PREM 19/1514

Part 3

Confidential Filing

ACARD

GOVERNMENT MACHINERY

Part 1 : May 1979

Part 3 : January 1982

Attached Folder : ACARD report "Exploitable Areas of Science".

Referred to	Date	Referred to	Date	Referred to	Date	Referred to	Date
~~25.1.82~~		~~4.10.85~~					
~~1.3.82~~		~~7.10.85~~					
~~5.3.82~~		~~31.10.85~~					
~~8.3.82~~		7.11.85					
~~25.3.82~~							
~~8.4.82~~							
~~15.4.82~~							
~~27.4.82~~		PART ENDS.					
~~4.5.82~~							
~~30.9.82~~							
~~6.1.83~~							
~~14.4.83~~							
~~27.5.83~~							
~~14.10.83~~							
~~17.1.84~~							
~~19.1.84~~							
~~23.2.84~~							
~~9.3.84~~							
~~9/4/84~~							
~~14.5.84~~							
~~12/7/84~~							
~~20/7/84~~							
~~20/7/84~~							
~~14/9/85~~							

PREM 19/1514

For Annual Review of Research 1953

See Seperate box

PART 3 ends:-

PM to Sir H Chilver 7.10.85

PART 4 begins:-

A. Tolan to MEA 5.3.86.

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.

1. Annual Review of government funded R & D (Cabinet Office paper)
   HMSO, 1984 [ISBN 0 11 630825 7]
2. Government response to the ACARD report on the Food Industry and Technology [MAFF paper]

Signed P Wayland Date 4 February 2014

PREM Records Team

10 DOWNING STREET

THE PRIME MINISTER

7 October 1985

Dear Sir Henry,

Thank you for your letter of 9 September and the report of the Council on "Exploitable Areas of Science".

I strongly support the main thrust of the report that United Kingdom R & D must be more exploitable and that we ourselves must exploit it better. As the report points out some other countries do seem able to identify the promising new areas with industrial potential sooner than we do and act on them more quickly. I therefore welcome the proposal in the report for improving the UK performance. I agree that the arrangements should be separate from and funded independently of Government but should, nevertheless, have a major influence on R & D supported by Government. Involvement of both the industrial and scientific communities will be vital if the private and public sectors are both to contribute towards increasing the exploitation of our national effort in science and technology.

Yours sincerely

Margaret Thatcher

Sir Henry Chilver

DRAFT 6
OVERTAKEN.

10 DOWNING STREET

THE PRIME MINISTER

7 October 1985

Dear Sir Henry.

Thank you for your letter of 9 September and the report of the Council on "Exploitable Areas of Science".

I strongly support the main thrust of the report that United Kingdom R&D must be more exploitable and that we ourselves must exploit it better. As the report points out some other countries do seem able to identify the promising new areas with industrial potential sooner than we do and act on them more quickly. I therefore welcome the proposal in the report for improving the UK performance. I agree that the arrangements should be separate from and funded independently of Government but should, nevertheless, have a major influence on R&D supported by Government. Involvement of both the industrial and scientific communities will be vital if the private and public sectors are both to contribute towards increasing the exploitation of our national effort in science and technology.

I agree to Part I of the report being given wider dissemination through publication and that it should be vigorously followed up along the lines which you have discussed with Sir Robin Nicholson.

Yours sincerely

Margaret Thatcher

Sir Henry Chilver.

Ale

bc Sir R. Nