now greater emphasis on nitrogen oxides or ozone. This put the spotlight less on coal burning and more on automobile emissions. The choice between lead burn engines and catalytic converters was an important one; the latter were capable of achieving better results but only if the converters were maintained. He offered to send the Prime Minister a note on acid rain, together with a draft PQ which could be used to put the UK's position on the record.

~~BF~~

I am copying this letter to those who attended the meeting.

Yours sincerely
Andrew Turnbull

Andrew Turnbull

Miss Elizabeth Hodkinson,
Department of Education and Science.

DCAAAA

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W.0329 2 May 1984

MR TURNBULL

PRIME MINISTER'S DISCUSSION ON THE SCIENCE BUDGET

I enclose a brief and handling notes on tomorrow's discussion. Also attached is a copy of the 1983 ABRC advice to Sir Keith Joseph. I recommend that this is <u>not</u> given to the Prime Minister because of its length but it may be useful for you or the Policy Unit to have it handy.

RBN

ROBIN B NICHOLSON
Chief Scientific Adviser

W.0328 2 May 1984

PRIME MINISTER

MEETING ON THE SCIENCE BUDGET, 18.00 hours, 3 May

Sir Keith Joseph suggested to you that it would be valuable if you could talk directly with the people concerned with the difficult issues of priorities within the Science Budget. After discussion you and he agreed that two separate meetings would be desirable;

(i) a small meeting about priorities and the processes by which the science bodies arrive at them;

(ii) a meeting with active scientists on recent scientific advances and the kinds of opportunities which they open up.

2. The second meeting is to take place at Chequers on 8 July. This brief covers the first meeting which takes place tomorrow. Present will be Sir Keith Joseph, Mr Peter Brooke, Mr David Hancock, Sir David Phillips (Chairman of the Advisory Board for the Research Councils) and Professor John Kingman (Chairman of the Science and Engineering Research Council).

Background

3. The size of the Science Budget for 1984-85 is £550 million. The sums for the five Research Council are as follows:

AFRC - £46 million (plus about £50 million for commissioned research)

MRC - £117 million

NERC - £65 million (plus about £20 million for commissioned research)

SERC - £279 million

ESRC - £22 million

Small sums went to the National History Museum, the Royal Society and the Fellowship of Engineering. The Councils account for roughly 1/8th of central government spending on R&D and 1/4 of civil R&D expenditure of about £2 billion. Defence R&D expenditure is also about £2 billion.

FLAG A

4. The trend of the Science Budget is shown in Annex 1. The figures allow real increases of £6 million in 1984-85, £8 million in 1985-86 and £7 million in 1986-87, to assist with the increased costs of international subscriptions, and £0.5 million each year to assist with restructuring costs. The DES argued unsuccessfully in last year's PES bid for a £98 million increase in spending spread over the next 3 years, on the grounds that these funds were required to support new work in fields such as the application of advanced technology to manufacturing engineering, food and nutrition, spectroscopic measurement of cosmic X-ray sources, neurosciences, biotechnology, deep geology, marine sciences, remote sensing and atmospheric sciences; also to provide for additional funds to obviate the one-in-five (and growing) rejection rate of first-rate ("alpha") grant applications and to assist in restructuring Research Councils to improve flexibility. The increases proposed represented about 4 per cent in 1984-85 and 7.5 per cent in 1986-87. It was claimed that our main competitors in the world markets are planning to increase their spending in basic research by 18 per cent (France), 8 per cent (USA) and 5 per cent (W Germany).

5. Because the PES bid was unsuccessful, the ABRC has decided to make possible the restructuring of AFRC and NERC by diverting research funds from the MRC and SERC. The total sums diverted will be some £3 million in 1985-86 and £6 million in 1986-87.

The ABRC also consider that it may be necessary to withdraw from a major area of science in order to allow greater scope for responding to new scientific opportunities. You have agreed to a review of the UK's participation in high energy particle physics to be carried out jointly by the ABRC and SERC. The review will be chaired by Sir John Kendrew. The £45 million pa expenditure on high energy particle physics is concentrated at CERN in Geneva.

6. An average of 25 per cent of Research Council budgets is spent on research grants to universities (AFRC 10 per cent, NERC 11 per cent, MRC 24 per cent, SERC 32 per cent).

7. The Science Budget is one part of the "dual-support" system of research at universities. The other part comes from the UGC block grant for teaching and research. There is no good current estimate of how much of this grant is spent on research. A 1970 estimate that there was then a 70/30 split between teaching and research would give a current research support figure of about £660 million - this is certainly an overestimate, perhaps substantially so. The UGC cuts on university grants seem to have fallen disproportionately on research.

8. There are many definitions of basic, strategic and applied research but I suggest we work to the following:

> Basic research is that undertaken primarily to acquire new knowledge, without any particular application in view.
>
> Strategic research covers the area where basic concepts are established, but where it is not yet possible to identify specific products or processes.
>
> Applied research is directed towards a specific practical aim, such as the development of new products or processes.

Handling

9. Sir Keith Joseph will wish to make a brief introductory statement on the origin and purpose of the meeting - a welcome opportunity for the scientists to tell you directly what they tell him. You should then ask Professor Kingman to speak on priorities and opportunities in SERC. Sir David Phillips will follow with comments on the other Research Councils and on ABRC.

10. I could then comment briefly on the possibility of redeployment of the Government's £4 billion R&D spend between Departments. Annex 2 indicates how this is currently spread between basic research, R&D in support of procurement, R&D in support of industry and R&D for Government's own needs, eg policy formulation, statutory and regulatory obligations. I shall be supporting Treasury in their PES discussions, using data gathered from the 1984 Review of Government R&D.

FLAG B

11. You may then wish to question Professor Kingman and Sir David Phillips on their contributions. I suggest that the discussion might be divided into two parts:

(i) Are the Research Councils efficient and effective in setting priorities and implementing them?

(ii) Are the Research Councils using the right criteria for setting priorities and what sorts of opportunities are being lost with the abandonment of lower priorities?

12. Efficiency and effectiveness in setting and implementing priorities

Possible issues are:

(a) Is the "peer review" system the best? How much does it cost? Does it lead to the support of established scientists at the expense of bright young ones? Does it penalise interdisciplinary areas where much of the most exciting science is being done?

(b) Are the Research Councils spreading their resources too thinly? How many Departments of Chemistry (say) are doing really good research? Is there too much support going to the others? Are the UGC and the Research Councils consistent in their support of the best research in universities?

(c) Are the Research Councils working well with Government Departments in their respective responsibilities for research? Is there overlap and duplication? Are there gaps - for example, why do we know too little about the science of acid rain at a time when there is a strong demand for action?

(d) Is the organisation of Research Council staff a limiting factor in stopping worked out areas of research and putting resources into new areas? The MRC seem to have a smaller proportion of tenured staff (70 per cent) and greater flexibility in closing and opening research units than other Research Councils; is this an example to be followed?

(e) Are the Research Councils sharing large equipment internationally to save costs? Can we control international facilities or are they all as gold-plated as CERN? Do we share telescopes, research ships, satellites, or only reactors and accelerators?

(f) Is ABRC just a bureaucracy as Sir Douglas Hague suggested in his Mond lecture? (You have seen Sir Douglas's lecture in which he concluded that ABRC needed to change, and that its bureaucracy needed to change - that a "learning" bureaucracy needed to be devised. He recommended that a small strategy unit be established, to challenge orthodoxies, to ensure change actually happens and to develop a 'top-down' view. The unit would need to monitor economic, technical, social and political developments outside

In folder at D
Page 15 onwards
are relevant

science, as well as activities in universities and Research Councils. Members would need to come from outside the Civil Service and the community of natural scientists and engineers - perhaps from economics, and certainly from business schools. You may wish to seek reactions to Sir Douglas's views.)

13. Criteria for determining priorities

Possible issues are:

(a) What balance of criteria are the Research Councils using? Scientific excellence? Prestige? Economic value to the nation? (Annex 3 shows the criteria which the ABRC "invited" Councils to use in 1975. Under the Science and Technology Act, 1965, the Secretary of State for Education and Science has powers to give directions to the Councils in relation to their activities financed out of the grant-in-aid).

FLAG C

(b) Is the likelihood of successful exploitation of research results a significant factor in choosing research projects? We seem to lead the science in many areas but fail to exploit it - are we doing as well as we should in medical instruments based on Nuclear Magnetic Resonance, for example?

(c) How do the Councils see their responsibilities for strategic research? (Lord Whitelaw reported the concern in the recent House of Lords debate, which echoed Sir Ronald Mason's recent report to ABRC, that strategic research was being squeezed out between Government Departments concentrating on applied research and Research Councils concentrating on basic research).

(d) 90-95 per cent of the world's R&D is done outside the United Kingdom - what criteria do the Councils use to place their limited resources in the world context?

14. Conclusions

Since this is the first of two meetings for information, there is no need to come to specific conclusions. You may wish to make some general comments: my expectation is that the Councils will be able to demonstrate that they have taken action and have further action in hand to make their setting of priorities and implementation of these much more efficient and effective. However, their criteria for setting priorities may still be woolly and insufficiently in tune with the country's needs. Nevertheless they will probably be able to demonstrate that important opportunities are being lost. You could say that you are looking forward to the meeting on 8 July and hearing more about the exciting science which is being done in the UK.

RBN.

ROBIN B NICHOLSON
Chief Scientific Adviser

Cabinet Office
2 May 1984

cc: Sir Robert Armstrong

ANNEX 1

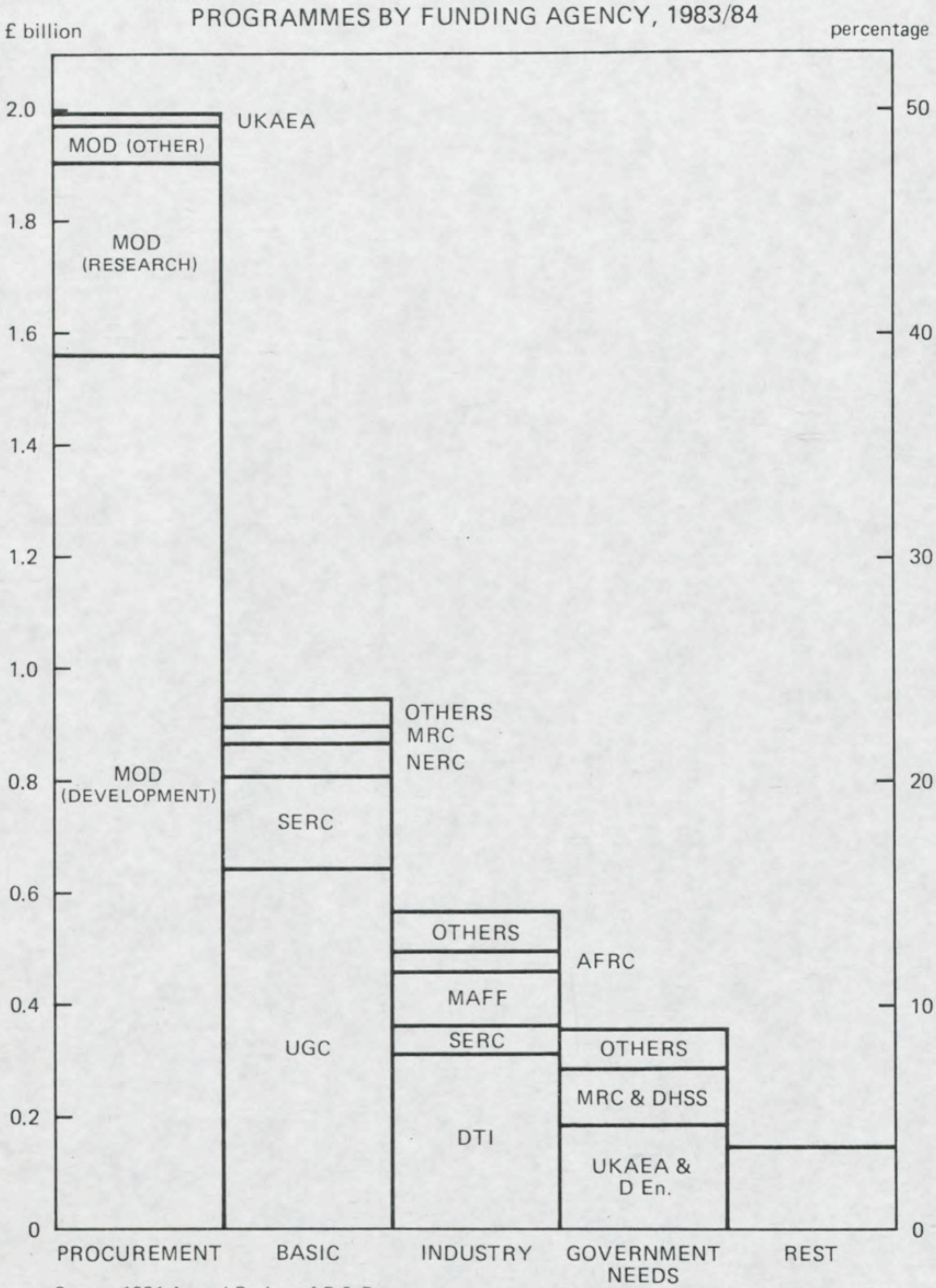
THE SCIENCE BUDGET 1984/85 TO 1986/87

£m cash

ALLOCATIONS	ESTIMATED OUTTURN	PROVISION	PROPOSED	
	1983-84	1984-85	1985-86	1986-87
AFRC	46.0	46.5	45.7	47.0
MRC	113.7	117.2	120.2	122.8
NERC	62.5	65.9	67.5	69.6
SERC	254.5	278.8	291.9	298.9
ESRC	22.4	22.0	23.0	23.7
NHM	9.4	9.75	10.15	10.45
Royal Society	5.0	5.3	5.7	5.85
Fellowship of Eng	-	0.15	0.15	0.15
Restructuring	-	-	4.0	7.2
Science Policy Studies	-	-	0.05	0.05
Sub-total	513.5	545.6	568.35	585.7
NHM (PSA)	3.3	4.4	5.1	5.7
TOTAL	516.8	550.0	573.45	591.4

Annex 2

PRIMARY OBJECTIVES OF GOVERNMENT FUNDED R & D PROGRAMMES BY FUNDING AGENCY, 1983/84



Source 1984 Annual Review of R & D

Note: For comparison, it is likely that private industry will have also spent around £4 billion on R & D in 1983/84, of which around £100 million will have been on basic research. Accurate figures are not, however available

Cmnd. 6430

APPENDIX IV

THE COMMON CRITERIA

(see Appendix I, para. 7)

1.* Councils and their Boards/Committees/Groups are invited to use the criteria listed here to discuss and compare relative benefits. Whenever practicable, reference should be made to objective data in support of the assessment (eg demographic data; social costs; relevant government expenditure etc.) in relation to the cost of the research.

Scientific Policy Criteria

(1) Excellence of study field
  Where benefits are attributable to a high proportion of the research being intrinsically of high intellectual value.

(2) Excellence of the research workers
  Where benefits are attributable to the exceptional quality of the individuals or teams to be employed in the activity.

(3) Pervasiveness of the activity
  Where benefits include the impetus to advances in other and related fields of science in addition to the primary field.

(4) Social and/or economic importance
  Where expected benefits arise from the work being directed to supporting social or economic aims.

(5) Significance for the training of scientific manpower
  Where benefits will include training and experience for scientific research workers.

(6) Educational importance
  Where benefits will include a contribution to education.

(7) Significance in maintaining national scientific prestige
  Where benefits will contribute to national reputation.

Management Criteria

2. A set of selected management criteria are also offered. These apply to the consideration, from a management policy point of view, of alternatives which have already been assessed on the scientific policy criteria.

A. Efficiency of operation
  Where improvements in organisation and/or plant would lead to a general increase in efficiency.

B. Obsolescence
  Where the maintenance of a capability (at whatever level of activity) requires replacement within the Forward Look period of a major item of obsolescent plant or equipment.

C. Timing
  Where a start on a new or increased activity within the Forward Look period is critical if the expected benefits are not to be lost or much reduced.

D. Dependence on Science Budget Support
  Where there is likely to be limited support, national or foreign, available for work related to the activity except the Science Budget.

E. Availability of scientific manpower
  Where an activity attracts priority by virtue of greater availability of scientific manpower for it (or its execution is constrained by lack of it).

F. Scope and limits of redeployment
  Where the priority accorded to an activity is conditioned by difficulties or opportunities of redeployment.

---

* Extract from instructions to Research Councils, 1975 Forward Look.

File 871

10 DOWNING STREET

From the Private Secretary 13 April, 1984

Dear David,

Science Budget: Proposed July Meeting on Recent Developments in Scientific Research

Thank you for your letter of 10 April. I have put your proposals to the Prime Minister who would like very much to hold a seminar along the lines you suggest. We have identified the evening of Sunday, 8 July at Chequers as a suitable date and place. We envisage starting at around 5 p.m. which might allow around two and a half hours for presentations and discussion. The Prime Minister would be pleased to offer supper afterwards to the visitors.

I agree with your suggestion that the emphasis of the meeting should be on the nature of scientific opportunities rather than on the resources available to pursue them. The latter issue is, as you know, the subject of a separate meeting.

BF I would be grateful if you could identify possible subjects and presenters. When you have drawn up a short list, perhaps we could get together with Robin Nicholson to decide on who should be invited.

I am copying this letter to Elizabeth Hodkinson (Sir Keith Joseph's Office), Mr. Glickman (Mr. Brooke's Office, Department of Education and Science), Mr. Hancock (Department of Education and Science), Dr. Nicholson (Cabinet Office) and Sir David Phillips.

Yours sincerely
Andrew Turnbull

ANDREW TURNBULL

D. W. Tanner, Esq.,
Department of Education and Science

ECL

PRIME MINISTER

Meeting on Scientific Research

I have investigated further your idea of a meeting or teach-in on developments in science. The attached letter from DES puts forward suggestions on how such a meeting might be structured. One possibility would be to hold it on a Sunday evening at Chequers, which might be quite attractive to those invited to take part and which might allow rather more than two hours to be set aside. The meeting could, for example, start around 5.00 and conclude with supper.

The diary for June is extremely full but a possibility is Sunday 8 July - if it were later there will be an increased risk that the scientists will be dispersed on holiday or lecturing abroad.

Do you wish to pursue the idea?
Are you content with the suggested format?
Are you content with the suggested date?

Yes MT

AT

12 April 1984

CONFIDENTIAL

CCNØ

Department of Education and Science
Elizabeth House York Road
London SE1 7PH
Telegrams Aristides London SE1
Telephone 01-928 9222 ext

10 April 1984

Andrew Turnbull Esq
Private Secretary
10 Downing Street
LONDON SW1

Dear Turnbull,

SCIENCE BUDGET: PROPOSED JULY MEETING ON RECENT DEVELOPMENTS IN SCIENTIFIC RESEARCH

You invited me to send you a draft prospectus for the second of the briefing meetings to which the Prime Minister has agreed, which you thought might take place during July.

Our understanding is that the purpose of this meeting is to give the Prime Minister an opportunity to hear from researchers themselves an account of the new scientific opportunities open to UK researchers in a range of natural science disciplines. We would seek to assemble say 8 young but distinguished researchers (in standing, on the brink of becoming Fellows of the Royal Society or recently admitted), chosen in pairs whose fields were contiguous or related. The seminar, which might last two hours if the Prime Minister is willing and can afford the time, might be divided into four presentations of 10-15 minutes each given by one of each of the four pairs, on the state of science in their field. Each presentation might be followed by 10-15 minutes discussion during which the second of the pair could as occasion offered expand on the state of science in his area, if that is the way discussion led. In each discussion the starting point, and the main theme, would be the science involved although one would expect talk to develop quite naturally into wider questions such as the implications of the work, economic and social as well as scientific. What we would hope would be conveyed would be the character, scale and variety of scientific opportunities as currently perceived, in some of the currently most exciting areas. Thus the seminar would emphatically be about science, not about money. That is not to say, of course, that discussion of resource aspects would be absolutely ruled out; rather that the occasion is not intended to be a debate about the level of public expenditure on science.

I would seek, from the natural science Research Councils and (perhaps indirectly) from the Royal Society, the names of 12-16 people, spanning a range of disciplines, from whom the 8 participants might be drawn; with Sir Keith Joseph, Mr Brooke, Mr Hancock, Sir David Phillips and Dr Nicholson we would have, with the Prime Minister, 14 people. I would need, in seeking names and preparing a short list, to give what guidance I could on the likely timing and venue of the seminar.

I will take no further action until you let me know the Prime Minister's wishes; I am copying this letter to Dr Nicholson, our Private Offices and Sir David Phillips.

Yours sincerely

David Tanner

D W TANNER

Science & Tech

Sept 83

Science Budget

Advisory Board for the Research Councils
Elizabeth House 39 York Road London SE1 7PH

Telegrams ARISTIDES LONDON SE1 Telex 23171
Telephone 01-928 9222 ext

Laboratory of Molecular Biophysics,
Department of Zoology, Oxford OX1 3PS.

Ms. C. Ryder,
10, Downing Street,
London W.1.

Your reference

Our reference

Date 6th April, 1984.

Dear Ms. Ryder,

Thank you for your letter of 2 April inviting me to attend a meeting with the Prime Minister and others on 3 May to discuss priorities in the Science Budget. I shall be very glad to attend.

Yours sincerely,

David Phillips

David Phillips

cf

SCIENCE AND ENGINEERING RESEARCH COUNCIL

Polaris House
North Star Avenue
Swindon
SN2 1ET

Telephone 0793 26222 Telex 449466

Professor J F C Kingman FRS

Chairman

Miss C Ryder
Private Secretary
10 Downing Street
LONDON SW1

6 April 1984

Dear Caroline

Thank you for your letter of 2 April to the Chairman. He is pleased to be able to accept the Prime Minister's invitation to a meeting at 1800 hours on Thursday 3 May to discuss priorities in the Science Budget.

Yours sincerely

Andrew

A KURZFELD
Private Secretary

CONFIDENTIAL

W.0273 CP.

5 April 1984

Ms RYDER, No 10

Dr Nicholson will be very happy to come to the meeting at 18.00 hours on Thursday 3 May to discuss priorities in the Science Budget.

Val Meadows.

Secretary to Robin Nicholson,
Chief Scientific Adviser.

10

10 DOWNING STREET

From the Private Secretary 3 April, 1984.

I am writing just to confirm the conversation you had yesterday with Andrew Turnbull regarding a meeting the Prime Minister wishes to hold at Downing Street to discuss priorities in the Science Budget.

We have now arranged this, in consultation with you, for 1800 hours on Thursday, 3 May. We have invited Peter Brooke, MP, David Hancock, Dr. Robin Nicholson, Professor Sir David Phillips and Professor John Kingman to be present.

Caroline Ryder

Miss Elizabeth Hodkinson,
Department of Education and Science.

CONFIDENTIAL

D8

CONFIDENTIAL

10 DOWNING STREET

From the Private Secretary 2 April 1984

The Prime Minister wishes to have a meeting at 1800 hours on Thursday 3 May to discuss priorities in the Science Budget. The meeting would take place at Downing Street and she would be most grateful if you would attend. We are also inviting Sir Keith Joseph, David Hancock, Dr. Robin Nicholson, Professor Sir David Phillips and Professor John Kingman to be present.

Caroline Ryder

The Hon. Peter Brooke, M.P.

CONFIDENTIAL

10 DOWNING STREET

From the Private Secretary

2 April 1984

The Prime Minister wishes to have a meeting at 1800 hours on Thursday 3 May to discuss priorities in the Science Budget. The meeting would take place at Downing Street and she would be most grateful if you would attend. We are also inviting Sir Keith Joseph, Peter Brooke MP, Dr. Robin Nicholson, Professor Sir David Phillips and Professor John Kingman to be present.

Caroline Ryder

David Hancock, Esq.

CONFIDENTIAL

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Caroline Ryder

Dr. Robin Nicholson

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Caroline Ryder

Professor Sir David Phillips, F.R.S.

10 DOWNING STREET

From the Private Secretary 2 April 1984

The Prime Minister wishes to have a meeting at 1800 hours on Thursday 3 May to discuss priorities in the Science Budget. The meeting would take place at Downing Street and she would be most grateful if you would attend. We are also inviting Sir Keith Joseph, Peter Brooke MP, David Hancock, Dr. Robin Nicholson and Professor Sir David Phillips to be present.

Caroline Ryder

Professor John Kingman, F.R.S.

Sci + Tech: Science Budget

FILE SH.

bcc: Mr. Letwin

10 DOWNING STREET

From the Private Secretary

2 April, 1984

The Prime Minister has seen your letter to me of 29 March. She agrees in principle to holding two meetings. I am putting in hand the arrangements for the smaller meeting to discuss priorities within the science budget. The most likely date for this is 3 May.

We spoke about the larger meeting to discuss advances in science and the opportunities for research. The proposal your Secretary of State originally discussed with the Prime Minister was to invite the Chairmen of the Research Councils plus two or three others. With this number it would have been possible to arrange the occasion around a dinner. Your letter suggests adding a further 8-10 specialists in particular scientific fields. The format of such a meeting will need to be thought out very carefully if it is to be successful. You are now considering this and will come back with proposals. The target date for this would be early in July.

I am copying this letter to Dr. Nicholson (Cabinet Office).

MR. A. TURNBULL

Miss C. E. Hodkinson,
Department of Education and Science

Diary
3 | 4 | 5 July

CC NO.

DEPARTMENT OF EDUCATION AND SCIENCE

ELIZABETH HOUSE, YORK ROAD, LONDON SE1 7PH

TELEPHONE 01-928 9222

FROM THE SECRETARY OF STATE

Prime Minister (1)

Agree 2 meetings, each with a different purpose? I suggest the bigger meeting be arranged around a dinner or a lunch.

AT 30/3

CONFIDENTIAL

Andrew Turnbull Esq
Private Secretary
10 Downing Street
LONDON SW1

29 March 1984

Dear Andrew

SCIENCE BUDGET

With my Secretary of State's agreement I am writing to confirm the proposals recorded in the first two paragraphs of your letter of 14 March. We suggest that the first, smaller meeting should be about priorities and the processes by which the science bodies arrive at them. The second, larger, meeting should, by contrast, concentrate on recent scientific advances in particular disciplines and the kinds of opportunities that are opening up. For this we would propose, in consultation with Dr Nicholson, the Research Councils and the Royal Society, some 8-10 names of active researchers at the forefront of their subjects.

If this pattern is acceptable, we suggest that the first meeting might take place fairly soon - perhaps just after Easter; and that the second might follow some 8-10 weeks later. Attendance at the first meeting would be as proposed in your letter.* For the second meeting the Secretary of State would like Mr Brooke, Mr Hancock and Sir David Phillips to accompany him; and we would hope that Dr Nicholson would be present too. Dates may be a difficulty; would the next step be for your office to give us some suggestions, if possible with a choice for both meetings? For the second meeting we may have to fit the names to the date, so we will cast our net correspondingly more widely.

Yours,

Elizabeth

Miss C E Hodkinson
Private Secretary

ie. * Prime Minister — 26 April / 3 May
Sir K. Joseph —
Mr Peter Brooke MP — junior
Mr Hancock —
Dr Nicholson —
Prof. Sir David Phillips — Corpus Christi
Professor Kingman — Chairman SERC, Palace [illegible]
Sir [illegible]

Priorities in the Science Budget.

1 hr.

Science + Technology : Science Budget Sept 83.

30 MAR 1984

(2)

Prime Minister
To note
AT 28/3

PRIME MINISTER

REVIEW OF HIGH ENERGY PARTICLE PHYSICS

To complete our exchanges on the launching of this review I thought I should just let you and our Cabinet colleagues know that it was announced on 22 March and for the record I am enclosing a copy of the official report.

I amended the terms of reference as suggested by Norman Tebbit to make explicit reference to engineering research as part of the context of the review but did not feel able to ask the ABRC to amend its advice retrospectively. It seemed to me a clear-cut choice between publishing the full exchanges or none, and I preferred full publication. In my letter to Sir David Phillips about the review I stressed its constitutional distance from Government and here and elsewhere have emphasised that the findings of the review are in no way pre-empted.

I quite take Peter Rees' suggestion that the study should cover our domestic as well as our international expenditure on high energy particle physics, and should if possible make some assessment of value for money. I will see that this matter is brought to the notice of the Group.

Finally, on Geoffrey Howe's continuing concern over the composition of the review team and the need to secure some association with a specialist in high energy particle physics, I had further discussion with the two Chairmen. The result was that Sir John Kendrew asked Dr Christopher H Llewellyn-Smith if he would be an adviser to the Group. Dr Llewellyn-Smith is a Reader in theoretical physics at Oxford and was recently elected Fellow of the Royal Society for his theoretical work in elementary particle physics. He is well known at CERN and more widely in the high energy particle physics community and I hope that his involvement, plus full and open opportunity for the community to present evidence to the Review Group, will provide the reassurance for our CERN partners which Geoffrey was seeking.

Finally I should record some slight alteration in the composition of the Review Group. Sir Peter Hirsch was too busy to serve and I am glad to say that Professor Eric Ash FRS has agreed to fill that place.

I am copying this minute to Cabinet colleagues, and to Sir Robert Armstrong and Dr Nicholson.

KJ

28 March 1984

(2) if he will make a statement on the circumstances in which a North Scottish helicopter was involved in an air miss with military aircraft when the helicopter was airborne to the North sea oil platforms;

(3) if he will make a statement on the circumstances in which a British Airways helicopter was involved in an air miss with military aircraft when the helicopter was airborne to the North sea oil platforms.

Mr. David Mitchell: Air miss reports were filed by a British Airways helicopter on 13 March, a Bristow helicopter on 14 March and a North Scottish helicopter on 15 March. They referred to sightings of military aircraft in the area offshore north east of Aberdeen. These incidents are being investigated by the joint air miss working group, which is a joint civil-military element of the National Air Traffic Services. Its findings will be reported to me and made known to the aviation industry.

Hampstead Garden Suburb Report

Dr. Twinn asked the Secretary of State for Transport if he will now make the Hampstead garden suburb report publicly available.

Mr. Ridley: Yes, shortly.

Road Condition Survey

Mr. Leigh asked the Secretary of State for Transport whether he has received the report of the 1983 national road maintenance condition survey; and if he will make a statement.

Mr. Ridley: The report of the 1983 national road maintenance condition survey is published today. I have placed a copy in the Library of the House. This report, which does not cover motorways, shows that the general condition of roads in England and Wales has remained stable since the survey began in 1977. If anything, there has been a slight improvement.

Compared with last year the survey suggests that there has been a slight deterioration in the condition of trunk roads. It would be premature to conclude from one year's results that this will continue, but the Department will be closely monitoring the position. The structural renewal of motorways must remain our priority. The local highway authorities will, I know, be examining the condition of their own roads in relation to the national picture, as a guide to their maintenance priorities.

The standing committee on highway maintenance has established the NRMCS as an objective statistical basis for discussion of road condition and maintenance expenditure. I commend the report of the 1983 survey to all who have an interest in roads.

Personalised Car Numbers

Sir David Price asked the Secretary of State for Transport what are the current rates for the transfer of personalised car numbers.

Mrs. Chalker [*pursuant to her reply*, 19 March 1984, c. *335*]: There is a single rate of £80 per transfer.

Sir David Price asked the Secretary of State for Transport how much revenue is raised annually by the transfer fees for personalised number plates; and what happens to it.

Mrs. Chalker [*pursuant to her reply*, 19 March 1984, c. *335*]: In 1982-83 the figure was £2·1 million. The revenue is used to offset the running costs of the driver and vehicle licensing centre.

Severn Bridge

Mr. Frank Field asked the Secretary of State for Transport if he will make available details of the survey of traffic loading on the Severn bridge by time of day and day of week.

Mrs. Chalker [*pursuant to her reply*, 19 March 1984, c. *333*]: A report on vehicle weight and classification data, based on a survey over 27 days in October and November 1982, was prepared by the Transport and Road Research Laboratory. I shall place a copy in the Library.

Transport and Road Haulage Industries

Mr. McQuarrie asked the Secretary of State for Transport what representations he has received from the transport industry and road haulage organisations on the effect of the Budget on this industry.

Mr. Ridley: None, but I have seen the Road Haulage Association's press release commenting on the changes in vehicle excise duty announced by the Chancellor in his budget speech, and also the view of the Freight Transport Association as reported in the press.

1091

EDUCATION AND SCIENCE

Advisory Board for the Research Councils

Mr. Jackson asked the Secretary of State for Education and Science what advice he has received from the Advisory Board for the Research Councils, in particular as it bears on United Kingdom participation in high energy particle physics research; and if he will make a statement.

Sir Keith Joseph: I am today publishing the advice I received during 1983 from the Advisory Board for the Research Councils, and my correspondence with Sir David Phillips the chairman; I am arranging for copies to be placed in the Libraries of both Houses. That advice includes a careful discussion of the case for greater selectivity in our priorities for research and of the corresponding need to keep under review the competing claims of current and new areas of scientific opportunity. As part of this process the board has proposed that, with the Science and Engineering Research Council, it should review United Kingdom participation in high energy particle physics. Without prejudice to the attitude the Government may take to the findings of the review and the board's subsequent advice I have informed Sir David Phillips and Professor Kingman of my concurrence in their making the review; the text of my letter follows, together with details of the proposed terms of reference and membership of the review group.

21 March 1984

Dear David,

UK Participation in High Energy Particle Physics: ABRC-SERC Review

In the advice of the ABRC that you submitted to me on behalf of the Board on 23 November 1983 you recorded the Board's intention to review, with the SERC, UK participation in high energy particle physics research. In recognition of the implications that such a review might have for our membership of CERN, to whose Convention the UK Government is a party, you and Professor Kingman kindly consulted me on your detailed proposals for the review, and sought assurances that the Government did not wish to circumscribe the review; and that any savings identified by the review would be available for redeployment elsewhere in the Science Budget.

I give the assurances you seek in recognition that they are fundamental to the exercise, as being concerned with the best value for money from a given level of resources for scientific research. Thus any proposal for redeployment of resources devoted by the UK to high energy particle physics would be made on the basis that there were higher priorities in other areas of science. While the level of the Science Budget for any future year will, of course, need to be considered in the light of all the circumstances at the time, I can say definitely that any such proposal to which the Government agreed would not be made an occasion for cutting the Science Budget as a whole.

I am content with your proposal that Sir John Kendrew should chair the Review Group, and with the membership you propose. I appreciated seeing the terms of reference that you have in mind. I think that it would be helpful if they were made public when the review is announced and with your agreement and that of Professor Kingman I will do this. I am content with what you envisage but I regard the precise final form as a matter for you and Professor Kingman to settle with Sir John Kendrew.

In giving these assurances and concurring in the review I am conscious that it is to be a review by, and for, ABRC and SERC, not a Government review. I need not emphasise, for you, the constitutional distinction between the Board's advice on a matter and what the Government may decide on that advice. This distinction is particularly important in respect of any change that might be proposed in our relations with CERN, of which the UK is a full and active member. Any change in that position would be a matter for Government, to be considered by due process and in consultation with other members; and any question of change lies beyond the report of the Review Group, and any advice on that the Board and SERC may choose to offer. For now, it is business as usual.

I am sure that the Review Group will approach their task in a positive and constructive spirit and with a full appreciation of what has been achieved in this field, particularly through international collaboration, and of its future potential.

I am sending a copy of this letter to Professor Kingman.

Yours sincerely,
Keith Joseph

Sir David Phillips
Chairman
Advisory Board for Research Councils
Elizabeth House
York Road
London SE1 7PH

ABRC-SERC STUDY OF HIGH-ENERGY PARTICLE PHYSICS

Proposed terms of reference

Having regard to the long-term health of British science and engineering research and to the Common Criteria* for the support enunciated by the Advisory Board for the Research Councils in its Second Report, 1974-75:

(i) to review UK participation in the study of high-energy particle physics, with particular reference to that necessarily carried out under international auspices;
(ii) to consider possible future involvement, the role and extent of international collaboration, and the implications of reallocation of the resources in whole or in part to other areas of science;
(iii) to report to the Chairman of the ABRC and the Chairman of the SERC.

*see Annex.

Membership

Sir John Kendrew FRS will chair the Review Group. The following people have agreed to be members of the Group:—Sir Douglas Hague; Sir Jack Lewis FRS; Professor K. Pounds FRS; Sir Francis Tombs. There may be one or two more members. The Chairman has also invited Dr. Llewellyn-Smith FRS to act as adviser to the Group.

THE COMMON CRITERIA

1.* Councils and their Boards/Committees/Groups are invited to use the criteria listed here to discuss and compare relative benefits. Whenever practicable, reference should be made to objective data in support of the assessment (eg demographic data; social costs; relevant government expenditure etc.) in relation to the cost of the research.

Scientific Policy Criteria

(1) Excellence of study field
Where benefits are attributable to a high proportion of the research being intrinsically of high intellectual value.
(2) Excellence of the research workers
Where benefits are attributable to the exceptional quality of the individuals or teams to be employed in the activity.
(3) Pervasiveness of the activity
Where benefits include the impetus to advances in other and related fields of science in addition to the primary field.
(4) Social and/or economic importance
Where expected benefits arise from the work being directed to supporting social or economic aims.
(5) Significance for the training of scientific manpower
Where benefits will include training and experience for scientific research workers.
(6) Educational importance
Where benefits will include a contribution to education.
(7) Significance in maintaining national scientific prestige
Where benefits will contribute to national reputation.

Management Criteria

2. A set of selected management criteria are also offered. These apply to the consideration, from a management policy point of view, of alternatives which have already been assessed on the scientific policy criteria.

A. Efficiency of operation
Where improvements in organisation and/or plant would lead to a general increase in efficiency.

B. Obsolescence
Where the maintenace of a capability (at whatever level of activity) requires replacement within the Forward Look period of a major item of obsolescent plant or equipment.

C. Timing
Where a start on a new or increased activity within the Forward Look period is critical if the expected benefits are not to be lost or much reduced.

D. Dependence on Science Budget Support
Where there is likely to be limited support, national or foreign, available for work related to the activity except the Science Budget.

E. Availability of scientific manpower
Where an activity attracts priority by virtue of greater availability of scientific manpower for it (or its execution is constrained by lack of it).

F. Scope and limits of redeployment
Where the priority accorded to an activity is conditioned by difficulties or opportunities of redeployment.

*Extract from instructions to Research Councils, 1975 Forward Look.

1089

School Leavers

Mr. Teddy Taylor asked the Secretary of State for Education and Science if he will introduce legislation to permit children who have attained the age of 16 years to leave school before the appropriate school leaving date if they have a firm offer of regular employment; and if he will make a statement.

Sir Keith Joseph: The possibilities for change in the school leaving arrangements set out in the Education (School Leaving Dates) Act 1976 have been considered from time to time and remain under review. I believe, however, that the balance of advantage lies in leaving the present arrangements unchanged and in continuing to concentrate attention on making the curriculum in the final years at school more relevant to pupils' needs. Further

Science + Tech Sept 83
Budget

File

cc Oliver Letwin
+ FCO
DES
HMT
CO

MJ

10 DOWNING STREET

From the Private Secretary

27 March 1984

Dear Richard.

Review of High Energy Particle Physics

The Prime Minister has seen your Secretary of State's minute of 26 March. She recognises the distinction he is making between fundamental research and expenditure on development. She has commented, however, that expenditure on the latter of some £1,500m. is a very large sum.

I am copying this letter to Len Appleyard (Foreign and Commonwealth Office), Elizabeth Hodkinson (Department of Education and Science), David Peretz (HM Treasury) and Richard Hatfield (Cabinet Office).

Yours sincerely

Andrew Turnbull

ANDREW TURNBULL

Richard Mottram Esq
Ministry of Defence.

SLH

Le da
cDES

10 DOWNING STREET

THE PRIME MINISTER

27 March 1984

Dear Sir Alec.

Thank you for your letter of 21 March. I am glad to see that you approve of the way in which the proposed review of the United Kingdom's commitment to high energy particle physics is to be conducted. The choices are certainly very difficult. Nevertheless I think it is absolutely right to conduct such a review. Meanwhile I will await your more considered thoughts on the matter.

Yours sincerely

Margaret Thatcher

Sir Alec Merrison, D.L., F.R.S.

2/4/4

CC PL

Prime Minister (2)

To note

AT 26/3

PRIME MINISTER

REVIEW OF HIGH ENERGY PARTICLE PHYSICS

The Secretary of State for Education and Science copied to me his minute of 5th March and I have seen the subsequent correspondence.

2. I was content with what he proposed. I should I think comment on the comparison made by both the Foreign and Commonwealth Secretary and the Secretary of State for Education and Science between the £28-30 million contribution to CERN and my Department's net expenditure of £1840 million on research and development in 1982/83. This does not compare like with like. Defence expenditure on research in 1982/83 amounted to some £300 million, of which 42% was spent in industry and the universities. This itself is a sizeable sum but it does put the CERN contribution of £28-30 million in a different light.

3. The expenditure on development, some £1500 million, was directed at the procurement of specific defence equipments, aircraft, warships, weapons, etc, from industry. This is an entirely different activity from fundamental research. But it is a very large sum

4. Copies go to Cabinet colleagues and to Sir Robert Armstrong.

Ministry of Defence
26th March 1984

Science & Tech Sept 85
Science Budget

TELEPHONE: BRISTOL 24161

VICE-CHANCELLOR:
SIR ALEC MERRISON, D.L., F.R.S.

THE UNIVERSITY,
SENATE HOUSE,
BRISTOL,
BS8 1TH.

21st March, 1984

R23

Personal and Confidential

Dear Prime Minister,

Sir Keith Joseph told me yesterday of the proposed ABRC/SERC review of high energy physics.

A little later, when I have had time to reflect a little on the matter, I should like to write to you about this. But in the meantime, while I would be passionately opposed to the United Kingdom abandoning high energy physics, I thought I should say to you that I think the approach which is being adopted to this difficult problem is a very fair one.

While I am writing, can I congratulate you on the stand you have made in Brussels on EEC financing? I am a very convinced 'European' and it is precisely because of that that I feel this financial nonsense must be put right.

With all good wishes

Yours sincerely

Alec Merrison

The Right Hon. Mrs. Margaret Thatcher, M.P.,
Prime Minister,
10 Downing Street,
London S.W.1.

CCOL

NDPM

AJ 19/3

SECRETARY OF STATE FOR ENERGY
THAMES HOUSE SOUTH
MILLBANK LONDON SW1P 4QJ
01 211 6402

The Rt Hon Sir Keith Joseph Bt MP
Secretary of State for Education and Science
Elizabeth House
York Road
London
SE1 7PH

19 March 1984

Dr Keith,

PROPOSED REVIEW OF HIGH ENERGY PARTICLE PHYSICS

Thank you for sending me a copy of your minute to the Prime Minister, and for inviting my Department to be represented on the shadow group of officials that will keep in touch with the proposed review.

My Department has no direct interest in high energy particle physics and so I have no reason to object to the proposed review. At the more general level, I am, however, interested in the parallels between a review of the UK participation in CERN and the Department's responsibilities for the UK involvement in the Joint European Torus (JET). Both JET and CERN are held up as shining examples of the benefits of pooling international effort on the most advanced scientific research. So any conclusions reached on CERN could have implications for future negotiations on JET. For this reason, I welcome the opportunity for my Department to be represented on the shadow group and nominate my Chief Scientist, Dr Pooley, who already represents the Department on ABRC.

Copies of this letter go to Cabinet colleagues, Sir Robert Armstrong and Dr Nicholson.

Yours,
Peter

PETER WALKER

Science & Technology : Science budget Sept. 83

CONFIDENTIAL

Prime Minister

To note. You may wish to look at the record of the 19 October meeting which is attached

AT 16/3

PRIME MINISTER

REVIEW OF HIGH ENERGY PARTICLE PHYSICS

Now that you, Geoffrey Howe and Peter Rees have consented to my agreeing that the ABRC and SERC should make this review the way is clear for an announcement. I thought I should let you and colleagues know that I propose to do this by written Parliamentary Answer on Thursday 22 March. At the same time I would announce publication of the ABRC's 1983 advice. I am also taking the other steps outlined in my minute to you of 5 March.

Colleagues have raised some detailed points about the review which I am considering and about which I will, where necessary, be in touch with them separately. But Geoffrey Howe, in his minute to you of 13 March, raised a major matter which deserves comment here, namely his anxiety about the effect of setting up a review on our European partners. I fully understand and respect his anxieties. Indeed, it would cause me no pleasure at all to see the UK withdraw from CERN. Its work is of the highest scientific quality - research at the frontiers of knowledge - and our scientists and engineers have made a very distinguished contribution to it. For the UK to cease to do science in this area would be a distinct sacrifice of our cultural heritage. Even so, I think that we must now be willing to contemplate the possibility.

In paragraph 5 of his minute, the Foreign Secretary points out that our contribution to CERN is not a large sum by comparison with what the Government spends on defence research and development. That is indeed true, as I pointed out in my minute to you of 15 September 1983 on maintaining the strength of the science base. We discussed my minute with Michael Heseltine and Peter Rees at No 10 on 19 October and it was felt that the case for expanding the Science Budget had not been made out.

My decision now to agree to a review of our involvement in HEPP was strongly influenced by that outcome - because the total cost, some £50 million a year, is by no means small when related to the cost of new scientific opportunities in other fields which the Research Councils are now unable to fund from the resources that the Government has allocated to them.

I am sending copies of this minute to Cabinet colleagues, and to Sir Robert Armstrong and Dr Nicholson.

KJ

16 MARCH 1984

SCIENCE + TECH. Science Base
Sept 83

CONFIDENTIAL

file ECL

cc Oliver Letwin

10 DOWNING STREET

From the Private Secretary 15 March 1984

Dear Brian,

High Energy Particle Physics

The Prime Minister has seen the Foreign Secretary's minute of 13 March. She recognises the difficulties which he identifies and accepts that it is right that they should have been brought to the attention of colleagues. Nevertheless she feels that it is necessary to conduct the review and to take the precautions suggested by the Secretary of State for Education and Science in order to minimise the adverse reaction from our partners in CERN.

I am copying this letter to Private Secretaries to members of Cabinet, to Richard Hatfield, Cabinet Office and to Dr Nicholson.

Yours sincerely
Andrew Turnbull

Andrew Turnbull

Brian Fall Esq
Foreign and Commonwealth Office

ECL

File

BP

cc Oliver Letwin

cc MASTER SET

10 DOWNING STREET

From the Private Secretary

14 March 1984

Dear Elizabeth,

Science Budget

When your Secretary of State came to see the Prime Minister today he suggested that in order to help her understand the difficult issues of priorities within the Science Budget, she should have a tutorial with the scientists most closely concerned rather than receiving reports second-hand through him. He recommended that the Prime Minister call a meeting with Sir David Phillips, Professor Kingman and Dr. Nicholson. He, Mr. Brooke and Mr. Hancock could also attend.

The Prime Minister wondered whether it would be right to confine the discussion to a narrow group which excluded scientists from a number of disciplines. An alternative would be a lunch or dinner for the Chairmen of all the Science Research Councils plus Sir David Phillips, Sir Henry Chilver and Professor Huxley. Your Secretary of State pointed out that discussion with this larger group would serve to keep the Prime Minister abreast of developments in scientific research but would not be the best way to talk about priorities. There would be a tendency for the different Chairmen to argue in defence of their areas, which would tend to undermine the work of the adviser particularly in defining priorities. It was agreed that there were two separate objectives which might lead to different meetings. Your Secretary of State agreed to reflect on this.

Your Secretary of State then raised the question of the low level of awareness in schools of the economic facts of life - among pupils, teachers and those teaching teachers. An earlier meeting of Ministers had considered what could be done to correct this. As a Minister, he was putting proposals to the Curriculum Council, the aim of which would be to ensure that there were some teaching of economics in schools in a practical rather than theoretical way. He regarded this, however, as a limited initiative.

He was also considering with Lord Cockfield and Sir Christopher Lawson what more could be done. Sir Christopher had proposed that an assessment, using opinion survey methods, be made of economic awareness in schools, and how this compared with experience on the Continent. When this was available Sir Christopher would discuss

/ the results

BP

the results with your Secretary of State and Lord Cockfield to see what practical steps could be taken to tackle the problem. Sir Christopher thought that business would be happy to finance this proposal which might cost £10 - 20,000.

The Prime Minister was content with this suggestion but was sceptical about what new the survey might reveal.

Yours sincerely

Andrew Turnbull

(Andrew Turnbull)

Miss Elizabeth Hodkinson,
Department of Education and Science

cc PL

(2)

Prime Minister

To note FCO concerns, though I do not think you need withdraw your endorsement of the review as these attitudes were known when you saw the papers.

AT 13/3

PM /84/48

PRIME MINISTER

Review of High Energy Particle Physics (HEPP)

1. Keith Joseph copied his minute of 5 March to you on this subject to Cabinet colleagues. I have sine seen Turnbull's letter of 8 March to Miss Hodkinson in the Department of Education and Science, giving your assent to what is proposed. As Keith Joseph says, he gave me warning of what he had in mind and I expressed my misgivings. You are aware of them too. But they are considerable, and other colleagues may wish to be aware of them also.

2. Though we may hope to limit the damage resulting from an announcement of the proposed review, there can be little doubt that it will be seen by many as heralding our withdrawal from CERN. Our partners in CERN, in particular France and the FRG, consider it a project of prime importance and President Mitterrand has emphasised his personal attachment to the project. We are unlikely to be able to persuade them to regard the review in a positive light.

3. Of course the consequences would be much more serious if the review were to lead to a decision to withdraw from CERN in due course. In the wider political context, our reliability as partners in European high technology programmes, industrial as well as scientific, will be calledinto question. Our recent decisions on the Airbus and Esprit have gone some way to offset the doubts some hold about our commitment to European collaboration, but the proposed review will revive them. We risk encouraging a more exclusive relationship between France and Germany as the two major powers in Europe with, as they see it, a vision of the future.

4. Our standing is likely to suffer more widely. The remarkable scientific advances of CERN, and the UK contribution to them, have

received global recognition. We risk indicating that we are ready to opt out of the small group of nations that take a leading role in scientific and technological advancement. This will affect how other counties regard us, and our attraction as a supplier of high-technology products.

5. I do not minimise the financial constraints which have led us to this point. But neither should the cost burden be exaggerated. Our contribution to CERN, at some £28-30 million a year, compares with Ministry of Defence net expenditure on research and development in 1982/83 of £1840 million. This is at a time when the R&D budgets of the Department of Trade and Industry and the Department of Energy were £257 million and £213 million respectively. The preponderance of expenditure in the defence field undoubtedly puts great pressure on other R&D budgets, and I wonder whether we have got our priorities right when we are brought to contemplate terminating UK involvement in a whole field of scientific research involving a relatively much smaller sum. This imbalance in our R&D expenditure is highlighted in OECD comparisons - the latest figures show that over half of the UK's government-funded research is on defence, while for the French it is about 36%. There is of course a further, even more striking contrast with the Japanese, - less than 3%.

6. One particular point which I have already raised with Keith Joseph continues to worry me, and that is the composition of theproposed review team. We need to persuade our partners in CERN that the team approaches its task with an open mind. I fear that a group charged with a review of high energy particle physics which includes no specialists in that discipline will not be regarded in this light, however distinguished its members may be in their own fields. Keith Joseph has told me why he finds it difficult to include such people, but I hope he will agree to look at it again.

7. I am copying this minute to Cabinet colleagues, and to Sir Robert Armstrong and Dr Nicholson.

GEOFFREY HOWE

Foreign and Commonwealth Office

13 March, 1984

Science & Tech Sept 83

Science Budget

CC Manpower: Special Employment Measures.

PRIME MINISTER

Meeting with Sir Keith Joseph

Sir Keith wants to talk about two subjects:

(i) Economic awareness. At the Seminar in September it was argued that the level of awareness of the economic facts of life in schools - both pupils and teachers - was lamentably low. Sir Keith Joseph undertook to discuss with Lord Cockfield and Sir Christopher Lawson how this might be rectified. Sir Keith will report on the outcome of those discussions.

(ii) Science budget. When, during the course of the bilaterals, Sir Keith was bidding unsuccessfully for additional resources for the science budget, he suggested that he might write to the Chancellor proposing that some of the big spending programmes (he mentioned agriculture in this context) should be reviewed to see if any savings could be made which could be devoted to the science budget. He felt that small savings on the larger programmes could make a significant impact on the science budget. You agreed that he could write to the Chancellor along those lines. I understand that he will be doing this shortly. I expect he will want to talk to you, away from the pressures of the Public Expenditure Survey, on the case for increasing the science vote. He might suggest that you hold an informal meeting with Dr. Nicholson, Sir David Phillips and Professor Kingman to establish whether it really is the case that good research projects are being turned down for want of resources.

You are aware of Sir Keith's proposal to establish a review of high energy particle physics. I have minuted out indicating your agreement to this. Since then, the Foreign Secretary has

/ minuted

minuted expressing his concerns. Since these were fully documented in the papers Sir Keith sent you I see no reason to change your view that a review of CERN would be beneficial.

AT

13 March 1984

Amended

cc DL

IS SCIENCE MANAGEABLE?

The Mond Lecture - Delivered by Professor Sir Douglas Hague
at Manchester University on 12 March 1984

Last June, I went on holiday to Scotland assuming that I should come back to run courses in Oxford for top managers. When I returned, two weeks later, I had agreed to become Chairman of what is now the Economic and Social Research Council. Thereby hang at least two tales, but I do not intend to tell either this evening.

The third tale I will tell. I realised of course that in my new role I should have responsibilities covering the whole of the social sciences. What I had not appreciated was the extent to which I should be involved with the natural sciences, engineering and medicine. In particular, chairmanship of my Council involves membership of the Advisory Board for the Research Councils (ABRC), which is responsible for advising the Secretary of State for Education and Science on the total size of the Science Vote and on the way in which it should be divided up between the research councils. As a result, I have become directly involved in the difficult problems of the funding and organisation of scientific research in the UK.

I regard it as a great honour to follow so many distinguished scientists in giving this lecture. I am equally honoured to have been asked to give it by the University of Manchester, an institution for which I have nothing but admiration and respect. I spent nearly twenty very happy years here during the period when we set up Manchester Business School, establishing it as one of the leading business schools in Europe and indeed the world.

Given that experience, I naturally looked at the working of the ABRC with the eyes of a management scientist, something which seems never to have happened before. What struck me at once was that we were concerned with what, to me at least, appeared managerial questions. Yet we were not seeing them as such. I went back to reread C P Snow's The Two Cultures. Snow, you will remember, spoke of "two groups - comparable in intelligence, identical in race, not grossly different in social origin, earning about the same incomes, who had almost ceased to communicate at all".(1)

(1) CP Snow, The Two Cultures, University of Cambridge Press, p2, 1964 edition

He later said "The degree of incomprehension on both sides is the kind of joke which has gone sour.".(2)

Like Snow, I still see a clear difference between the way that scientists look at issues and the way that I do. I would not, however, regard myself as belonging to the arts culture. While Snow contrasted the cultures of science and the arts, one of the points on which he was most criticised was the implication that there were two cultures only. He pointed out in the 1964 revision of The Two Cultures, that the only word in the title which was not attacked was 'The'. As he says, the implication was that the title Two Thousand and Two Cultures would have been better. Snow insisted that the number of significant cultures really is very small. He was, however, prepared to accept that there would be soon, if there were not already, a third culture - that of the social sciences. Snow himself here included social history, sociology, demography, political science, economics, government (in the American academic sense), psychology, medicine, and social arts such as architecture. Though recognising that it was "a mixed bag" he saw "an inner consistency. All of them are concerned with how human beings are living or have lived.".(3) I should myself make a further distinction. That is between social sciences like economics and sociology and professional subjects like accountancy and law. Management - which is to be a major topic this evening - is a hybrid. It draws heavily on those social sciences that can be used to help analyse the business environment and the elements in business problems. It also draws on mathematics, accountancy and law which have more specific contributions to make - especially to business-decision taking.

The social sciences still have a long way to go before they can be recognised alongside the natural sciences, not least because one cannot easily carry out valid experiments. Nevertheless, the outlook and the approach to problems which the social sciences have given me over the years provide a distinctive approach to problems which is that neither of the scientists nor of the mainstream arts man.

Perhaps what brought home most clearly the great divide between the thinking of the natural scientist and the social scientist was this. For reasons

(2) ibid, p11

(3) ibid, p70

I do not need to go into, I recently circulated a short paper on the role and activities of the ABRC to a number of scientists to get their reactions. Almost to a man, they insisted that they found what anyone from a business school would regard as a totally conventional approach, as verging on the incomprehensible.

The fact that the inhabitants of these "cultures" have difficulty in communicating would be less serious if we did not live in a rapidly changing world. It is during periods of rapid change that we most need to communicate about what is going on and least succeed in doing so.

The changes are complex and interconnected. They are difficult to understand and to explain. For today's purposes I believe we can make sense of what is going on in the UK if we pick out three.

First, and most important, we are entering a period of rapid technological change. There are bound to be independent economic and social changes, but I believe that much of the change in the 1980s will be driven by technology, not economics. Walt Rostow, the distinguished American economist/economic historian describes this as the fourth industrial revolution - the information revolution. Around 1970, we came to the end of Rostow's third industrial revolution - that associated with oil as a fuel, the motor car, consumer durables (like domestic equipment, radio and television), plastics, man-made fibres, etc.

Rostow's fourth revolution will do two things in particular. First, it will enable us to refurbish manufacturing industry. Older industries like steel, automobiles and engineering will, by using robots, increase output per man and reduce costs to stay competitive even with industry in countries like Japan and South Korea. Second, a new range of high-technology industries will develop, many concerned with the information revolution. I think especially of consumer electronics, electrical activities like the production of cables, switching equipment and micro-wave communication equipment, as well as aerospace, especially communication satellites. We can also look forward to dramatic developments in biotechnology. The fourth industrial revolution may also see the development of alternative sources of energy.

We are, in more senses than one, in a period like the 1930s. As then, the industrialised world faces high unemployment. As then, though we have less excuse, economists are profoundly gloomy about the possibility of creating future employment. In the 1930s, they talked of secular stagnation, implying that economic history had come to an end. Everything that was to be invented already had been invented. I well remember, when I was a student in the 1940s, how writers on economics insisted that all we could do was to spread the existing standard of living to the last Chinese coolie. Then, "The economic problem would be solved.". Even Keynes mistakenly wrote of "making capital cease to be scarce within a generation". He (and they) had misread the importance of technological change.

The reason why economists got it wrong then was that they largely ignored science and technology. That is why most economists still get it wrong today. Whether disciples of Keynes or Friedman, they are obsessed with how to manage national demand. Problems of supply - and especially the role of technological change - are largely ignored. The writings of Schumpeter, the Viennese economist who stressed the role of invention and innovation in economic development, go largely ignored by professional economists. We let the 1950s and 1960s take us by surprise. There is no need to let the 1990s do the same.

I am therefore more optimistic now that I would have been in the 1930s. I see - as other economists should have seen both then and now - a new wave of technological development, leading to more rapid economic growth.

But I may be wrong: not about the fourth industrial revolution - which is a certainty - but about our ability to take advantage of it in a changing world. This is the second important change which is affecting us. In the 1950s and 1960s we were able to create jobs and prosperity throughout Western Europe by cashing in on the third industrial revolution. We did so because Western Europe and the United States dominated the industrialised world. This is no longer true.

The area of most rapid industrial development in the remainder of this century will be the Pacific. There is not only Japan, herself a formidable-enough competitor, but also of other newly industrialising countries. Not least, there is what Paul Samuelson calls the 'Gang of Four' -

Singapore, Hong Kong, Taiwan and South Korea. We in the West will not have the fourth industrial revolution to ourselves in the way that we did the third.

Also on the international front there is the problem of oil. The two big oil price increases in 1973-74 and 1978-79 diverted both demand and wealth from the developed countries to OPEC, and especially to the oil producers around the Arabian Gulf. The economic problems this has caused have been serious. However, since they are basically problems of finance and demand they are not germane to this lecture because I am concentrating on technology.

The third element I wish to highlight turns out to be the joker in this pack. It is what has come to be called the post-industrial society. There seem to be two schools of thought about this. The first, wracked by fears of a "deindustrialisation" denounces the notion as unthinkable or, should it nevertheless become a reality, undesirable. The second group accepts the post-industrial society as inevitable but, with few exceptions, fails to understand it.

This has been forcibly brought home to those willing to listen by work in the Science Policy Research Unit at Sussex University. In particular, there is an important book Social Innovation and the Division of Labour by Jonathan Gershuny. Gershuny characterises the conventional view of economic development as comprising "a march through the sectors". Economies begin by concentrating on primary production - agriculture and minerals. They then move into the industrial phase where the primary sector provides food and raw materials for an industrial sector which dominates the economy. Then, in the post-industrial society, the industrial sector shrinks and, in turn, domination of the other two sectors by service activities begins.

Gershuny points out that what actually happens is much more complicated. He does not quarrel with the characterisation of what happens in the primary sector. It is one which, as economic development takes place, represents a smaller and smaller proportion of both output and employment. The complexity arises over the relationship between manufacturing and service activities, which are not separate, but linked. When the conventional wisdom talks of services it confuses two things. First, there are final services. Those in the private sector include restaurant and hotel meals and accommodation, like haircuts, entertainment, etc. In the public sector are the services which we normally refer to as the 'welfare state'. All of these are final services.

This conventional wisdom leaves out two things. First, there are what Gershuny calls intermediate services. Thus, for example, when we pay for a motor car we buy not only the product itself but also the services of large numbers of people carrying out service activities - people working in garages, or showrooms, in advertising etc. There are also consumer intermediate services providing advice, equipment and maintenance to households. For example, these maintain washing machines, refrigerators, TVs, videos and will in future deal, for example, with computer programmes. This must be a major growth area during the remainder of the century.

While you may not have thought of all this complexity for yourself, none of it will strike you as surprising. Here, however, Gershuny adds a new twist to the analysis. First a slight digression. We can distinguish four types of occupation. First, there is formal employment by an employer: what we call "work". Second, there are three types of informal activity. Some of this activity takes place inside the household, with members of the family working for others; some takes place within voluntary organisations; and some takes place within the underground, or "black" economy.

Gershuny's twist relates to the household, which is much the most important of these informal sectors. As economies become richer, economic forces mean that a growing proportion of the population does <u>not</u> buy final services directly from those in formal employment. Instead, individuals and households provide many services for themselves - doing their own cleaning instead of using domestic servants; cooking meals instead of going to restaurants; transporting themselves by car instead of using buses or trains; and so on. Indeed, Gershuny's twist goes further. In order to provide most of these services the household will have to buy capital equipment - what we call consumer durables. The capital equipment is then used in the informal not the formal economy. This has two results. First, output in manufacturing industry is higher than one might suppose when one is talking of a shift towards service activity. Second, there is a shift from formal to "do-it-yourself" employment in the household. Employment and unemployment figures are no longer quite what they seem. We can choose either to work longer and then buy more final services directly, but usually expensively. Or we can work less long, earning enough to buy vacuum cleaners, washing machines, lawn mowers etc and then take off sufficient time to do our own housework and gardening.

Now that Gershuny has pointed all this out so clearly, we can recognise that we have been moving through this kind of phase for some time.

The fact that we have passed substantially through the phase where we were buying consumer durables, television sets and videos means that the products of the new industrial revolution are appearing at a time when a new market is conveniently opening up for them. We could not have afforded to spend money on micro-computers, cable television, etc if we were still buying motor cars, TV sets or videos.

To sum up, the post-industrial society will be a very complicated one. There will be markets for the products of high technology industry both in business and in the household. You must expect the information revolution to lead, as the consumer durable revolution has done, to competition between the household and final services - even final services currently provided by educational institutions. It will be possible to receive much of the education currently provided by a university while sitting at home with a TV set, video and mini-computer. Perhaps too few of us have taken on board the fact that the information revolution will compete with apparently quite disparate activities. I suspect that the universities are going to find it immensely difficult to come to terms with the information revolution.

One can put the situation in what is undoubtedly an over-simplified way, but one which should give us pause for thought. We may say that the problem for manufacturing business is that it will have to compete with the Pacific. The problem for service industries is that they must compete with the household. The problem for the universities is that they will have to compete with the information revolution.

As you know, I gave this lecture the rhetorical title, Is Science Manageable? I want to make clear at once that the word "science" certainly includes technology. Beyond that, I think I have shown already that scientific, and especially technological developments during the rest of this century will pose threats and challenges that will be extremely difficult to manage.

In answering my question, I could clearly address myself to all or any of a huge field. Since I am speaking in a university I propose to answer the question with respect to two particular fields. First, can those of us who have to do the job "manage" the educational system in such a way that Britain makes a success of the fourth industrial revolution? Second, at the national level, can those of us who are responsible for individual research councils or for the research councils as a whole "manage" what we are doing there?

So far, I have not tried to say what I take the word management to mean. In particular, what is it that management education can and does teach us? Professor Leavitt, an eminent American management scientist, gave the Stockton Lecture at the London Business School, last year. I agree with him in seeing management education as having gone through three phases. I speak only of the UK, though he spoke of the USA as well. One phase, which in Britain had its heyday in the 1960s and early 1970s, put great emphasis on techniques, often mathematical, which permit rational decision taking. These techniques were relatively easy to teach and learn because, being formal, they could be taught formally in the classroom or read about in a book by even those with fairly limited mathematical knowledge.

Two major problems arose from this. First, the analytic problem solvers thus produced were mainly economists, accountants or operational researchers and they thought on the grand scale. They could decide on the optimal way of operating a large system, for example by using computers to apply linear programmes. Some of them even believed that a very large number of human beings in an organisation could be replicated and managed equally well by those who applied rational thought.

As Leavitt points out, this kind of expert - whether in a business or a business school - found it difficult to cope with a second group of people - the implementers. The implementation phase began earlier than the decision-making phase, and is still with us today. Those concerned with implementation - mainly psychologists and sociologists - did not live too easily with the problem solvers. The problems solvers saw reason as good and emotion as bad. And they saw the implications as excessively concerned with emotion. There was therefore a conflict, though it has probably proved fruitful and productive, rather than the opposite.

Inevitably, the rational analyst takes the view that one first decides on the solution to a problem and then decides to implement it. That is what many of the management text books say including, I must admit, my own. But the fact that business schools tended to produce <u>either</u> those who specialised on planning and decision making <u>or</u> those who were concerned with emotion, working and implementation led to problems. I quote Levitt. "Although it makes logical sense to solve the problems first and then to implement the solutions, it does not make psychological sense to do so within organisations. The reason is that in organisations many human beings are always involved in the process. If the human bodies doing the problem solving and the decision making are a different set from the bodies assigned to carrying out the decisions, trouble will follow."

Problem solvers, of course, are unhappy about this, as I frequently discovered when chairing meetings in the Business School. Being "democratic" in decision making slows everything down. Moreover, the decisions, being committee decisions, may well be mediocre. The decision makers complain that good, clear decisions which they propose are ruined by the trade-offs and compromises of the implementers.

As time passes, I believe that these tensions are being reduced. In particular, I believe that the business schools are beginning to produce graduates who have the qualities both of the problem solver and the implementer. Perhaps one reason is that the success of the Japanese both undermined the self-confidence of the problem solvers and showed the importance of good implementation.

The information revolution is helping as well. In both the high-technology sectors of the economy and in service activities we are less and less willing to use people basically as machines. Even the degree of control that time and motion studies and the like gave over people disappeared. In a different context, ranged along a spectrum from the large, mass-production company to the small, entrepreneurial company operating as an innovational team, the conflicts between the problem solvers and the implementers are being contained, if not eliminated. Indeed, a residual degree of tension is perhaps necessary to maintain vitality.

A third, and new, phase has now begun. Certainly in the UK a surprising number of people now talk of the need for leadership. Leadership is a word that went out of fashion after the war, perhaps because it implied the need for organisations like those used by the military where they seemed unlikely to work. Leadership is now coming back. I suggest that this is because, in a changing and perplexing environment, we accept that someone has to show the way. We are concerned with what, in his Stockton Lecture, Leavitt called pathfinding.

In a strategic leadership programme which we have designed at the Oxford Management Centre, we have concluded that the successful leader, whatever his field, requires drive and determination, intelligence and/or commonsense, an ability to communicate, and luck. Respect from his colleagues, earned from mastery of his own technical field, also helps. In the Oxford course, we emphasise the need for the leader to learn about him (or her) self, by developing basic skills like self-organisation, by working within his own temperament, by getting the best out of others, by developing efficiency, integrity and enthuasiasm in himself and others, and so on. Above all, we see leadership today as requiring an ability to motivate teams of people and make them effective. This is especially true in high-technology activities where those concerned will often be highly trained, at least in technical subjects where, in many ways, the high-technology team is one of equals. The leader today cannot be isolated from his team.

Leadership today requires the formulation and implementation of effective strategy, with much more emphasis than before on the need to design organisations which will work effectively in a changing world. Leaders must understand, more than perhaps they needed to do in the past, issues like organisational behaviour and organisational design.

I would therefore contend that the business schools now have a good deal to teach us about designing and leading effective businesses, within which decisions can be taken logically and implemented satisfactorily by blending the qualities of the problem solver and the implementer. Increasingly, I believe, these qualities will be blended through those of the leader - the pathfinder.

I have now laid the groundwork required to answer my self-imposed question: is science manageable?

First, the business schools. It has not been easy, even in the past two decades, for the business schools to work out what to do. They now face their biggest challenge - but correspondingly their biggest opportunity. British business schools have not yet really come to terms with production management. True, as I have already explained, manufacturing businesses perform a wide range of service activities, and the business schools have certainly made a contribution there. But the truth is that British business schools do not have a structure which is fully appropriate for helping manufacturing businesses. To the extent that they dealt with manufacturing at all, British business schools were concerned with the content and processes of manufacturing. The specific problem of manufacturing is how to manage a situation in order to make well-designed products more effectively. But manufacturing departments also have to be integrated effectively into the rest of the business. I have recently discussed these issues with a major multinational company. This has led me to take the view that while the problems of marketing, systems theory, personnel, organisational development, finance and accounting are all important, their teaching has not yet moved to a stage where it does enough to treat the manufacturing company as a coherent whole. Training for manufacturing industry must enable the business to manage this process of integration with increasing effectiveness.

For example, one result of the approach which the business schools have taken is that purchasing, which covers perhaps between 30-40% of total turnover in a manufacturing business, is virtually unrepresented in British business schools. There is only one chair of purchasing in the UK, and none in a major American business school.

Similarly, since business schools concentrate heavily on the service activities linked to manufacturing, this affects the way business schools look at the strategies of their own organisations. It is likely that those who are expert in systems theory, finance, industrial relations and organisational development will play major roles in determining the strategy of a business school rather than those concerned with production. The multinational I consulted takes the view that this is "an upside-down reflection of the realities of manufacturing business .... manufacturing is only a part of British business but it is probably where our problems are most serious and where we are also historically least able". It is surely overstating the case to go on as they do to argue that the British seem to have a natural flair for banking, insurance and shop-keeping. Nevertheless, the grain of truth in even that comment is bigger than I would like.

Even at Manchester Business School (MBS), we failed to build up any real rapport rapport with what I shall describe as the metal bashers. We have been more successful with the process industries. For example, we worked with two major companies to develop our Operational Management Course which goes from strength to strength. But we found it much easier to develop relationships with the banks, especially the international banks.

The problem with the "metal bashers" was, I think, that we in the business schools saw their problems as intellectually uninteresting - though they were difficult enough in all conscience. They saw us as intellectually arrogant and bored by practical problems.

Our record in building up relations with manufacturing is not strong. Yet there is now a paradox. This is that the business schools may prove soon to appear weak even in what they now see as their area of greatest strength.

I refer again to my multinational business. It takes the view that the business schools are rapidly becoming out-of-date in systems ideas; that the impact of cheap computing power may be pushing the technology of information systems to a level which is beyond even the intellectual understanding of those in business schools. In their view, business schools are missing out as agencies in teaching information technology. Three years ago information technology might have been taught in a business school. Now, major companies claim that they have to go to a computer manufacturer or a private consultant instead. When it comes to understanding how to integrate manufacturing - and also science -

into the business and to identify the appropriate technology for its systems, there is a danger that British business schools will actually be left behind their clients.

We at MBS failed to understand the metal bashers, because we were intellectually arrogant. To the extent that we built up rapport with the process industries, we did so, roughly, as equals. So we did with the banks. I do not believe that business schools will find it easy to build up relationships with the high-technology industries in a situation where they will now frequently be intellectual inferiors.

This is the nature of the challenge, and perhaps it applies to science and technology as well. In the multinational I have been quoting, ten years ago one of their factory managers would not necessarily have been a graduate. Now, the job cannot be done unless the manager is a PhD. Perhaps it is <u>they</u> who are now becoming intellectually arrogant, but the high-technology industries are increasingly arguing that even those with engineering degrees are now insufficiently creative to deal with the attitudes, knowledge and skills required in systems management and systems engineering. The criticism is that instead of doing what is required, the universities invariably deal with facts, because facts can be treated in traditional ways.

Business schools and university engineering departments seem now to be under similar criticism. They are under criticism from the industries of the future, industries in which those engaged would argue that systems practice has raced ahead of systems theory.

Now for my punchline. Since both engineers and business schools are under criticism from the same source, they have a joint opportunity. Especially in universities like Manchester, I should like to see - and would strongly support - a determined effort. This would bring together business schools and science and technology faculties in a three-fold endeavour.

First, there should be research. If, as I am told is the case, modern systems are too expensive to duplicate in universities, then this will have to be a joint effort with high-technology industry. It will be better, not worse, for that.

I am, I suppose, talking here of basic research. The business school probably has less place than with any of the other issues I shall discuss today. It really does seem to be a case, as was once said in another context, of having to cast one's bread upon the water hoping that some of it will come back buttered. Second, there is development with an even bigger challenge and opportunity. Again I would like to see collaboration between science and technology faculties in business schools. Again, I would like to see them collaborate with business. Whether or not we could replicate modern technological systems within universities, or indeed the management problems of science-based businesses, is beside the point. There is no need. Development and application can best be done on site, in collaboration with those who work there. Maybe we should begin in a small way. Maybe the best instrument is the teaching company scheme of the Science and Engineering Research Council, with which I hope my own Council will increasingly collaborate. I believe that business schools could make a major contribution here. We, in Manchester, have a long record of "action research", or "action learning". In technological development one is not dealing simply with physical phenomena. One is also dealing with people in organisations, and that is where the business schools have strength. There is enormous scope here for genuine collaboration both within the university, and between the university and business.

Third, such collaboration would link both back into research and forward into teaching. It would link back into research because good theory is the foundation of good practice. It would link forward into teaching, because teaching could then be based on genuine understanding of current practice and current problems. Indeed, I would go further. I hope that "action learning" will play as big a part in degrees in science and technology as it already does in the business schools' MBA programme. And teaching (learning) must be <u>genuinely</u> interdisciplinary.

We do not need to restrict ourselves to Manchester. I have done so this evening partly because I see Manchester as having as much potential for giving leadership in this direction as any other university. I have done so also because we are in Manchester. But I should like to see similar developments pursued elsewhere, not least in Oxford and London. Collaboration, perhaps between the London Business School or the London School of Economics and Imperial College must have potential.

Then there is Oxford. Admittedly, there are times when I am convinced that Oxford will make no major contribution to management education during this century. But I should like to be proved wrong, and am delighted to see that my colleague Michael Earl has recently established the Oxford Information Management Institute. But this is only the beginning. Perhaps the best next step is to ensure increased collaboration between those who teach science and engineering and those who teach management. In Oxford, and I suspect in many other universities with the enhanced engineering degrees, there still seems to me insufficient collaboration in teaching. Perhaps the best way to move towards effective collaboration in teaching is through developments in research of the kind I have outlined.

In this context, then, my answer to my question - is science manageable? - is that it must be. These developments will not happen by themselves. We must have a vision. We must then manage the achievement of that vision with determination. I hope that what I have said today may provide a spark both to such vision and to such determination.

I now move on to even more difficult problems though, having listened to me, you may wonder if that is possible. As we move on to the national level, though, there is a problem of comprehension, of understanding, as well as one of management. We could spend a long time arguing over whether the research councils and the ABRC do, could, or should "manage" those who receive funds from them. I do not propose to do so on this occasion. What I do want to do is to point to the complexity of the problems with which the ABRC has to grapple, whether or not you apply the word management to what it does.

I suppose that the complexity - even the near-impossibility - of doing what we want to do at the national level is especially obvious to me as a newcomer. Even the field covered by my own Council - enormously smaller than that covered, for example, by both the SERC and the MRC - provides a daunting degree of complexity. How much greater is the complexity dealt with by the Advisory Board for the Research Councils, which covers all the areas of all the research councils. The basic problem of the ABRC is therefore how to comprehend (manage) extreme variety.

One can divide that complexity into three parts. First, there are facts. There are facts about the range of research topics covered by individual researchers and research institutions; there are facts about research methods; about people; about ideas, etc.

Second, there is complexity in the concepts which researchers use. Current discussion of science is greatly influenced by Thomas Kuhn's book The Structure of Scientific Revolutions.(4) Kuhn points to periods when we engage in what he calls "normal science". We then see theories not so much as to be tested as to be used in order to solve what our former Manchester colleague F R Jeavons would call puzzles. In these periods science operates within the framework of existing theory, which provides a powerful puzzle-solving tradition, and an effective set of tools and techniques for carrying out research. At times, however, there are "revolutions". Clearly, these occur relatively infrequently, but there are periods when what Kuhn calls new "paradigms" are developed. I have often been worried over the difficulty I have in defining a paradigm, but am somewhat consoled by F R Jeavons. As he points out, "an eager student has managed to distinguish no fewer than twenty-one slight variants!". Kuhn admits to "having lost control of the word". For Kuhn a paradigm is a coherent tradition of scientific research, such as Newtonian dynamics or wave optics.

During periods of revolution when paradigms are being developed, knowledge is increased through criticism. Good research means making bold conjectures and then ruthlessly criticising them, in an attempt to disprove them.

The ABRC, then, not only needs to know what is going on in normal science; it not only needs to know what is going on in current revolutions; perhaps most of all it needs to know where the new revolutions - the possibility of developing new paradigms - may lie. The complexity here is large, which is why I refer to complexity of concepts.

Third, there is the complexity of the organisations - research councils, research institutes, universities and individual researchers - with all the attendant problems of organisational behaviour in a linked set of organisations. I find it inconceivable that this range of facts, concepts

(4) University of Chicago Press, 2nd edition, 1970, p10

and institutions could be comprehended by any individual. The question is whether it could be comprehended by any group.

One problem, which I am sure many of you will have noticed already, is that the field covered by the ABRC is far from clearly distinct from that covered by ACARD - the Advisory Council for Applied Research and Development. Indeed, I sometimes wonder whether the division made between the fields covered by ABRC and ACARD is tenable, and even more whether it is useful.

Be that as it may, the role of the ABRC is to understand the fields covered by the research councils, and these cover the whole vast field of basic and applied research, and indeed much development too.

The most forcible conclusion I have drawn from my recent return to Whitehall is that most of the really difficult problems are essentially managerial problems. Certainly, a body like the ABRC has to manage itself and even if it does not manage the research councils, they must manage themselves. The research councils have to devise effective ways of allocating money to research centres, researchers and postgraduate students. One can point to the need for the ABRC to give autonomy to researchers, universities and - to a degree - the research councils themselves. One can then quibble over whether anyone is managing the system at all. To me these quibbles seem very much beside the point. So far as I am concerned, all these _are_ managerial problems.

The original notion lying behind the establishment of the ABRC made it a unique body. It brings together representatives of a wide range of sectional interests together with able independents. One issue - which has perhaps not been sufficiently thought through - is whether it is appropriate that a body whose basic job is to advise on the allocation of money to the research councils should itself have the five research council chairmen as its members. Leaving that on one side, the ABRC is essentially a forum. I therefore doubt whether the complex problem that I have already identified - and which I hope you will allow me to describe as managerial - can be tackled by a forum. In my view, the ABRC needs to be more purposive than that. Harking back to what I said earlier, this requires, above all, relevant leadership. There is clearly a managerial job which has to be done in making the ABRC work well.

To do the job I would insist that a change in the ABRC's culture - in the climate of the ABRC's thinking - is also required. This task of managing "the ABRC" is not eased by the backgrounds of those who compose it. I think here, especially, of the way that businessmen and civil servants approach this kind of task.

Businessmen seem to me to find it especially difficult to recognise the complexity of management problems in the public sector. That is, I suspect, why businessmen often perform badly when brought in to tackle broad political issues - for example as ministers. On the other hand, they perform rather well when tackling specific problems, as Lord Rayner has done. Business management is difficult enough in all conscience but in business, perhaps, leadership can by itself overtake the complexity of the situation. The problems of business actually begin to look rather simple when compared with those of government. This is, of course, why solutions to governmental problems proposed by businessmen often seem naive.

With civil servants, the problem is different. If anything, their difficulty is precisely that they are not naive when they think about these issues. They would say: not only must what is done be fair; what is done must be seen to have been done in a way that ensures fairness; and that fairness must be demonstrable to ministers, to Parliament and to the public. As a result, solutions to problems which I would regard as managerially efficient are ruled out because they imply, if you like, a degree of dictatorship. In many cases, I suspect, allowing the Secretary of State for Education and Science to reach a decision by himself on issues on the field of science would be as effective as the complex and expensive procedures we actually follow. But it could not be defended in a democracy.

A further problem with the Civil Service is that the automatic reaction in Whitehall to the discovery of any problem seems to be to tackle it by establishing a committee. As I have myself once said,(5) the Whitehall problem is that there are too many clever people sitting round tables. When, as with the ABRC, one has

(5) Public Policy and Private Interests (1973)
Hague, Mackenzie and Barker (London: Macmillan)

sitting round the table 25 or 30 clever people who rarely meet outside ABRC meetings the problem is compounded. Perhaps the ABRC should establish an operations room, with charts and other visual aids showing what is happening in the field covered by the ABRC so that its members could have a better understanding of what is going on. Perhaps we should go beyond that to an idea borrowed from a young man called Robert Bittlestone. At recent operational research society conferences Robert has organised what he calls meta-conferences. Those who attend the conferences have access to mini-computers. During breaks between sessions or in the evening they use these computers to discuss with each other how the conference is going; what they think about it; how it might be improved. In the end, perhaps this is how we shall improve communication between members of large committees - by communication through the computer between meetings. We should at least then know what each other was thinking, rather than having to interpret scowls or gestures from across the table.

I believe, then, that the ABRC needs to change, but I believe that its bureaucracy also needs to change. Conventional bureaucracies cannot, by definition, produce fundamental solutions. We somehow need to devise a learning bureaucracy, rather than an administering bureaucracy. We need Whitehall to develop a connected set of learning organisations. This would comprise the ABRC, the research councils, parts of the Department of Education and Science and indeed parts of other Whitehall departments.

Nor is this simply a matter of trying to improve the relationship between the Whitehall machine and science. There are wider questions about how the members of the ABRC should act in their role as scientists.

Science has a double responsibility here. First, as scientists we need to set a good example by devising an effective organisation - in this case the ABRC. Beyond this, the responsibility goes much wider. Just as the ABRC has a responsibility for the whole science community, so the ABRC needs to show that wider community that it is both necessary and possible to design organisations that work well. That means designing an organisation which can learn.

How could this be done? First, the ABRC needs to come to terms with the fact that its role is as difficult as it really is - that it has to deal with a very complex set of facts, concepts and organisations. Having grasped the degree and nature of that complexity, the Board needs to consider the appropriateness of its own procedures.

In particular, it seems to me, proposals for using the customer/contractor relationships need to be evaluated in this light. When Lord Rothschild produced this principle he must, consciously or unconsciously, have been seeking to use it as a device to reduce the variety which those at the centre were called upon to manage. He saw them delegating part of that variety to the joint management of a customer and a contractor. If there are many fields where that relationship has not worked, that may may well be because we were trying to use it in inappropriate circumstances. In the market sector of an economy, the customer/contractor solution does work: that is because there the customer really is the customer. That may be why the device also appears to work in the defence field. But it was bound to be difficult, and perhaps proved impossibly difficult, for other departments to act as proxy customers. We need to come to terms with the issues that this raises as we decide where, whether and when to use the customer/contractor principle.

How then could we make better use of the resources devoted to the ABRC I would myself put this in terms of the need to devise some way of institutionalising creativity and innovation - to create what I have just described as an organisation that learns. I see several elements in this process. First, there are questions to do with, for example, the size, composition and modus operandi of the Board. Second, there is a need to develop, or more probably to bring in, people with appropriate backgrounds, training and disposition. Third, there is the need to go on to make desirable things happen.

To organise this process, I would myself establish a strategy unit. Its detailed role would need to be worked out by those with more experience than I have. But I would see its ethos as being to challenge orthodoxies, to promote learning within the ABRC and to ensure that change actually happens, because it is institutionalised in the strategy unit.

The unit would need to monitor what was going on in the relevant parts of the external environment and to evaluate their implication for research. This would obviously mean monitoring economic, technical, social and political developments both within the UK and outside. It would also mean monitoring new ideas and practices which were being evolved in universities, research institutes and research councils.

The task would then be to ensure that these developments were taken into account so that the ABRC could trigger off creative and worthwhile activity, and could do so not merely within the research councils but within the wider scientific community.

One can see at once the kind of objection that will be raised against this proposal. First, "think-tanks" are not in fashion in Whitehall. My own belief is that part of the reason for this is that the "think-tanks" we know have been given too much of a separate existence. This is especially true of the CPRS - the Central Policy Review Staff - which was closed last year. I would therefore suggest the establishment only of a small strategy unit, briefed and actuated by the ABRC and reporting to it. In my own role as Chairman of the ESRC, I feel a similar need for advice to help us make good policy, and am taking steps to receive it. How much more, then, does the ABRC - with the vast field which is has to cover - need such help.

The second objection would be to the likely manning of such a strategy unit. The role of the strategy unit would be to provide a bureaucracy that was creative. This would mean bringing in new ideas, attitudes and indeed people both from outside the scientific establishment and, indeed, from outside the Civil Service. This would raise again some conventional objections to think-tanks. The problem is that there are few, if any, civil servants with the background and training required of members of such a unit. At least some of its members would have to come from outside the community of natural scientists and engineers - perhaps from economics and certainly from business schools. A third objection might be that my proposal would follow Professor Mason in his recent suggestion that it is important to "strengthen" the ABRC. I have suggested that to say this is rather like saying that Stockport County could always beat Manchester United if they were always allowed to play thirteen men against eleven. My worry about what Professor Mason says is that it seems to me to imply that, once strengthened, one would have a next-to-omniscient ABRC which could, despite all that I have said, manage extreme variety with reasonable success. Perhaps a multi-disciplinary team of the kind I am proposing could make a good fist at omniscience. But it could do so only if it did not concentrate solely on developing a top-down view. It would need to encourage the formulation of alternative ideas in a much wider constituency. And it would need to listen to these ideas. It would certainly not succeed as a single cell of creativity and knowledge in an embattled and conservative system. It would need to tap sources of creativity wherever these were.

The final objection might be that such a strategy unit would be expensive to man. Perhaps it would but, given the size of the total science budget - around £550m - this might be money well spent.

I now tackle one final topic. Looking at what the ABRC does, a purely managerial "solution" would be much less elaborate than the one I am envisaging. A management scientist might not go so far as to suggest giving the Secretary of State the final say. But he might feel that there was some merit in the idea of replacing the ABRC with a very small committee, with a leading scientist as chairman, and with the heads of the research councils as its members. This committee could then divide up the science vote and report directly to the Secretary of State. They would be accountable to him both for the way that the whole science vote was used and for the way that the individual research councils were run.

The problem is that while this might appear managerially efficient it would not appear constitutionally acceptable. There is a permanent and inevitable tension in a democracy between managerial efficiency and constitutional propriety. It may be that, too often, we take constitutional propriety too seriously and spend more than we need. This is certainly an issue which needs debate, but such debate will almost always end by requiring a more elaborate organisation than a purely "managerial" solution would require. There is a price to be paid for Parliamentary accountability and democratic control. It is right that such a price should be paid. The important question is how much more we need to spend - to keep Parliament and the public happy - over and above what it would cost to achieve what a manager would regard as an efficient solution. For the price we pay - in money and in time "given" to public sector work - is high.

So, for example, we should have to debate the role of the peer group. All research councils devote a good deal both of expenditure and of expert time to the evaluation of research proposals, research programmes and research institutions by "peers". Some would argue that a more dictatorial procedure - giving money "to the best people" - would cost much less! Others would defend the peer group system to the death, almost regardless of what it costs. There is a whole field here which needs debate, and rarely sees it.

How, then, do I answer the rhetorical question: Is science manageable? - at the national level. The answer must be: Probably not, in a strict sense, but we have to go on doing our best.

Let me, in conclusion, summarise my basic thesis. I have tried to show that many of the most important problems covered by the ABRC, the research councils and the universities are - as I would describe them - managerial. I therefore believe that we need much more collaboration within universities between social scientists, natural scientists and engineers if we are to tackle and solve these problems effectively. I also believe that we are at the beginning of a new phase of rapid technological development. Many of the most pressing problems for science and technology are therefore problems of applying new kinds of technology. So the collaboration which I urge within the universities needs to be extended outside - to bring in those in business. I have argued that whether or not existing arrangements for university/industry collaboration have been adequate, there is a genuine danger that they will cease to do so before the information revolution has gone much further. I similarly plead for a new look at the way in which Whitehall organises itself to tackle the problems of funding science.

Obviously, fostering successful collaboration within universities, between universities and business and between Whitehall and the science community is bound to be a long and difficult process. But we can at least resolve to begin.

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NBPM AT 12/3

SECRETARY OF STATE
FOR
NORTHERN IRELAND

The Rt Hon Sir Keith Joseph Bt MP
Department of Education and Science
Elizabeth House
York Road
LONDON
SE1 7PH

12 March 1984

Dear Keith

PROPOSED REVIEW OF HIGH ENERGY PARTICLE PHYSICS

I have seen your minute of 5 March on high energy particle physics and am entirely content that such a review should proceed on the basis you have outlined.

I am copying this letter to the Prime Minister, members of the Cabinet, Sir Robert Armstrong and Dr Nicholson.

Yours

Jim

Science & Tech

Sept 83

Science Budget

NBPM AT u 13 cc OX

FROM: CHIEF SECRETARY
8 March 1984

PRIME MINISTER

PROPOSED REVIEW OF HIGH ENERGY PARTICLE PHYSICS

I have seen a copy of Keith Joseph's minute to you of 5 March.

I very much welcome the ABRC's initiative. It is to the credit of the scientific community, and can do its cause with Government nothing but good, that it should be ready to conduct a vigorous appraisal of the costs and benefits of our present commitment of a sizeable proportion of the science budget to this area of activity.

I would be content for you to give the first of the assurances which Sir David Phillips and Professor Kingman seek - indeed the review would have little point if radical options for our involvement in CERN were off the agenda - and at least to enter fully into the spirit of the second. The size of the science budget will, of course, remain an issue for successive Public Expenditure Surveys. One cannot predict what factors we or our successors will consider relevant to future decisions, but we will need *inter alia* to take a view about the value of the activities supported by the science budget at the time. To the extent that the balance of those activities would be affected by a decision to scale down or abandon our involvement in high energy particle physics, that view might be affected also at the margin - one way or the other. I do not think it is possible, therefore, to state categorically that the science budget would be precisely the same whether or not we ended our present commitment to high energy particle physics; and I am sure that ABRC and SERC will understand this. (They will recall, too, that the increase in the budget agreed in the 1983 Survey was specifically related to the increased costs of participation in CERN.)

What I can say is that I view the proposed study as an exercise in obtaining the best value for money from a given level of resources for scientific research. If it were to conclude that, within those resources, the share allocated to high energy particle physics should be reduced, I would certainly not seek to exploit such a finding as an argument for cutting the science budget as a whole.

I should add that I hope the study will look not only at options for our involvement with CERN but also at the value for money obtained from the £20 million a year being spent on other high

CHIEF SECRETARY TO THE TREASURY

energy particle physics work. And in this we need to consider not only matters of high scientific policy but also such mundane issues as the best use of accommodation and staff, which could prove no less productive.

I should be very happy for Treasury officials to take part in the proposed 'shadow' group.

Copies of this letter go to other members of Cabinet, Sir Robert Armstrong and Mr Nicholson.

PR

PETER REES

SCIENCE + TECH: Science Base
Sept 83

CONFIDENTIAL

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10 DOWNING STREET

From the Private Secretary

8 March 1984

Dear Elizabeth,

Review of High Energy Particle Physics

The Prime Minister has seen your Secretary of State's minute of 5 March proposing a review of high energy particle physics to be conducted by a group under the chairmanship of Sir John Kendrew. She has noted the Foreign Secretary's concerns and recognises that our partners in CERN will need to be handled with care. Nevertheless, she believes a review is right and agrees that the assurances sought by Sir David Phillips and Professor Kingman should be given. Unless scientists are assured that savings identified by the review are available for redeployment elsewhere in the Science Budget, there is unlikely to be a rigorous study of priorities.

The Prime Minister has noted the steps which your Secretary of State proposes to take in order to minimise misunderstandings and misrepresentation. She agrees that no announcement should be made until after 20 March and she attaches importance to the proposal to give warning before the announcement to Ministers in CERN member states and to the CERN Director.

I am copying this letter to Private Secretaries to members of Cabinet, Richard Hatfield (Cabinet Office) and Dr. Nicholson (Cabinet Office).

Yours sincerely

Andrew Turnbull

Andrew Turnbull

Miss C.E. Hodkinson,
Department of Education and Science.

CONFIDENTIAL

da

10 DOWNING STREET

(1)

Prime Minister

Sir Keith Joseph sounded you out on a review of high energy particle physics. He has consulted the Foreign Secretary who predictably is unhappy. (Sir Keith has sent you copies of this exchange of correspondence).

Dr Nicholson supports review and proposals for handling it.

Agree?

AT
7/3

I agree with Dr. Nicholson. I note the F.O. view. Of course France is concerned - the new LEP ring is largely on her territory and we benefit from it.

MT

W.0197 6 March 1984

PRIME MINISTER

PROPOSED REVIEW OF HIGH ENERGY PARTICLE PHYSICS

I strongly support, indeed I have been urging for some time, a review of the UK's participation in high energy particle physics.

2. At a time when the Research Councils are having to reassess their priorities, reallocate their resources and cut back some parts of their research, it would be quite wrong to apply double standards and allow High Energy Particle Physics to be sacrosanct simply because most of the work is done on an international collaborative basis.

3. I believe the review will be welcomed by most of the scientific community in the UK and, notwithstanding the inevitable posturing by some European Governments, by much of the scientific community abroad as well. The MRC showed in their recent review of the UK's participation in the European Molecular Biology Laboratory that it is perfectly possible to review our role in a European collaborative activity and to gain respect and understanding for our position in doing so.

4. The proposed membership of the Working Party is excellent - Sir John Kendrew himself and most of the members are well-known and revered in Europe. There will be deep interest in, and respect for, the results of their deliberations.

5. I believe the two assurances sought by Sir David Phillips and Professor Kingman are eminently reasonable. An automatic confiscation of funds by Treasury from any reduced or discontinued area of research would make reassessment of

priorities and reallocation of funds towards priority growth areas in science impossible - yet this is the discipline which the Secretary of State has repeatedly urged on Research Councils.

6. Withdrawal from CERN must be contemplated as one option on completion of the study - it would be unreal to exclude it. Personally I doubt that it will come to that. More likely will be recommendations to improve the cost-effectiveness of CERN (you've seen the gold plating yourself) and, crucially, to slow down the pace and hence the rate of spend on this area of research. There is no reason why the tax-payers of Europe and the USA should have to fund a private race between two scientific cliques carried out at a pace determined largely by their own curiosity and arrogance. I expect the Working Party to recommend a reduced rate of spend to correspond with a better judgement of the value of this area of science vis-à-vis competitive areas.

7. Handling this issue will be crucial from the point of view of public perception at home and abroad. I welcome the Secretary of State's proposal to establish a shadow group of officials to advise Ministers on this. I would be happy to be part of it and to keep you informed of the progress of the review.

8. I am copying this minute to Sir Robert Armstrong.

RBN.

ROBIN B NICHOLSON
Chief Scientific Adviser

6 March 1984

MR TURNBULL

Ftc

HIGH ENERGY PARTICLE PHYSICS: REVIEW

Keith Joseph's plan to review spending on CERN seems admirable.

We are not competent to comment on the scientific issues involved: you will have a note from Robin Nicholson on that. But we do wish to support the proposal that the exercise should be regarded as a basis for redistribution within the Science Vote, rather than as a means of reducing spending.

We should certainly contain - and, if possible, reduce - spending on science. But we should not use the review as a vehicle because, if we do, the scientists will become defensive, and will refuse to tell us what we need to know - viz, whether whatever funds we do allot would be better spent on CERN or on other scientific ventures.

We suggest that the Prime Minister should agree to a review on the terms that Keith Joseph proposes.

Oliver Letwin.

OLIVER LETWIN

£/0L

PRIME MINISTER

PROPOSED REVIEW OF HIGH ENERGY PARTICLE PHYSICS

1. You will know from our talk that the Advisory Board for the Research Councils (ABRC) has proposed, in its recent advice to me on the allocation of the Science Budget, that jointly with the Science and Engineering Research Council (SERC) it should review UK participation in research into high energy particle physics. My purpose in minuting you and our Cabinet colleagues now is to let you know that I propose to tell Sir David Phillips and Professor Kingman that - with two important assurances that they seek but entirely without commitment as to Government's attitude to the findings - the Government agrees that they can make the review; and to seek your formal concurrence, and that of colleagues, in that step.

2. The background to the proposal is given in the enclosed extract from the Board's advice; I also enclose copies of the proposed terms of reference and membership of the Review Group. Sir John Kendrew is willing to be Chairman; no one else has yet been approached.

3. The intention is to make a full appraisal of options for the future level of UK activity in this field. Our current commitment approaches £50m pa, nearly a tenth of the Science Budget; and the largest slice of this - about £30m - is our direct subscription to CERN, where our research effort is concentrated. The UK Government is signatory to the CERN convention; SERC is its representative.

4. The two assurances requested by Sir David Phillips and Professor Kingman are:

(i) that the Government, entirely without prejudice to any action it may or may not take consequent on the review, does not wish to preclude from consideration, in the review, UK withdrawal from CERN as one of several possibilities for future UK positions in this subject:

Without this assurance the scientists will not weigh alternatives frankly. AT ✓ Agreed MT

(ii) that, barring sudden crises, any funds that might in due course be released by reduction in our commitment to high energy particle physics should be available for redeployment elsewhere within the Science Vote.

5. As to the first of these, I would emphasise that it is far from being a foregone conclusion of the review (or of subsequent Government action, if any) that we should withdraw from the subject, and thus from CERN. But, realistically, that must be one of the possibilities examined by the Group; and we, as a Government, must I think be willing to let this examination go on. I shall, of course, want to stress when I announce the review (as I shall have to do) that it implies no prior attitude by the UK Government and is without prejudice to any future decision.

6. In addition to assuring Sir David Phillips and Professor Kingman that the Group may explore objectively the implications of withdrawal from CERN I propose also to give them the second assurance that they seek. Without it, one of the main corner-stones of the exercise - an across-the-board assessment of the scientific opportunity costs of our commitment to high energy particle physics - would be missing; and there would be no incentive whatsoever for the Board to face the hard decisions on redeployment required by our public expenditure decisions.

7. I recognise that embarking, publicly, on this review has its risks. Within CERN itself, as Professor Kingman our delegate has pointed out to me, one possible result is that - jibbing at

complete withdrawal - we become a half-hearted, unattractive and therefore less influential partner, having to abandon our present strategy (positive and constructive on science, hardheaded on finance) without the compensation of freeing significant resources. More widely, our CERN partners (notably France and Germany) may - cynically or not - act as though the review is a preliminary to withdrawal from CERN; and invoke it, to our disadvantage, in other areas of our dealings and negotiations with them.

8. Because of these possibilities I thought it right to give Geoffrey Howe some preliminary warning of what we have in mind. Understandably the prospect does cause him anxiety; and I was grateful for his recognition of the financial and scientific considerations that have led me to agree to the review. The financial aspects are well known to you and our Cabinet colleagues from last year's PES. What my talks have made clearer (and I have had thorough discussion recently with Sir David Phillips and Professor Kingman) is that we owe this appraisal to people in other parts of UK science who believe that they can give better value for money and are pressing for a frank discussion of the issues and options. Moreover, UK scientists are not alone, internationally, in feeling some concern at the scale of investment, present and prospective, in high energy particle physics; and there is a real hope that this review will help more widely to chart the course of future international collaboration in this subject, and to assist a fuller public understanding of its achievements and future potential.

9. In short I believe that, if we are open and frank about the occasion and nature of this review and see that its positive aspects are at least as visible as its negative, we can minimise damage arising unnecessarily from misunderstanding or mis-representation, and may well find support from unexpected quarters. We cannot avoid all adverse criticism (nor would I want to) but there are some steps I think it prudent to take:

(i) to avoid a negative signal in the run-up to Brussels I would make no announcement until after 20 March;

(ii) coincident with the announcement I am proposing to publish the full advice of the ABRC, which sets the review in context;

(iii) after 20 March but before the announcement I will write to warn Ministers in CERN member states; and will arrange for Sir Alec Merrison (as Chairman of the CERN Council) and the CERN Director Dr Schopper to be warned;

very important

(iv) with FCO colleagues, my officials will make preparations to brief posts against the announcement;

(v) I am establishing a shadow group of officials - also involving Sir John Kendrew, Sir David Phillips and Professor Kingman - whose purpose it will be to keep in touch with the review, give assessorial help, and offer advice on minimising unnecessary damage. Geoffrey Howe has already agreed that his officials should participate; and I hope that Nigel Lawson, Norman Tebbit and Peter Walker will agree that it would be useful for their officials to join in. If you are willing, I should like Robin Nicholson to be a member.

In these ways I hope the review might lead to positive and constructive developments, not just for UK science, but for wider international collaboration in high energy particle physics and perhaps in other areas of big science. That is the spirit in which I would ask the Group to approach their task.

10. I should be grateful for your agreement, and that of our colleagues, to proceed on this basis.

11. Copies go to Cabinet colleagues, Sir Robert Armstrong and Dr Nicholson.

KJ

5 March 1984

ANNEX A

Extract from the 1983 Forward Look Report of the Advisory Board for the Research Councils submitted to the Secretary of State for Education and Science on 23 November 1983

"WITHDRAWAL FROM A MAJOR AREA OF SCIENCE

81. We believe that the problems which now face the Research Councils are so grave that it would be wrong of us not to consider the possibility of creating greater scope for responding to the many challenges of science by withdrawing completely from a major area of scientific activity. The difficulty is that no part of science is unrelated to the rest and it is impossible to foresee where the next critical advance will be made. In considering where economies might be made in the Science Budget, it is essential, therefore, to ensure as far as possible that we continue to fund adequately the most outstanding people and the best ideas whenever they appear and in whatever field of science. At the same time we must seek to safeguard the ability of Research Councils to develop existing ideas in those areas likely to contribute to new technologies.

82. But some scientific research can be conducted only at great cost because it requires the use of elaborate facilities, or complex and expensive apparatus, or expensive consumable materials, or highly-trained scientists or some combination of all these different resources. In such circumstances it is clearly not possible to fund good people and ideas regardless of cost and hard choices have to be made. In making them the Research Councils take into account not only the originality and intrinsic scientific value of the proposed research but also its cost, its potential industrial importance, its effect upon the provision of trained manpower and other economic and social considerations.

83. For these reasons it has been accepted for some years that the UK can participate in some branches of scientific research (eg high-energy particle physics, satellite-based astronomy, astrophysics and earth sciences) only through international collaboration in the provision of the expensive apparatus and facilities that are needed. Furthermore general studies in physics, chemistry, earth sciences and biology depend increasingly upon the provision of expensive apparatus and facilities (eg neutron and synchrotron-radiation sources, research vessels) and the strong trend is for these also to be provided by international collaboration.

84. There are other fields of research to which access is limited even though they depend upon the use of relatively inexpensive equipment. For example, lasers, electron-beam lithography and diagnostic imaging are being concentrated to an increasing extent in one or a few centres with the risk that this will slow down the general adoption of new technologies both in research laboratories and in industry. Similarly the need for costly consumable materials (eg radioactive isotopes, enzymes, etc) in much seemingly inexpensive laboratory work in biotechnology means that only a limited number of centres can be encouraged to adopt these new methods despite their evident potential in many fields of research.

85. In all of these ways the aim of supporting first class people and ideas wherever they arise is moderated by overriding financial and economic constraints and the Research Councils are continuously involved in making difficult judgements about how best to proceed. It is in this context that the ABRC and the Research Councils must now consider with renewed urgency whether complete withdrawal from some area of science would release resources that could be better deployed in other areas and in making the whole system more flexible and responsive to new opportunities.

86. The fundamental difficulty remains of identifying areas that could be neglected without causing major damage to the overall vitality of UK science or to the prospect of increasing its value through international collaboration. Discussion in the ABRC over the last year has pointed at two particularly costly areas, high-energy particle physics and satellite-based astronomy. The latter is of course closely associated with ground-based astronomy on the one hand, and earth-oriented space science and technology on the other.

87. High-energy particle physics is concentrated in CERN. We identify this area with great reluctance because the fundamental science and the supporting technology are of the highest quality and the UK is internationally recognised as being among the leaders in this field. You will know that the international team of scientists working at CERN discovered two new subatomic particles this year, the W and Z^o vector bosons. These discoveries provide strong supporting evidence for a theory which combines the weak and electromagnetic forces of nature. Simultaneous developments are consolidating the quark model of the strong force.

88. On the other hand we recognise that little application can be seen for the work at present (although, remembering Rutherford's view of the relevance of his

research, we would be rash to state that no application will be found in the future), while the resources devoted to this field (£30M) are high in relation to the size of the scientific communities served. We note also the intense international interest in this work, in Europe and in the USA, the USSR and Japan.

89. Support for both high-energy particle physics and satellite based astronomy is the responsibility of SERC. The Council keeps under regular review its commitment to all the areas of science which it funds and has not hesitated to make major shifts in funding where it considered such shifts would ensure the most effective deployment of its resources. You will know that over the past eight years, SERC has substantially increased the resources for "little science" and engineering at the expense of nuclear physics and astronomy.

90. The Mitchell Report on nuclear (structure) physics has enabled the Council to adopt a lower, but still scientifically justifiable, level of activity in this area, as suggested by the Board last year. We welcome the review of space policy which the SERC is conducting under the chairmanship of Professor Richmond, and which will examine not only the very fruitful ad hoc collaborations with other countries (such as the IRAS project), but also the involvement of SERC with DTI in the European Space Agency.

91. The pressures on the Science Vote are such that, despite the scientific achievements, the Board must question the continued participation of the UK in CERN. It is therefore establishing a joint working group with SERC to examine the future of high-energy particle physics, and one possible long-term option is to advise the Government to withdraw from the CERN Convention.

92. Any such action would have serious consequences in diplomatic and economic terms extending outside the remit of the ABRC. But it would also render far more difficult the efforts to strengthen international collaboration in other areas of science, and in particular to attract support for the SNS, SRS and the observatories."

ABRC-SERC STUDY OF HIGH-ENERGY PARTICLE PHYSICS

DRAFT TERMS OF REFERENCE

Having regard to the long-term health of British science and to the Common Criteria for the support of science enunciated by the Advisory Board for the Research Councils in its Second Report, 1974-75:

(i) to review UK participation in the study of high-energy particle physics, with particular reference to that necessarily carried out under international auspices;

(ii) to consider possible future involvement, the role and extent of international collaboration, and the implications of reallocation of the resources in whole or in part to other areas of science;

(iii) to report to the Chairman of the ABRC and the Chairman of the SERC.

THE COMMON CRITERIA

1.* Councils and their Boards/Committees/Groups are invited to use the criteria listed here to discuss and compare relative benefits. Whenever practicable, reference should be made to objective data in support of the assessment (eg demographic data; social costs; relevant government expenditure etc.) in relation to the cost of the research.

Scientific Policy Criteria

(1) Excellence of study field
    Where benefits are attributable to a high proportion of the research being intrinsically of high intellectual value.

(2) Excellence of the research workers
    Where benefits are attributable to the exceptional quality of the individuals or teams to be employed in the activity.

(3) Pervasiveness of the activity
    Where benefits include the impetus to advances in other and related fields of science in addition to the primary field.

(4) Social and/or economic importance
    Where expected benefits arise from the work being directed to supporting social or economic aims.

(5) Significance for the training of scientific manpower
    Where benefits will include training and experience for scientific research workers.

(6) Educational importance
    Where benefits will include a contribution to education.

(7) Significance in maintaining national scientific prestige
    Where benefits will contribute to national reputation.

Management Criteria

2. A set of selected management criteria are also offered. These apply to the consideration, from a management policy point of view, of alternatives which have already been assessed on the scientific policy criteria.

A. Efficiency of operation
    Where improvements in organisation and/or plant would lead to a general increase in efficiency.

B. Obsolescence
    Where the maintenance of a capability (at whatever level of activity) requires replacement within the Forward Look period of a major item of obsolescent plant or equipment.

C. Timing
    Where a start on a new or increased activity within the Forward Look period is critical if the expected benefits are not to be lost or much reduced.

D. Dependence on Science Budget Support
    Where there is likely to be limited support, national or foreign, available for work related to the activity except the Science Budget.

E. Availability of scientific manpower
    Where an activity attracts priority by virtue of greater availability of scientific manpower for it (or its execution is constrained by lack of it).

F. Scope and limits of redeployment
    Where the priority accorded to an activity is conditioned by difficulties or opportunities of redeployment.

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* Extract from instructions to Research Councils, 1975 Forward Look.

ANNEX C

ABRC-SERC STUDY OF HIGH-ENERGY PARTICLE PHYSICS

Proposed membership of the Working Party

Sir Douglas Hague	Chairman, ESRC
Sir Peter Hirsch FRS	Chairman, UKAEA
Sir John Kendrew FRS (Chairman)	President, St John's College, Oxford
Sir Jack Lewis FRS	Professor of Chemistry, University of Cambridge
Sir John Mason FRS	(Recently retired) Director-General of the Meteorological Office; Pro-Chancellor, University of Surrey
Professor K Pounds FRS	Professor of Space Physics, University of Leicester
Sir Francis Tombs	Chairman, Turner and Newall; Chairman, The Weir Group; Director, NM Rothschild and Sons; Director, Rolls Royce

Sci + Tech
Science Budget
9/83

D3CON8

Personal and Confidential

PRIME MINISTER

REVIEW OF HIGH ENERGY PARTICLE PHYSICS

I thought it right to consult Geoffrey Howe informally and on a personal basis before coming more formally to you and Cabinet colleagues for agreement to proceed. I think you should know of our exchanges and am sending copies with this minute; a copy of this minute goes to Geoffrey too.

KJ

5 MARCH 1984

D3CON9

Personal and Confidential

DEPARTMENT OF EDUCATION AND SCIENCE

ELIZABETH HOUSE, YORK ROAD, LONDON SE1 7PH

TELEPHONE 01-928 9222

FROM THE SECRETARY OF STATE

5 March 1984

Dear Geoffrey,

REVIEW OF HIGH ENERGY PARTICLE PHYSICS (HEPP)

Thank you for your minute of 2 February. I greatly appreciated your careful analysis of the difficulties, diplomatic and other, that face us in entering on this review; and your recognition of the financial constraints on the Science Budget.

I have discussed your analysis, and the advice from posts, very thoroughly with Peter Brooke and my officials, and with Sir David Phillips, Professor Kingman and Dr Nicholson. We understand, and to an extent share, the misgivings you voice; but, on balance, I have decided that it is right to press ahead. I am therefore minuting the Prime Minister, and our other Cabinet colleagues; your copy comes with this letter.

I discussed, in particular, with Sir David Phillips and Professor Kingman your suggestion that the seven members of the Review Group should include at least two scientists expert in high energy physics or closely allied fields. There are, as you say, good reasons for considering this, to enhance the credibility of the Group's work and report; and I wholly agree that the membership must be seen to be balanced and the review fair. I think there are difficulties about including high energy particle physicists - for them and for the Group. For practising people, more than a fair share of responsibility might be attributed to them, both for putting across the views of the HEPP community, and for the conclusions and recommendations; and there would be a real risk of a minority report. On the other hand, to take someone who has been eminent in the field, but is so no longer, could similarly expose him to unreasonable expectations or criticisms. There are risks either way but on balance we concluded that it would be best to rest on the present broadly-based peer membership pattern (which includes three physicists eminent in other fields, one of them - Pounds -

/in a subject

The Rt Hon Sir Geoffrey Howe QC MP
Secretary of State for Foreign and
Commonwealth Affairs
Whitehall
London SW1H

in a subject that has significant relations with high energy particle physics); and on full opportunity for the HEPP community to present evidence to the Group, singly and collectively, written and oral, and to engage in discussion with it.

We welcome your Department's involvement in the shadow Group and will shortly convene a first meeting, involving Sir John Kendrew, to discuss procedure and briefing for posts. We will also consult your officials on timing of an announcement; and, as you suggest, I will write to Ministers in CERN member states before making an announcement.

Yours ever,

Kevin

Prime Minister (2)
To note
AT 23/2

W.0151

21 February 1984

MR ANDREW TURNBULL, No 10

RESEARCH COUNCIL CHARTERS

1. The Prime Minister took a meeting on 19 October to discuss proposals from the Secretary of State for Education and Science for maintaining the strength of the science base. Your note of that meeting said that, in the course of reviewing research policy, I should investigate the Charters of research bodies. The point in question at the meeting was the extent to which the Secretary of State is empowered to direct Research Councils' activities. I have now taken advice on the legal status of the Research Council charters in relation to that of the Science and Technology Act 1965, and on the interpretation of relevant parts of the Act. Because of the clear-cut nature of the advice, I have not felt it necessary at this stage to go for independent legal advice outside Whitehall.

2. The Charters themselves assign to the Secretary of State powers in the following areas - the appointment of chairmen and members of Councils; the numbers of staff employed; and the terms of appointment of Council and committee members, and of Council employees (details are included at Annex 1). But more significantly, the Science and Technology Act 1965 states (Section 2(1)):

> "The Secretary of State may, out of monies provided by Parliament, pay to any of the Research Councils such sums in respect of the expenses of the Council as he may with the consent of the Treasury determine, and so far as relates to the use and expenditure of sums so paid the Council shall act in accordance with such directions as may from time to time be given to it by the Secretary of State". (My underlining)

3. The advice of the Legal Branch of the Department of Education and Science (DES) on the interpretation of the above statement is that the Secretary of State's power of direction is wide, limiting his power to

impose conditions of grant in only two respects:

(i) he cannot give directions relating to those activities of the Research Councils that are not financed out of the grant-in-aid;

(ii) he cannot direct a Council to do something which it has no power to do under its Royal Charter.

4. The Councils' powers under their Charters are limited by the objects for which the Councils are established and incorporated. These objects (set out in Annex 2) are, however, very widely drawn - eg 'to carry out research and development in science and technology', 'the organisation and development of agricultural and food research'. The second constraint in 3 above hardly therefore imposes any practical limitation on what directions the Secretary of State might give. Furthermore a Council must comply with any direction by the Secretary of State requiring it to "take over from, or transfer to, any Research Council or Government Department the responsibility for any activities in relation to scientific research" (Science and Technology Act 1965, Section 3(6)).

5. In legal terms, therefore, the Secretary of State enjoys wide powers of direction. But these powers need to be viewed in the context of Government policy. The general basis of policy for the conduct of Government-financed R & D is stated in the review of the Rothschild arrangements for funding research ("Review of the Framework for Government Research and Development, Cmnd 5046", Cmnd 7499) as follows:

a. research which is not undertaken with direct application in mind, but for the purpose of advancing knowledge, is the responsibility of the scientific community. The community itself decides how the available funds should be spent in the light of its best judgement on what research is most likely to lead to fruitful discoveries, having regard to existing knowledge and scientific capability;

b. other R & D is promoted by each Government Department in its own area on the scale and pattern which it judges to be most appropriate to the formulation and pursuit of its policies.

For the first of these two categories, the Secretary of State for Education and Science is responsible for making resources available directly to the universities, Research Councils and also to other bodies who have broad responsibility for supporting research mainly fundamental over a wide field. R & D in areas falling within Departmental responsibilities is supported in accordance with priorities set by Departmental Ministers, and the responsibility for funding areas of R & D which cross the boundaries between Research Councils or Departments are determined by agreement between the bodies concerned.

6. My conclusion is that it is Government policy, not the Research Councils' Charters that determines the nature and scope of the Councils' research programmes. Successive Governments have determined that the grants-in-aid to the Research Councils should be one of the two main sources of public sector support for UK fundamental research (the other being the UGC block grant). Nevertheless, on occasion, Secretaries of State have influenced the balance of activity, most recently with information technology and the expansion of Antartic research.

7. I am copying this minute to Miss C E Hodkinson (DES) and other recipients of your letter of 19 October.

RBN

ROBIN B NICHOLSON
Chief Scientific Adviser

Annex 1

The powers of the Secretary of State described in the Research Council Charters

The following powers of the Secretary of State are defined in the Charters of the Agricultural and Food Research Council (AFRC), Economic and Social Research Council (ESRC), Medical Research Council (MRC), Natural Environment Research Council (NERC) and Science and Engineering Research Council (SERC):

a. He appoints the Chairmen and most of the members of the Councils, within the following constraints:

i. For all Councils except the ESRC a certain proportion of the members should be appointed for their qualifications in science or technology. (For MRC 3/4 out of a total of from 14-18; for NERC 2/3 out of 13-19; for SERC 2/3 out of 14-18; for AFRC at least 6 out of 18-21).

ii. In the case of the MRC, NERC and SERC not more than 4 members should be appointed by the DES Secretary of State on the nomination of such Ministers as the Secretary of State shall determine; for the AFRC it is specified that 4 members shall be appointed by the Minister of Agriculture, Fisheries and Food, and that not more than 2 members be appointed by the Secretary of State for Scotland.

iii. In the case of any member being appointed on account of his qualifications in science and technology, the Secretary of State should consult the President of the Royal Society.

iv. In the case of the AFRC, before appointing a Chairman the Secretary of State should consult the Council; in the case of the MRC, consultation with the Council is required in respect of appointments of the Chairman, Deputy Chairman and scientific members of the Council.

b. With the approval of the Minister for he Civil Service, the Secretary of State determines the remuneration, allowances, pensions, gratuities or compensation of Council members, and the remuneration and allowances of Committee members appointed by the Council.

c. The Councils need the approval of the Secretary of State (and in the case of the AFRC of the President of the Royal Society) to appoint a Secretary. The Secretary of State's approval, together with that for the Minister for the Civil Service is also required for the numbers of other officers and other persons employed. As with Council and Committee members, the approval of the Secretary of State and the Minister for the Civil Sevice is required for the levels of remuneration, pensions etc of the Councils' employees.

The objects for which the Councils are established and incorporated

The objects for which the Councils are established and incorporated, as defined by their Charters, are as follows:

AFRC

a. the organisation and development of agricultural and food research;

b. the establishment or development of institutions or departments of institutions for investigation and reseach relating to the advancement of agriculture or the production and processing of food;

c. the making of grants for such investigation and research.

ESRC

a. to encourage and support by any means research in the social sciences by any other person or body;

b. without prejudice to the foregoing paragraph, to provide and operate services for common use in carrying on such research;

c. to carry out research in the social sciences;

d. to make grants for students for post-graduate instruction in the social sciences;

e. to provide advice and disseminate knowledge concerning the social sciences.

MRC

The objects for which the MRC is established are stated in the Council's current Charter to be the purposes for which a Committee of the Privy Council was appointed by Order in Council dated 11 March 1920. That Order did not however specify the objects of the MRC.

The Charter granted to the MRC by Order in Council dated 25 March 1920, gave as its prime purpose to `secure the continued performance of the duties heretofore performed by the Medical Research Committee'; the Medical Research Committee was established in 1913 to administer funds provided for medical research under the terms of the National Insurance Act 1911. This lack of precise definition appears to have been deliberately intended to leave the Council with the flexibility to adapt to the country's changing needs and circumstances. From the first report of the Medical Research Committee, covering 1914-15, it is clear that administrative flexibility was seen from the outset as a positive virtue - the `general scheme' approved by the Minister begins with the words `The object of the research is the extension of medical knowledge with the view of increasing our powers of preserving health and preventing or combating disease. But otherwise than that this is to be the guiding aim, the actual field of research is not limited...'. Insofar as the objects of the MRC have ever been formally stated and aproved, it was in this `general scheme' as approved by the responsible Minister in November 1913.

NERC NERC

a. to encourage and support by any means research by any person or body in the earth sciences and ecology in particular (without prejudice to the foregoing) in geology, meteorology, seismology, geo-magnetism, hydrology, oceanography, forestry, nature conservation, fisheries or marine and freshwater biology;

b. to carry out research in any field aforesaid;

c. without prejudice to paragraph a. above, to provide and operate ships, equipment or other facilities for common use in research in any field aforesaid by universities, technical colleges or other institutions or persons engaged in research;

d. to provide advice and disseminate knowledge in any field aforesaid;

e. to make grants for post-graduate instructions in subjects related to the Councils activities.

SERC

a. to carry out research and development in science and technology;

b. to encourage and support by any means research and development in science and technology by any other person or body;

c. without prejudice to the foregoing paragraph, to provide and operate equipment for other facilities for common use in research and development in science and technology in universities, technical colleges or other institutions or persons engaged in research;

d. to make grants for post-graduate instructions in science and technology;

e. to disseminate knowledge in science and technology.

The SERC Charter states that `science´ includes the social sciences.

SCIENCE + TECH: Maintaining the strength of the Science Base
Sept 83

NOTED

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SECRETARY OF STATE FOR EDUCATION AND SCIENCE

Proposed Review of High Energy Particle Physics

1. In my minute of 20 January I said I would let you have a considered reply to your letter of 17 January. I am most grateful for the opportunity to comment before the question of the review is raised more widely. I can understand the financial pressures which have led the Advisory Board for the Research Councils to propose the review, and you to favour it.

2. I have now consulted our posts in CERN member states. Their comments reinforce my own anxieties that the review would inevitably be seen as evidence that the UK intended to withdraw from CERN, and that the UK was not a reliable and committed partner in collaborative scientific projects, and indeed in other forms of European collaboration. This perception could affect the willingness of other European countries to collaborate with us on high technology programmes. It would inevitably add weight to the voices of those who say that we are not committed to Europe or the Community and cannot be relied upon when the going becomes difficult. You may like to see the enclosed copies of telegrams from Paris, Bonn and Geneva which make these points fully and well (your officials have already seen them and other posts' comments too).

/3.

3. In addition to the political implications, I am concerned at the possible effect on the UK's standing in international science. We have seen direct evidence of the value which other member countries place on CERN. The French, for example, approached us on instructions on 28 November to express concern over a threat of withdrawal which the UK representative had made in the CERN Council during a debate about reallocating refunds to member countries. Denmark and other member countries also voiced their concern direct to SERC at the time. Moreover, the review would inevitably affect the UK's negotiating position on other new projects now under discussion (for example, the Spallation Neutron Source, the European Synchrotron Radiation Facility, the development of the Institut Laue Langevin and - though it is not your responsibility - the European Transonic Windtunnel). The UK's reputation in the field of European research and development could also be adversely affected - a field which is likely to be of increasing importance. In the Community our commitment to co-operation in research and development is already in doubt as a result of our inability to agree Community programmes because of the continuing disagreement in Whitehall about attribution.

4. That said, I am only too well aware of the financial constraints which have brought about the proposal for a review. However, it is important to set the cost of CERN to the UK - some £28-30 million a year - in the context of the sums spent on other research at home and abroad. For example, in 1982-83, the MOD spent £1,920 million on R&D; the Department of Energy spent £361 million; and the Department of Trade and Industry £335 million. This

/underlines

underlines the extent to which - as we both noticed in more than one NEDC discussion - we spend a uniquely large proportion of our research funds in the defence field. The consequences are made starkly plain in your present problem. Surely the balance is not irreversible)

5. Whatever the answer to that question, other countries are bound to compare what they will regard as penny-pinching with their own research programmes. The FRG, which already pays more to CERN than does the UK, has a 1984 civil R&D budget of some £1,820 million (a 3% increase over 1983); support for large science institutions, the major non-university research organisations and international subscriptions has been increased by 3.6%, 4.9% and 3.5% respectively. The Germans contribute 9.6% of their civil R&D budget to international collaborative projects. France, which also contributes more to CERN than does the UK, has emphasised the importance they attach to research by legislating for an annual 17.8% increase in real terms in expenditure on civil research and development. In 1984 French expenditure on fundamental research is expected to rise by 12.2% in nominal terms.

6. I know that you will take these considerations carefully into account, and you may see advantage in ensuring that the ABRC and SERC are properly aware of them. If, however, they continue to recommend the proposed review, and you consider that in view of the financial and other considerations involved you must accept this recommendation, I hope there will be an opportunity for the FCO to put my anxieties directly and confidentially to the Review Group, and to participate in the official shadow group which you

/propose

propose in your letter. We would of course be glad to help the Review Group in any way we can; in particular, our posts overseas would be pleased to help in arranging their overseas visits.

7. As to the Review Group itself, I am a little concerned at the proposed membership. I think it important that the Group should not only be as balanced as possible, but be seen so to be. At first sight it would seem that none of the people you have in mind have expertise primarily in high energy physics. In order to convince people in other CERN member states that the membership is balanced and the review a fair one, it might be better to have at least two scientists expert in high energy physics or closely allied fields among the seven or so members of the Group.

8. I am grateful for your point that any changes on which we may embark would have to be brought about by due process according with the Treaty requirements and taking account of our moral obligations. I entirely concur in this important principle.

9. If it is decided to go ahead with the review, we shall need to consider carefully the terms of any public announcement and its timing in relation to action on the wider international scene. I have particularly in mind, of course, the European negotiations. We must take great care not to inject a negative signal at what might be a critical stage in the run-up to Brussels. I hope you might agree, for example, to write to Ministers in CERN

/member

member states, as well as CERN itself, to warn them in advance of any announcement and explain the purpose of the review.

(GEOFFREY HOWE)

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Foreign and Commonwealth Office

2 February 1984

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TO IMMEDIATE FCO
TELEGRAM NUMBER 63 OF 20 JANUARY
INFO PRIORITY UKMIS GENEVA ROUTINE BONN, WASHINGTON, UKREP BRUSSELS

YOUR TEL NO 36 TO BONN: PROPOSED REVIEW OF HIGH ENERGY PARTICLE PHYSICS.

SUMMARY
1 THE REVIEW AND THE IMPLIED POSSIBILITY OF WITHDRAWAL WOULD GO DOWN BADLY IN FRANCE, INCLUDING WITH MITTERRAND PERSONALLY. WITHDRAWAL WOULD AFFECT WIDER INTERESTS.

DETAIL
2. MITTERRAND EMPHASISED THE IMPORTANCE HE ATTACHES TO CERN WHEN HE INAUGURATED THE NEW LEP RING NEAR GENEVA ON 13 SEPTEMBER. IN HIS SPEECH HE PAID TRIBUTE TO THE SUCCESS OF CERN AND ITS TALENTED RESEARCH TEAMS AND HELD IT UP AS AN EXAMPLE WHICH COULD BE USED AS A MODEL FOR FUTURE EUROPEAN SCIENTIFIC RESEARCH. CERN, HE SAID, BORE WITNESS TO THE FAITH PLACED IN IT BY THE MEMBER STATES AND TO THE POTENTIAL FOR FUTURE EUROPEAN TECHNICAL INDEPENDE-ENCE. THE SCHEME HAD BEEN APPROVED DESPITE THE ECONOMIC RECESSION. RECALLING SUCCESSFUL EUROPEAN COLLABORATION IN SPACE AND AVIATION, MITTERRAND SAID THAT A POLICY OF EUROPEAN COLLABORATION IN APPLIED SCIENCES THROUGH COMMON EXPERIMENTAL FACILITIES WOULD BE A CORNER-STONE ON WHICH TO BUILD A BROADER EUROPEAN RESEARCH POLICY. SPEAKING XABOUT THE FUTURE ROLE OF CERN, MITTERRAND SAID THAT FRANCE WOULD SPARE NO EFFORT IN ORDER TO GUARANTEE THE RESOURCES NECESSARY TO CAPITALISE ON THE OPPORTUNITIES OFFERED BY THE NEW FACILITY.
3. IT IS CLEAR FROM CONTACTS WE HAD AT THE TIME WITH STAFF AT THE ELYSEE WHO ACCOMPANIED THE PRESIDENT TO CERN THAT HE WAS EXPRESSING A VERY FIRMLY HELD PERSONAL VIEW WHEN SPEAKING IN THESE TERMS.
IS THEREFORE REASONABLE TO CONCLUDE THAT HE WOULD BE PERSONALLY CONCERNED BY ANY SUGGESTION THAT THE UK MIGHT WITHDRAW FROM CERN. WE WOULD BE KNOCKING A HOLE IN HIS IDEAS FOR A BROADER BASED EURO-PEAN RESEARCH POLICY AND TARNISHING THIS MODEL FOR FUTURE EUROPEAN COLLABORATION IN MAJOR TECHNOLOGICAL VENTURES. HE IS UNLIKELY TO TAKE KINDLY TO IT AND IT COULD WELL AFFECT HIS ATTITUDE ON OTHER ISSUES.

Of course - the Lep ring is largely on French soil.

4. THE ESTABLISHMENT OF A REVIEW COMMITTEE IN THE UK WOULD ITSELF PROBABLY BE REGARDED AS A PRECURSOR TO AN EVENTUAL UK WITHDRAWAL. INDEED, THE WARNING SHOTS FIRED IN THE 1 DECEMBER EDITION OF NATURE HAVE NOT GONE UNNOTICED HERE.

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5. AN EVENTUAL DECISION BY THE UK TO WITHDRAW FROM CERN WOULD BE GREETED WITH DISMAY BY THE SCIENTIFIC COMMUNITY. IT WOULD BE TAKEN AS AN ILLUSTRATION OF BRITISH UNWILLINGNESS TO BACK THE LARGE-SCALE SCIENTIFIC COLLABORATION NEEDED TO MAINTAIN CENTRES OF EXCELLENCE IN EUROPE

6. IF THE UK WERE TO WITHDRAW THE FRENCH POLITICAL COMMITMENT TO SCIENTIFIC ADVANCEMENT AND TECHNOLOGICAL INDEPENDENCE FROM THE US IS SUCH THAT THEY WOULD PROBABLY BE WILLING TO INCREASE THEIR OWN CONTRIBUTION, DESPITE THEIR OWN ECONOMIC DIFFICULTIES, IN ORDER TO KEEP CERN IN BUSINESS. THEY DID THIS WHEN WE DROPPED OUT OF THE INSTITUT LUE LANGEVIN (ILL) AT GRENOBLE AND WENT AHEAD WITHOUT THE UK UNTIL WE ASKED TO BUY OUR WAY BACK IN.
OUR EARLY PARTICIPATION IN AIRBUS AND ARIANE WENT THROUGH A SIMILAR PHASE. THERE ARE OTHER EXAMPLES.

7. UNTIL RECENTLY THE UK HAD A REPUTATION IN FRANCE AS AN UNRELIABLE PARTNER IN LARGE EUROPEAN SCIENTIFIC AND TECHNOLOGICAL PROJECTS. WE HAVE HEARD LESS OF THAT AS BIT BY BIT WE HAVE RESTORED OUR REPUTATION. BUT THE PROSPECT OF WITHDRAWAL FROM CERN WOULD REVIVE EARLIER DOUBTS AND CAST A SHADOW OVER OTHER FORMS OF COOPERATION WE ARE SEEKING INCLUDING THOSE IN THE DEFENCE AND COMMERCIAL SPHERES.

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TO IMMEDIATE FCO

TELEGRAM NUMBER 69 OF 20 JANUARY

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PROPOSED REVIEW OF HIGH-ENERGY PARTICLE PHYSICS

YOUR TELNO 36 OF 18 JAN

1. THE GERMANS WOULD REGARD SERIOUS DISCUSSION OF OUR POSSIBLE WITHDRAWAL FROM CERN WITH SOME DISMAY: A DECISION TO WITHDRAW WOULD CARRY POLITICAL AS WELL AS SCIENTIFIC AND COMMERCIAL PENALTIES. IT WOULD BE SEEN AS EVIDENCE OF A PENNY-PINCHING UNENTHUSIASTIC ATTITUDE TO COLLABORATION WITHIN EUROPE IN AN AREA OF IMPORTANCE AND IT WOULD CAST DOUBT ON OUR ABILITY TO MAINTAIN OUR POSITION IN SCIENTIFIC, TECHNOLOGICAL AND INDUSTRIAL DEVELOPMENTS.

2. THE GERMANS SEE CERN AS A MOST SUCCESSFUL EXAMPLE OF INTERNATIONAL COLLABORATION IN SCIENCE. ITS EXISTENCE HAS ENABLED EUROPEAN MEMBER STATES AT REASONABLE COST TO STAY IN THE FOREFRONT OF DEVELOPMENTS IN A FIELD WHICH IS NOT ONLY SCIENTIFICALLY IMPORTANT BUT WHICH HAS ALSO STIMULATED HIGH-TECHNOLOGY INDUSTRY AND PROVIDED CONTINUOUS OPPORTUNITIES FOR THE RIGOROUS TRAINING OF MANY OF EUROPES'S FIRST CLASS MINDS. THE RECENT PROOF BY THE CERN TEAM OF THE BASIC TRUTH OF THE ELECTRO-WEAK HYPOTHESIS RANKS WITH ANY OF THE GREAT LEAPS OF UNDERSTANDING OF THE PAST. IN DOING THIS CERN BEAT THE LARGER AND BETTER FUNDED US AND RUSSIAN TEAMS VERY CONVINCINGLY AND US PHYSICISTS ARE NOW TALKING OF BUILDING A ''SUPER CERN'' - THE DESERTRON. THE US GOVERNMENT AWARE OF THE NEED TO RETAIN SCIENTIFIC AND TECHNOLOGICAL SUPREMACY WILL UNDOUBTEDLY FUND THE DESERTRON. THE GERMAN GOVERNMENT HAS DECIDED TO SUPPLEMENT THE CERN PROGRAM WITH A NATIONAL ONE OF ITS OWN AT DESY IN HAMBURG WHOSE COST ALONE CONSIDERABLY EXCEEDS OUR CONTRIBUTION TO CERN.

3. IN THE UK WE NOW HAVE NO INDIGENOUS HIGH-ENERGY FACILITIES SO WITHDRAWAL FROM CERN WOULD BE SEEN AS TANTAMOUNT TO A WITHDRAWAL FROM FUNDAMENTAL PARTICLE PHYSICS AS WELL. THE GERMANS WOULD TAKE THIS AS A CONFESSION BY THE UK THAT WE NOW RANK OURSELVES WITH THOSE SMALLER POWERS WHO CAN NO LONGER AFFORD TO PLAY A ROLE IN THE SIGNIFICANT SCIENCE OF THE TWENTIETH CENTURY. THE CONTRAST WITH SPAIN WHICH HAS RECENTLY DECIDED TO JOIN CERN WOULD BE POINTED. THE GERMANS WOULD NOTE THAT OUR CONTRIBUTION TO CERN IS ONE QUARTER OF THEIR RESEARCH MINISTRY'S UNDERSPEND FOR 1983 EXCLAM.

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4. WITHDRAWAL WOULD INEXORABLY, IN GERMAN EYES, LEAD TO A DOWN-GRADING OF OUR TECHNOLOGICAL REPUTATION AND THIS IN TURN WOULD MAKE IT THAT MORE DIFFICULT TO SELL UK HIGH TECHNOLOGY HERE. WITHDRAWAL WOULD ALSO ENSURE THAT OUR HIGH TECHNOLOGY INDUSTRIES WOULD FIND IT DIFFICULT IF NOT IMPOSSIBLE TO GET FURTHER CONTRACTS FROM CERN ITSELF. ALREADY THE GERMANS HAVE INDICATED THAT WE WILL GET NO SIGNIFICANT ORDERS FOR EQUIPMENT FOR HERA AT DESY BECAUSE WE ARE NON-PARTICIPANTS.

5. WITHDRAWAL OR EVEN A DISCUSSION OF WITHDRAWAL WOULD PREJUDICE THE EFFORTS OF SERC TO ALLEVIATE ITS OTHER BIG PROBLEM, THE FUNDING OF ITS OWN LARGE NATIONAL ESTABLISHMENTS DARESBURY, RUTHERFORD ETC. THESE EFFORTS RELY ON AN INFLUX OF GERMAN AND OTHER EUROPEAN RESEARCHERS BRINGING WITH THEM RESEARCH FUNDS. HOBBIS AND ATKINSON OF SERC WERE HERE VERY RECENTLY DISCUSSING SUCH A SCHEME WITH MEMBERS OF THE RESEARCH MINISTRY. IF WE WITHDRAW FROM CERN HIGH ENERGY PHYSICS WOULD BECOME ONE MORE FIELD WHERE THE GERMANS MIGHT TURN TO EVEN CLOSER COOPERATION WITH THE FRENCH. THE GERMANS AND FRENCH WOULD THEN PROBABLY GO AHEAD WITH BUILDING EUROPEAN SYNCHROTRON RADIATION AND SPALLATION NEUTRON FACILITIES IN THEIR RESPECTIVE COUNTRIES. SERC MIGHT THEN BE IN EVEN WORSE FINANCIAL PLIGHT.

6. THE GERMAN SCIENTIFIC COMMUNITY WOULD FIND IT HARD TO UNDERSTAND THE REASONING BEHIND ANY WITHDRAWAL FROM CERN. IN PARTICULAR THEY WOULD QUESTION WHETHER THE ALTERNATIVE SMALL SCIENCE COULD HOPE TO BE EQUALLY GOOD SCIENCE WITH CLEAR COMMERCIAL VALUE. THEY WOULD ARGUE THAT SCIENCE IS A CULTURAL ACTIVITY IN ITS OWN RIGHT: AND THEY WOULD ALSO RECALL THAT HAHN AND STRASSMAN'S PURE SCIENCE LED EVENTUALLY TO NUCLEAR POWER STATIONS.

7. THE GERMANS WOULD FIND OUR DILEMMA OVER PAYMENT CURIOUS IN THAT THEY SEPARATE SUBSCRIPTIONS PAYMENTS (BMFT) FROM THE ACADEMIC RESEARCH SUPPORT SYSTEM (BMBW VIA DFG). THERE IS THUS NO CONFLICT OF INTEREST.

8. THE GERMANS HAVE A HEALTHY REGARD FOR BRITISH SCIENCE AND CONSIDER OUR ACHIEVEMENTS A VALUABLE ASSET FOR EUROPE AND ONE MOREOVER WITH GREAT POTENTIAL FOR FURTHER EUROPEAN COLLABORATION. WITHDRAWAL FROM CERN, ARGUABLY ONE OF EUROPE'S MOST SUCCESSFUL SCIENTIFIC VENTURES WOULD SORT ILL WITH OUR PROCLAIMED READINESS TO BE EAGER PARTICIPANTS IN NEW EUROPEAN INITIATIVES AND POLICIES FOLLOWING THE SUCCESSFUL CONCLUSION TO THE POST-STUTTGART NEGOTIATIONS.

9. WE CONCLUDE THAT DISCUSSION OF WITHDRAWAL FROM CERN AND, A PRIORI, WITHDRAWAL ITSELF WOULD SERIOUSLY DAMAGE OUR SCIENTIFIC AND EUROPEAN CREDENTIALS WITH THE GERMANS AND PLACE US AT A COMMERCIAL DISADVANTAGE HERE, IN THE FIELD OF HIGH TECHNOLOGY.

FCO PLEASE PASS TO SAVING ADDRESSEES.

TAYLOR

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PS/MR WHITNEY
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TO IMMEDIATE FCO
TELNO 17 OF 20 JANUARY
INFO PRIORITY UKMIS GENEVA
INFO SAVING HMCG GENEVA HMCG ZURICH

YOUR TELNO 36 TO BONN: PROPOSED REVIEW OF HIGH ENERGY PARTICLE PHYSICS

1. WHILST PART OF THE NEW ACCELERATOR IS IN FRENCH TERRITORY MOST OF CERN'S INSTALLATIONS ARE IN SWITZERLAND AND IT IS AN IMPORTANT INSTITUTION FOR THE SWISS. AN ANNOUNCEMENT OF THE REVIEW WITH THE IMPLICATION OF POSSIBLE UK WITHDRAWL FROM THE ORGANISATION WOULD BE UNLIKELY TO LEAD TO PUBLIC REACTION BY THE SWISS GOVERNMENT BUT THERE WOULD BE CONSIDERABLE CONCERN AND REGRET EXPRESSED IN PRIVATE. SUCH A DEVELOPMENT WOULD STRENGTHEN THE FEELING, ALREADY PREVALENT IN SWITZERLAND, THAT THE UK DOES NOT INVEST SUFFICIENTLY AND DOES NOT FOLLOW THROUGH ITS INVESTMENTS PROPERLY. IT WOULD INCREASE THE TENDENCY TO VIEW THE UK AS PERIPHERAL. IT WOULD ALSO HAVE ADVERSE EFFECTS IN SCIENTIFIC CIRCLES. REACTIONS AMONGST THE GENERAL PUBLIC WOULD DEPEND ON THE PROMINENCE GIVEN TO THE DECISION IN THE LOCAL MEDIA BUT WOULD PROBABLY NOT BE OF MUCH SIGNIFICANCE.

2. IN FINANCIAL TERMS, IT SHOULD BE BORNE IN MIND THAT WHILST THE UK CONTRIBUTION TO CERN'S 1984 BUDGET WILL BE APPROXIMATELY £28 MILLION (16% OF THE TOTAL), THE ORGANISATION'S PURCHASES OF SERVICES AND EQUIPMENT FORM THE UK IN 1984 MAY BE EXPECTED TO BE APPROXIMATELY £5/6 MILLIONS (APPROXIMATELY 6.5% OF CERN'S PURCHASING BUDGET). THE GAP BETWEEN THE UK CONTRIBUTION AND THE IMMEDIATE COMMERCIAL RETURN IS NOT A PROBLEM FACED BY THE UK ALONE. THE SCANDINAVIAN COUNTRIES AND ITALY ARE IN A SIMILAR POSITION AS IS THE FRG, WHICH AS THE LARGEST CONTRIBUTOR SUPPLIED SFR 157.5 MILLION IN 1982 AND RECEIVED ORDERS WORTH ONLY SFR 37.8 MILLION IN RETURN. CERN IS AWARE OF THE PROBLEM AND HAS BEEN DOING WHAT IT CAN, WITHIN THE TERMS OF ITS CONSTITUTION, TO INCREASE PURCHASES FROM THE UK. THIS AND THE FACT THAT MORE BRITISH FIRMS ARE BECOMING AWARE OF THE OPPORTUNITES AT CERN, MEANS THAT WE MAY EXPECT TO SEE AN INCREASE IN OUR SALES TO THE ORGANISATION OVER THE NEXT FEW YEARS.

3. CERN IS BOUND BY ITS STATUTES TO PURCHSE EQUIPMENT IN MEMEBR STATES UNLESS THEY CAN PROVIDE NO SOURCE OF SUPPLY.
THUS UK WITHDRAWL WOULD MEAN THE END OF PURCHASES FROM THE UK. SINCE CERN IS EUROPE'S LEADING SINGLE PURCHASER OF HIGH TECHNOLOGY EQUIPMENT IN MANY AREAS (EG ELECTRONICS, COMPUTERS, CYROGENICS AND HIGH VACUUM EQUIPMENT) UK WITHDRAWL WOULD DEPRIVE BRITISH INDUSTRY OF THE OPPORTUNITY OF COMPETING ON EQUAL TERMS WITH ITS MAIN TRADING PARTNERS IN AREAS OF BUSINESS CRUCIAL TO THE REVIVAL OF BRITISH INDUSTRY.

4. THE ADVANTAGES FOR FIRMS OF SELLING TO CERN ARE DIFFICULT TO QUANTIFY BUT STUDIES HAVE SHOWN THAT THEY CAN EXPECT COMMERCIAL SPIN-OFF IN MUCH THE SAME WAY AS US COMPANIES BENEFIT BY SELLING TO NASA. FIRMS CONCERNED CONSIDER CERN TO BE AN IMPORTANT REFERENCE AND FREQUENTLY QUOTE COST OR BELOW COST PRICES TO OBTAIN BUISNESS THERRE. MANY FIRMS HAVE RECEIVED ORDERS FROM OTHER ISTITUTIONS WITH WHICH CERN HAS LINKS AS A DIRECT RESULT OF HAVING SOLD TO CERN.

5. CERN EMPLOYES SOME 330 BRITISH SCIENTISTS AND TECHNICIANS. A UK WITHDRAWL WOULD MEAN THAT THEY WOULD HAVE TO FIND EMPLOYMENT ELSEWHERE AND, AS VIRTUALLY NO HIGH ENERGY PARTICLE PHYSICS RESEARCH IS UNDERTAKEN IN THE UK, MANY OF THEM WOULD PROBABLY GRAVITATE TO OTHER RESEARCH ESTABLISHMENTS IN EUROPE OR THE UNITED STATES AND THEIR SERVICES AND SPECIALISED KNOWLEDGE WOULD BE LOST TO THE UK.

6. THERE ARE THUS STRONG POLITICAL AND COMMERCIAL GROUNDS FOR CONTINUED MEMBERSHIP BUT THEY ARE OF COURSE SECONDARY TO THE SCIENTIFIC CONSIDERATIONS.

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YOUR TELNO 36TO BONN: PROPOSED REVIEW OF HIGH ENERGY PARTICLE PHYSICS

1. IN VIEW OF THE LINE WE HAVE BEEN TAKING RECENTLY OVER FINANCE FOR FUTURE PROJECTS, THE CERN MANAGEMENT WOULD NOT BE GREATLY SURPRISED BY THE ANNOUNCEMENT OF THE PROPOSED REVIEW. BUT IT WOULD BE A SERIOUS BLOW FOR THEM - PARTICULARLY IF, AS SEEMS TO BE THE CASE, THE REVIEW COMPRISES SOLELY HIGH ENERGY PARTICLE PHYSICS. CERN WOULD SEE THIS AS A PRELIMINARY STEP TO ALMOST CERTAIN UK WITHDRAWAL, EITHER PARTIAL OR COMPLETE.

2. THE CERN MANAGEMENT AS SUCH COULD HARDLY OBJECT TO THE SETTING UP OF A REVIEW.. BUT THEY - VERY POSSIBLY WITH MEMBER GOVERNMENTS - WOULD NOT FEEL INHIBITED IN USING THEIR WIDE CONTACTS WITHIN THE SCIENTIFIC COMMUNITY INFORMALLY TO ADVANCE THE CASE FOR CONTINUED BRITISH PARTICIPATION IN CERN . ANXIETY AMONG THE 300-ODD BRITISH SCIENTISTS AND TECHNICIANS EMPLOYED BY CERN ABOUT THEIR FUTUTRE IF THE UK WITHDRAWS WOULD REINFORCE THIS PRESSURE.

3. THE CERN MANAGEMENT MIGHT SEE THIS REVIEW AS THE THIN END OF THE WEDGE, FEARING THAT IF THE UK, AS A MAJOR PARTICIPANT, CALLS INTO QUESTION THE PRACTICAL VALUE OF CERN'S WORK, OTHER MEMBER GOVERNMENTS MAY SIMILARLY RE-EXAMINE THEIR OWN INVOLVEMENT, WITH A POSSIBLE KNOCK-ON EFFECT. PERSONALLY, HOWEVER I WOULD BE MORE INCLINED TO EXPECT THAT BOTH CERN AND OTHER MEMBERS WOULD REGARD OUR DEPARTURE MORE AS A REFLECTION ON OUR FINANCIAL POSITION AND SCIENTIFIC ASPIRATIONS IN THIS FIELD FOR THE FUTURE THAN ON THE VALIDITY OF THEIR VISIBLY SUCCESSFUL PROJECTS.

4. THE CERN AUTHORITIES MIGHT ALSO PUZZLE OVER HOW SOON THE UK COULD EXPECT TO SAVE ITSELF SUBSTANTIAL SUMS BY REDUCING ITS INVOLVEMENT IN CERN. THEY WOULD PROBABLY ASSUME THAT WE WERE COMMITTED TO CONTINUING TO CONTRIBUTE TO THE MAJOR LEP PROJEC
T
UNTIL IT IS COMPLETED AROUND THE END OF THE DECADE.

5. ASSUMING THAT THE ANNOUNCEMENT GOES AHEAD AS PLANNED, I WOULD RECOMMEND THAT THE DIRECTOR-GENERAL OF CERN BE GIVEN ADVANCE WARNING EITHER BY SERC OR VIA THIS MISSION.

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DEPARTMENT OF EDUCATION AND SCIENCE

ELIZABETH HOUSE, YORK ROAD, LONDON SE1 7PH

TELEPHONE 01-928 9222

FROM THE SECRETARY OF STATE

17 January 1984

Dear Geoffrey,

PROPOSED REVIEW OF HIGH ENERGY PARTICLE PHYSICS

I am taking the unusual step of writing to you informally on what on the face of it is an arcane subject because it may have diplomatic consequences meriting some rather careful thought and preparation.

Briefly, the Advisory Board for the Research Councils (the ABRC, which advises me on the distribution of the £500m or so per annum that constitutes the Science Budget) has reached the stage of questioning whether the UK can afford to continue to engage in research across the whole frontier of science, or should consider selective withdrawal from some major field. One obvious candidate, and probably the largest coherent activity, is high energy particle physics, where virtually the whole of the UK effort (which is, I am advised, first rate by world standards) is concentrated in CERN, to which most other West European countries also subscribe. Currently the UK subscription is about £30m per annum, about 5% of the Science Budget and over 10% of the budget of the Science and Engineering Research Council (the SERC, through whom the UK Government operates its membership). The ABRC has proposed to me that, with the SERC, it should review UK participation in high energy particle physics. An extract from the Board's advice and the proposed terms of reference and membership of the Review Group, are enclosed as Annexes A-C.

You will see that the intention is to make a full appraisal of options for the future level of UK activity in this field. It is far from being a foregone conclusion that we should withdraw from the subject, and thus from CERN. But, realistically, that must be one of the possibilities examined by the Group; and we, as a Government, must I think be willing to let this examination go on

/despite

PERSONAL AND CONFIDENTIAL
The Rt Hon Sir Geoffrey Howe QC MP
Secretary of State for Foreign and
  Commonwealth Affairs
Whitehall
LONDON SW1H

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despite the clear implication that, if the result were a recommendation to withdraw from CERN, we would address that proposal seriously. Indeed the two Chairmen concerned - Sir David Phillips and Professor Kingman - have asked me for an assurance on this point. There would of course be absolutely no prior commitment on our part one way or the other to any particular outcome.

The other assurance that the two Chairmen have sought is that, barring unpredicted crises, any funds that might in due course be released by reduction in our commitment to high energy particle physics should be available for redeployment elsewhere within the Science Vote.

I think the request for those two assurances entirely reasonable and intend to write formally to you, Nigel Lawson and our other Cabinet colleagues in due course to seek concurrence. I have had a preliminary word with the Prime Minister and believe she will be willing to see the review proceed on these terms.

However I thought it best to write to you first because the diplomatic consequences, especially for our relations with the other senior members of CERN - France and Germany - might prove to be the most problematic area in getting the review launched. There has been some limited reference in the science press to a possible review, and I believe that privately it will come as no surprise to our partners and to the top people at CERN. But that of course is a very different thing from saying that there will be little or no fuss when the review is formally announced (as it would have to be).

I can well see that you may wish to take soundings with posts on possible repercussions following an announcement of the review and any guidance they might have to offer on its public presentation. I hope this can be done rapidly. To be of use, the findings of the review should be available for the ABRC and SERC, and for Ministers, by the autumn even though any PES consequences are not likely to begin before the last year of the PES period. It is an exercise that, if it is to happen, should happen with dispatch; and I would ask the Group to try to complete its work within about six months. That would mean that they need to get started pretty soon.

Officials here have already had a first discussion with yours and stand ready to collaborate fully in the further work that will be required, as in providing briefing for posts. We, and the Review Group, will also need to look to your Department for help during the review, which will have to include some visits overseas and probably scientific and diplomatic soundings. I suggest that we should form an official shadow group chaired from here and including your Department in membership (as also the Treasury, DTI, Department of Energy and Dr Nicholson). The role of the shadow group would be to co-ordinate the preparation of Departmental evidence and briefing, and generally to keep in touch with the work of the Review Group. In this way we might avoid weighing down the latter with assessors while keeping the exercise on the rails.

/One

One other aspect to which your people may wish to give some preliminary thought is the legal. I am open to correction, but I do not see this as something requiring urgent examination before the review begins although it must be properly taken on board in the course of the review. As I see it, any changes we may subsequently embark on would have to be brought about by due process according with the Treaty requirements and taking account too of our moral obligations. I recall in particular that we undertook to participate in the construction of LEP Phase 1 although the commitment here was moral rather than legal. Any changes must take due account of such commitments and, if there were to be significant diminution in our contribution to CERN, my guess is that it is only realistic to think of the main impact coming towards the end of this decade and after.

As I said, I am writing only to you at this stage; I should of course be very happy to have some discussion if you wished. Either way I should be grateful if you could let me know fairly quickly that you see no objection to my proceeding to write more formally to colleagues, and whether there are aspects you would particularly like me to bring out in that letter.

Yours ever

Keith

CONFIDENTIAL

File

Subject cc Master.

bc. O. Letwin

10 DOWNING STREET

From the Private Secretary

13 January 1984

THE SCIENCE BUDGET

Your Secretary of State came to see the Prime Minister yesterday on the science budget. He said Professors Phillips and Kingman had suggested to him that the £30 million which the UK was spending on high energy particle physics could be spent more productively elsewhere within the science budget. Currently, because of pressure of resources, a number of valuable research projects with more immediate application for industry, were being passed over. They had suggested that an inquiry be set up to consider the UK's continued participation in CERN.

Your Secretary of State said that initially he had been sceptical, suspecting that the Professors might have been putting forward the most controversial option for cuts, but after a discussion with them he now believed that there should be a review. He felt that there might well be substantial support within the scientific community for this switch of emphasis. It would be difficult to refuse the science budget both additional resources and the chance to redeploy existing resources. There were, however, a number of international aspects to be considered, e.g., the effect on the UK's reputation as a reliable partner in international projects. Before minuting colleagues, your Secretary of State said he wanted to take the Prime Minister's mind.

B/F

The Prime Minister recognised the scientific interest in high energy particle physics, but she felt that CERN, in common with many collaborative projects, was extravagant. She therefore accepted the idea of a review. It was agreed that your Secretary of State would minute the Prime Minister, Foreign Secretary and Chancellor of the Exchequer. It was envisaged that the review would be chaired by Sir John Kendrew.

ANDREW TURNBULL

NR

Elizabeth

Miss C.E. Hodkinson,
Department of Education and Science.

CONFDIENTIAL

SECRET

File 2

cc O Letwin.

NOTE FOR THE RECORD

Sir Keith Joseph came to see the Prime Minister yesterday. In addition to the science budget, a discussion of which is recorded in my letter of 13 January to Elizabeth Hodkinson, he raised his initiative on teaching standards. He said that Mr. Philip Merridale, Chairman of the ACC Education Committee, was negotiating with the teachers' unions on proposals to secure:

(i) assessment of teachers by their peers for effectiveness;

(ii) new pay scales which would relegate poor teachers to a low scale with no increments and place those considered to be effective classroom teachers to higher scales.

In addition, there would be a definition of teachers' functions, e.g. whether they were expected to supervise lunchtimes.

Sir Keith said he had told Mr. Merridale that the Government was in no way committed to providing more money, but he thought it inevitable that the Government would be asked to provide additional resources if the package were to be accepted. Financing the new pay scales could cost between £100-200 million, beginning in 1985-86. (The teachers' pay bill is currently about £4 billion.) Sir Keith said he would put these proposals to colleagues in February or March and they could then judge whether the deal was worth accepting.

The Prime Minister expressed concern at the cost but did not oppose Sir Keith's wish to put forward the proposal.

Sir Keith said he felt the Treasury was softer on other departments, e.g. DTI, MSC and MAFF, than on DES. He wished to raise this in Cabinet if the Prime Minister did not object. She said she would be content provided the other Ministers concerned were given advance warning.

AT

13 January 1984

cc Education
Teachers Pay Pt 3.

PRIME MINISTER

Sir Keith Joseph is coming to see you tomorrow for an informal talk outside the context of PES and the Star Chamber, on various issues on science and education.

There are no papers. He might raise:

FLAG A

i) Science Budget - For figures see attached table.

Financial pressure is causing him to think seriously about UK participation in CERN. This suffers from lack of financial control characteristic of many international projects. It has high status in the scientific community but is a very long way from producing direct benefits for industry. Sir Keith may propose a review of some sort.

ii) Teachers' Superannuation

You recently disagreed with his proposals, arguing that teachers should bear some proportion of the required increase in contributions. Attached is the exchange of correspondence.

FLAG B.

iii) Standards

You could discuss with him the reaction to his recent initiative. He may raise the difficulty of seeing it through with the staff he currently has available in his Department.

iv) Standards in teaching

You could ask him for progress on his proposals to raise standards without conceding an increase in the wage bill for teachers.

v) Tenure

Sir Keith owes you a paper on this which should be available shortly.

AT

11 January 1984

Reference..

Copy to Miss A Brown
Mr R P Norton
Mr A G Myatt (and file)
DWT

MISS C E HODKINSON

SCIENCE BUDGET 1983/4 AND THE CERN SUBSCRIPTION

1. From the 1983-4 Supply Estimates

Council etc	Grant-in-Aid £M (rounded)	% (rounded)
AFRC	46.0	9
MRC	113.7	22
NERC	62.5	12
SERC	254.5	50
(of which, CERN	27.9	11)
ESRC	22.4	4
BM(NH)	9.4	2
Royal Society	5.0	1
Total	513.5	100
(of which, CERN	27.9	5)

2. The out-turn for the CERN subscription is expected to be higher - £32.1M - because of changes in exchange rate. This would be nearer 13% of SERC's grant-in-aid, the difference having to be met within their cash limit and without augmentation.

DWT

D W TANNER
11 January 1984

CODE 18-77

CONFIDENTIAL

Subject

File

cc Master

cc Master

10 DOWNING STREET

From the Private Secretary

19 October 1983

MAINTAINING THE STRENGTH OF THE SCIENCE BASE

The Prime Minister took a meeting today to discuss your Secretary of State's proposals for maintaining the strength of the science base. Also present were the Chancellor of the Exchequer, the Secretary of State for Defence, the Chief Secretary, Treasury, the Minister of State for Industry and Information Technology, Sir Robert Armstrong and Dr. Nicholson.

Your Secretary of State opened by saying that he was seeking additional funding for the Science Budget of £35 million, £55 and £75 million over the next three years. In his bilaterals with the Chief Secretary, additions had been agreed to cover the cost of subscriptions to international bodies such as CERN.

He explained the background to his remaining bids. Additional money was needed to maintain existing programmes to enable the Research Councils to finance pay settlements determined elsewhere; to make good pension fund deficiencies; and to provide continued funding of the IT programme. In addition, he was seeking to finance further developments. These would cover re-structuring as the Research Councils were required to finance redundancies out of their own budgets. He was also seeking additional finance to allow a higher proportion of top grade projects to be accepted. He argued that the money could be found by transfers from the Defence Budget. In discussion it was argued that the Science Budget of nearly £550 million was already very large; that if difficult choices on priorities had to be made, this was equally true in other areas both in the public and private sectors; that the UK had for years financed fundamental research generously but with poor results. The priority now was to boost the commercial exploitation and application of technology. It was also argued that if transfers from the Defence Budget were to be allowed these should go not to the Research Councils but to industrial research.

Your Secretary of State suggested that some of the Ministry of Defence's own research could be routed through the universities. It was agreed that universities could tender in competition with the private sector on the understanding that they would be contractors, doing work specified by MOD, within budget limits specified by MOD. There could be no question of providing any subsidy to the universities. It was noted, however, that even

/on these terms

AC

on these terms this would be a desirable development as it would help to spread overheads.

Summing up, the Prime Minister said that the case for expanding the Science Budget had not been made out. It should be possible to absorb the proposed additions within the existing Budget. The priority was to achieve commercial exploitation of technology rather than the expansion of fundamental research. It was agreed that Sir David Phillips should approach the Chief Scientist at MOD to discuss the terms on which universities could secure additional defence research work. The Chief Scientific Adviser, in the course of his review of research policy, should look at the charters of research bodies. The DES should look again at the problem of removing tenure in the Research Councils.

I am copying this letter to John Kerr (H.M. Treasury), John Gieve (Chief Secretary's Office, H.M. Treasury), Richard Mottram (Ministry of Defence), Neil McMillan (Office of the Minister of State (IT) Department of Trade and Industry), Dr. Nicholson and to Richard Hatfield (Cabinet Office).

MR. A. TURNBULL

Miss Elizabeth Hodkinson,
Department of Education and Science.

Prime Minister (1)

AT 18/10

CONFIDENTIAL

W.0699

18 October 1983

PRIME MINISTER

Maintaining the Strength of the Science Base
Handling Notes

1. The Secretary of State for Education and Science wrote to you on September 15 suggesting an increase in the Science Vote which might be funded by savings in Defence R & D. You responded that a discussion of the general principles involved would be worthwhile but that many of the issues raised in his minute were matters for the Public Expenditure Survey.

Flag A

2. The discussion is planned for 3 p.m. on Wednesday, October 19. Those attending are:

Chancellor of the Exchequer
Secretary of State for Education and Science
Secretary of State for Defence
Minister of State for Industry and Information Technology
Chief Secretary
Sir Robert Armstrong

Background

3. In his minute Sir Keith Joseph recalled the comments made by industrialists at your Seminar on Science, Technology and Industry on the importance of maintaining a high quality science base. He believed that current resources were insufficient to do this and that the maintenance of the existing range of research, the opening up of new areas of science and the redeployment of resources within research councils were all being hindered as a result. He suggested increased expenditures for the Science Vote of £35 million in 1984/85, £55 million in 1985/86 and £75 million in 1986/87. Finally, he indicated that offsetting savings might be found within the R & D budget in the Ministry of Defence.

Flag B 4. In response, Mr Heseltine pointed out that only £330 million of the £1,900 million R & D budget in MoD was spent on research and of that £150 million was spent in industry and the Universities (£9 million of the total). He indicated that his policy was to maximise the amount of defence R & D to be carried out in industry and Universities.

Flag C 5. In my own minute of October 14 (which has not been circulated to Ministers), I supported Sir Keith Joseph's proposal to increase the Science Vote on the basis that I perceived real signs of damage to the quality of the science base. I suggested that a decision on where to make offsetting savings would be better left to the 1985/86 PES discussions at which time Ministers would have the report which you asked me to prepare on Government Research Capability.

Flag D 6. Mr Mount's minute of October 18 argues that the shift of R & D resources from MoD to DES has merit but that this can only be accomplished in the PES bilaterals.

Handling

7. I suggest that you separate the principle of an increase in the Science Vote from the practicalities. On the principle you will wish to ask Sir Keith Joseph to introduce the discussion. Mr Heseltine and Mr Baker may wish to comment. I expect their remarks to be broadly supportive although Mr Baker may query whether any extra resources would better go towards stimulating industrial R & D through the DTI Support for Innovation scheme. You may wish to ask Sir Keith Joseph how he intends to ensure that any extra resources go towards real improvements in the science base and what measures he proposes to increase the flexibility and efficiency of Research Councils.

8. Possible conclusions are:

(a) the DES case is not made;

(b) the DES case is made but not to the extent of the full amount proposed (£35 million in 1984/85);

(c) the DES case is made to the full amount;

(b) or (c) seem the most likely conclusions.

You are aware of position here. With £130 million of additional bids still on table, scope for offsetting savings in DES programme is limited AT

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9. On practicalities, you could ask the Chief Secretary to report on the state of his PES bilateral with DES and the possibility of including arrangements for offsetting savings at this stage in the 1984/85 PES round. Mr Heseltine will wish to indicate his preference for increasing the allocation of defence R & D expenditure in Universities but keeping the responsibility for it in MoD. Sir Keith Joseph will want to stress the urgency of taking action in 1984/85.

10. Possible conclusions are:

(a) the matter cannot be dealt with until 1985/86;

(b) a PES or post-PES transfer to DES can be arranged in 1984/85;

(c) an increase in the Science Vote for 1984/85 can go ahead followed by a search for offsetting savings in 1985/86.

Treasury Ministers are likely to argue for (a) or (b), but Mr Heseltine will not want (b) since the only clear source of the transfer at this stage is MoD. Sir Keith Joseph will argue for (b) or (c) on grounds of the urgency of the need. As a result of your Seminar, you yourself will have reached a view on the importance of the science base and the degree of urgency of putting increased resources towards it.

11. I am sending copies of this minute to Sir Robert Armstrong and Mr Mount.

RBN.

ROBIN B NICHOLSON

SECRET

18 October 1983
Policy Unit

PRIME MINISTER

MAINTAINING THE STRENGTH OF THE SCIENCE BASE

MS

The DES Bid

Keith wishes to enlarge the DES science budget by roughly 10 per cent. He is making extra bids of:

1984/5	1985/6	1986/7
£35m	£55m	£75m *

Of this, Peter Rees has already conceded:

£6m	£8m	£7m *

to cover the increased cost of subscriptions to international bodies, such as CERN.

Robin Nicholson supports the DES view that the remaining bids are very worthwhile (see Annex for description). But it is worth pointing out that they mostly seem to be towards the "purer" end of the research spectrum. By contrast, the defence research budget is likely to be predominantly "applied", even if sometimes misapplied.

The Proposed Transfer

It should surely be our aim to switch public funds from defence research to civilian research. Our whole economy is distorted by the present preponderance of research on defence. But we ought not to start until Robin Nicholson has completed his general study of Government-funded scientific research.

Meanwhile, Robin argues that the funds sought by Sir Keith should be taken from the general defence budget.

We disagree because:

1. The Treasury is seeking large reductions in the MOD PES bid. If £35 million could be cut from the MOD bid, then it should simply be cut, not regarded as free cash for DES.

* Figures rounded for PESC purposes

SECRET

2. To allow a switch from one general departmental budget to another, outside the PES discussions, would be to set a dangerous precedent, not only for the future years, but for the next few weeks. MAFF and DTI might both demand a share of the Defence Research savings.

We therefore suggest that:

(a) You reject the DES request.

(b) After Dr Nicholson has reported, you should ask for the science research budget to be considered as a whole across departmental boundaries, and funds allocated in the desired proportions. A small ad hoc Scientific Research Committee of Ministers, chaired by you, might need to be set up for this purpose.

Increasing MOD Research in Universities

Sir Keith's second suggestion, that MOD should farm out more of its research to the universities, is welcomed by all parties.

We suggest that you should encourage Michael Heseltine to go ahead with his investigation and bring forward proposals to the Scientific Research Committee.

FM

FERDINAND MOUNT

SECRET

ANNEX

EXTRA DES BIDS FOR SCIENTIFIC RESEARCH

NOT YET CONCEDED BY THE CHIEF SECRETARY

		1984/5	1985/6 £m	1986/7
1.	Continuation of existing policies, including run-on cost of IT programme, and increases in cost of pension funds	9	12	23 *
2.	Policy developments, including:			
a.	Raising acceptance rate of alpha-quality research grants (including those deriving from new blood appointments)	4.0	6.9	8.5
b.	Restructuring	5.3	8.3	11.6
c.	Application of advanced technology to manufacturing engineering	2.1	2.8	3.5
d.	Biotechnology	1.1	2.2	3.5
e.	Food and nutrition	0.5	1.1	2.3
f.	Neurosciences, medical aspects of nutrition, diagnostic imaging	2.4	2.6	2.7
g.	Remote sensing, atmospheric sciences, marine sciences, deep geology	3.2	4.4	5.8
h.	Spectroscopic measurement of cosmic X-ray sources by space telescope	1.1	2.8	3.2
i.	British Museum (Natural History) - refurbishment consequent on East Infill cancellation, including PSA fees	2.4	2.5	2.6
	TOTAL:	£22.1m	£33.6m	£43.7m

* Figures rounded for PESC purposes

SECRET

~~cc NO~~

W.0682

14 October 1983

MR TURNBULL, No 10

I attach my minute for the Prime Minister on the subject of 'Maintaining the strength of the science base'.

2. As we agreed, I will confer with Oliver Letwin on his return from Blackpool on the subject of producing a brief handling note for the Prime Minister for her meeting on 19 October.

RBN

ROBIN B NICHOLSON

cc: (with attachment) Mr Letwin

W.0683 14 October 1983

PRIME MINISTER

MAINTAINING THE STRENGTH OF THE SCIENCE BASE

1. I have seen a copy of the minute to you from the Secretary of State for Education and Science (dated 15 September) on maintaining the strength of the science base.

2. From the remarks made at your Seminar on Science, Technology and Industry, it is clear that the private sector of industry sees the successful exploitation of a strong science base as a key ingredient in developing a modern, competitive industry.

3. Scientific achievement is one league table where I believe the UK is still top in per capita terms and second probably only to the USA in absolute terms. If the UK is to have a prosperous future, it is imperative that this position is maintained and, of course, exploited far better than has been the case in the past.

4. The Research Councils, like our Universities, undoubtedly developed flab during the years of rapid expansion in the 1950s and 1960s. But the flab has been lost in the last ten years as new scientific and engineering opportunities have had to be accommodated in a Science Vote which has been static in real terms.

But the economy has been static in real terms

5. Now, as I have seen at first hand both as a member of SERC and in the last two years as a member of the Advisory Board for the Research Councils, the excellence of our science base is starting to be eroded through insufficient funding. The evidence is:

(a) a substantial fraction of first-class proposals from Universities to Research Councils in existing areas of science are not being funded (these are the so-called "alpha" proposals which are judged to be essential to the development of the subject in question: no merely desirable "beta" proposals have been funded for many years now);

(b) we are not moving as fast as our competitors into some of the exciting new areas of science: neuroscience, biomolecular electronics, artificial intelligence, remote sensing, robotics, novel materials, medical diagnostic techniques;

(c) there is a renewed 'brain drain' amongst young people in some of the most exciting areas of science.

6. For these reasons, I strongly support the Secretary of State's bid for additional resources for the Science Vote in 1984/85 and subsequent years. I also welcome his intention to allocate the resources in a way which ensures that they are used to meet the problems I have referred to above and to continue the reform of research councils' organisation so that they become more flexible and better able in future to respond rapidly to the new scientific opportunities.

7. On the question of offsetting savings, raised in the Secretary of State's minute, I believe there are opportunites for these in the rest of the UK's R & D spend and that these opportunities will be more readily identifiable by Ministers after the study I am currently doing for you on the Government Research Capability (my minute to you of 2 August).

8. It is too early in the study for me to predict where savings might be found but it seems unlikely that it will be possible to find arguments to sustain the privileged position of the Ministry of Defence and the United Kingdom Atomic Energy Authority whereby they conduct substantial programmes of basic research themselves. As Professor Kingman pointed out in your Seminar, there are considerable difficulties in predicting which areas of basic research are likely to be relevant to specific technologies.

9. The Secretary of State for Defence is right in saying in his minute to you of 4 October that there are one or two technologies, such as nuclear weapons technology, where MoD has to do its own basic research. But I very much doubt that this argument can be used to justify more than a part of the £330M research spend of MoD or the £50M spend of UKAEA on long-term and non-nuclear R & D.

10. However, I must advise against making offsetting savings for the 1984/85 additional bid for the Science Vote by anticipating the outcome of my study. It would be better to treat the 1984/85 bid as an additional R & D cost and make plans to offset, in whole or in part, the 1985/86 and 1986/87 bids through properly planned savings.

11. It is tempting, of course, to postpone the increase in the Science Vote until the year when savings can accrue. I believe that this would be a disastrous course of action. It will be much harder (and more expensive) to restore the quality of our science base once it has started to erode rapidly; we must act quickly now to maintain its quality. Additionally the momentum created by your Seminar, which promises to redouble peoples' efforts in science and its application, will be lost.

12. I have copied this minute only to Sir Robert Armstrong.

Robin

ROBIN B NICHOLSON

Cabinet Office
14 October

cc/NO

Prime Minister ②

A meeting is arranged on this for 19 October.

AT 6/10

MO 26/1

PRIME MINISTER

MAINTAINING THE STRENGTH OF THE SCIENCE BASE

In his minute to you of 15th September, Keith Joseph suggested inter alia that an increase in his Science Budget might be funded in part by redeploying funds from "the very large expenditure on defence research and development", and that my Department might contract work to University Departments as an alternative to recruiting replacements for MOD scientists reaching retirement age. I understand that we are to meet to discuss the general issue of strengthening the science base: you may find helpful some initial comments on the defence related issues.

2. I think it is important to put expenditure on defence research into proper perspective. As I explained at your Science Seminar, of the £1900M we plan to spend this year on Defence Research and Development some 83% is for the development of specific weapons and equipment for the Armed Services and the bulk of this will be spent in industry. We plan to spend £330M on research itself: some £150M of this will be spent either in industry or the Universities (£9M of the total), partly on specific projects and partly on maintaining a capability in technologies of particular relevance to Defence. A transfer from defence R&D to "pay for" increases in the science budget would in practice represent a cut in the defence budget and would have to be justified as such and addressed, as you have already suggested, in this year's public expenditure round.

3. As regards recruitment, my policy is that defence R & D should to the maximum extent possible be carried out in industry or the Universities. We have already devolved a lot of work to industry and plan to devolve more. The number of civil servants employed at Defence R & D Establishments, since 1979, has been reduced by some 4,500 including 1,400 (some 14%) in the Science, Professional and Technological Groups. Recruiting has been constrained for some years; but we too must maintain an inflow of good quality people if we are to have the capability we need in the future for the nuclear programme (which has to be done in-house) and for the essential support of the Services and their equipment programmes. This said I should be very happy to look at the scope for increasing the proportion of our effort which is placed with the Universities.

4. I am copying this to Nigel Lawson, Keith Joseph, Cecil Parkinson, Peter Rees and Sir Robert Armstrong.

MH

Ministry of Defence
4th October 1983

SCIENCE + TECH: Science Base

Sept 85

- 6 OCT 198[illegible]

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file

bc Ferdie Mount

BOP

10 DOWNING STREET

From the Private Secretary

20 September 1983

MAINTAINING THE STRENGTH OF THE SCIENCE BASE

The Prime Minister read with interest your Secretary of State's minute of 15 September on this subject.

Mrs. Thatcher recognises that many of the issues raised in this minute are a matter for the Public Expenditure Survey. But she agrees to a discussion of the general principles involved, and we will be in touch with you and the other Ministers' offices concerned to fix a date.

I am copying this letter to John Kerr (HM Treasury), Richard Mottram (Ministry of Defence), Jonathan Spencer (Department of Trade and Industry), John Gieve (Chief Secretary's Office) and Richard Hatfield (Cabinet Office).

M. C. SCHOLAR

Mrs. Imogen Wilde,
Department of Education and Science

CONFIDENTIAL

Prime Minister

This is partly a matter for the expenditure survey. But would you like a discussion with Sir Keith, the Chief Secretary and Mr Heseltine on the principles involved?

MCS 16/9

PRIME MINISTER

Yes

MAINTAINING THE STRENGTH OF THE SCIENCE BASE

Your pioneering Science Seminar came incidentally at a particularly opportune time because we shall soon have to decide the budgets of the five Research Councils. In preparation for these decisions Sir David Phillips, Chairman of the ABRC, has advised me that there is:-

(a) scope for some economies and consequent redeployment of resources within the science budget - you are already aware of some suggestions for the ARC. Sir David Phillips recently, with my approval, invited Sir Ronald Mason to make a quick survey of the effects of commissioned research on the Science Budget/Research Councils and this, I am told, is likely to identify further possibilities in one other Research Council;

(b) need for some more money even after the above redeployment to maintain the existing range of research; and

(c) need also for modest extra resources to enable research into whole new areas of science recently opened up.

2. The importance of maintaining a high quality science base across a wide field was stressed at your seminar by representatives of industry. Sir Geoffrey Allen, for example, said that industry relied on the Government to provide a scientific

establishment which gave industry a window on the world of science and technology; an entrée to new or unfamiliar areas of science; and a supply of scientists, technologists and engineers of the right quality. Sir Clive Sinclair stressed the need to be in the new technologies if we are to remain competitive because other countries will not share commercially exploitable new technologies with us.

3. Sir David Phillips has emphasised to me that which was explained by Professor Kingman and others at the seminar. A top quality science base requires a steady inflow of the most talented young people into science and the right standard of equipment in the laboratories in which they work. There is clear evidence of concern on both these counts. Opportunities to appoint young research workers have fallen and the condition of some "well-found" laboratories has deteriorated.

4. We have, of course, taken steps to deal with these problems, in particular the new blood initiative. But I believe that, to protect the quality of the science base, we must do more. I have, in order to make (b) and (c) above possible, submitted in the current public expenditure round a bid for an increase in the present science budget of £35 million in 1984-85 (which is about 6% of the baseline provision for that year) rising to £55 million in 1985/86 and £75 million in 1986/87.

5. It is most certainly not my intention to give the Research Councils this extra money and leave it at that. They are already redeploying resources from one area of science to another and this process must be intensified. It will involve the closing of research institutes and redundancies - some were announced last week by the ARC. I am sure that more could be done to increase efficiency and value for money, to attract private finance (eg from industry as suggested by the Advisory Council for Applied Research and Development) and to share the costs of big science with other suitable countries. Action on these fronts is in hand. But I am satisfied that over the next few years the

Science Vote needs more money to finance the redeployment. (As you probably know, the cost of pensions to staff made redundant are a charge to the Science Vote and are not, as with Government Department redundancies, borne elsewhere.) In return for the extra funds I would ask the Research Councils to commit themselves to a programme of action on the lines sketched out above.

6. These proposals would, I believe, represent a good bargain for the Exchequer. Even so, I recognise that they present a problem to the Treasury and I think that we should consider whether, if not for 1984/85 then for later years, there are any ways of solving the problems to which I have referred without adding to the Treasury's difficulties. One possibility might be to redeploy funds from some other expenditure programme. The one that seems to me relevant in this context is the very large expenditure on defence research and development.

7. We have all for many years had doubts whether this large concentration of resources was deployed in the best interests of the country as a whole. Michael Heseltine told the seminar on Monday about the latest efforts to increase civil spin-off. I think there may in addition be a case for switching some funds from the Defence Budget to the Science Vote in order to maintain the quality of the science base - on which the defence industries and the Armed Forces depend as well as everyone else.

8. There is another way in which cooperation between the Ministry of Defence and the general scientific community could help to preserve and enhance the quality of the science base. I understand that a significant number of Government scientists in the defence research establishments are reaching retirement age and will be difficult to replace. Rather than increasing recruitment for the scientific Civil Service, would it not be better for the Ministry of Defence to give suitable contracts to selected university departments? The security problems should not, I think, be an overriding obstacle - the United States

6

Government gives very highly classified contracts to its universities. And there would be clear advantages:-

i. We would hold down the size of the Civil Service.

ii. By limiting the time-scale of each contract, the Ministry of Defence (and the Universities) would retain the flexibility to switch from one specialism to another as needs changed with the passing of time.

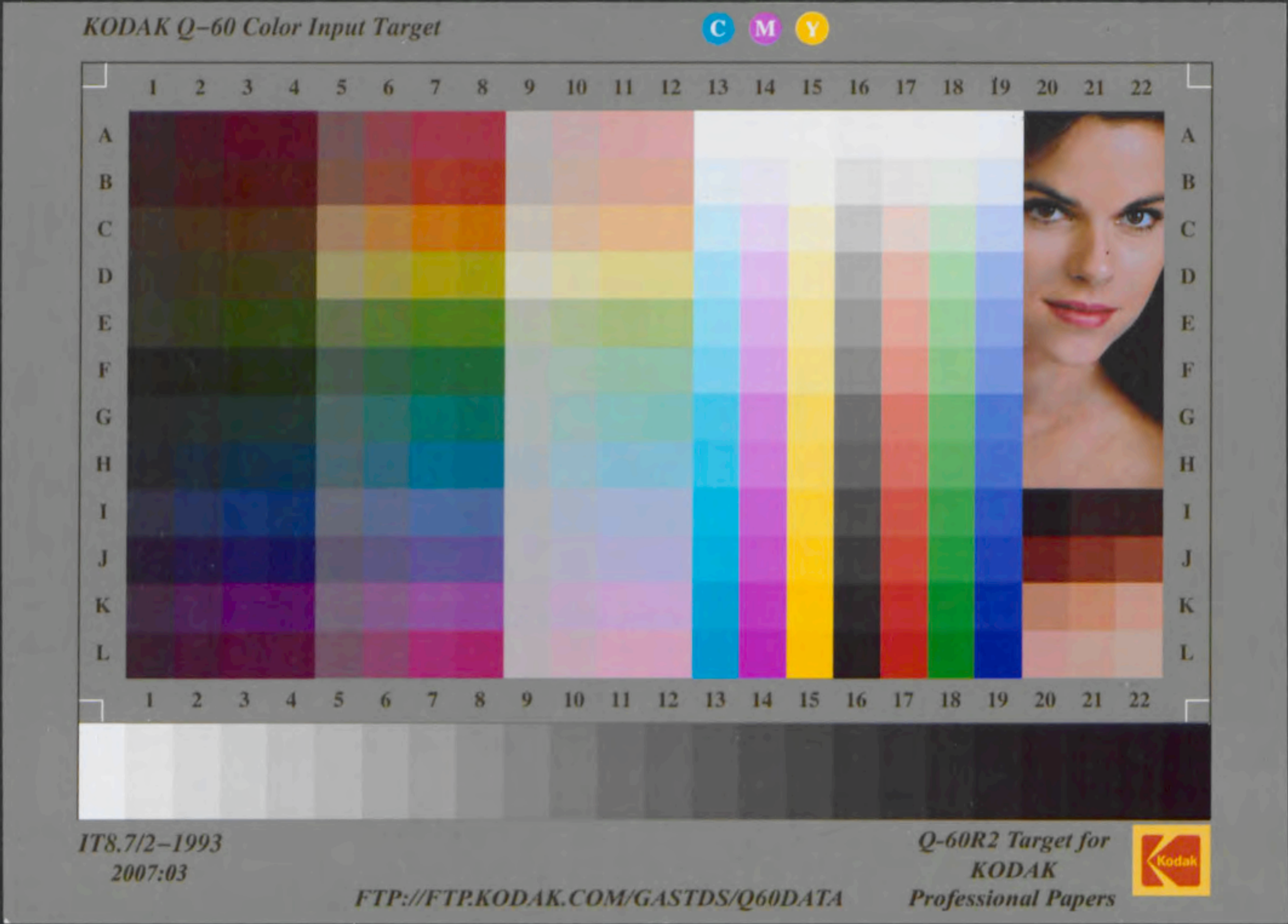
iii. Standards at the Universities would be kept up by first-class well-funded research; and under-graduates would benefit from being taught by staff engaged in extending frontiers of knowledge - a point stressed by Professor Kingman at your Seminar.

7. These are big issues important to the Government as a whole. They merit serious discussion. I hope you will call us together for that purpose in the near future.

10. I am sending copies of this minute to Nigel Lawson, Michael Heseltine, Cecil Parkinson, Peter Rees and Sir Robert Armstrong.

KJ 15.9.83

6 SEP 1983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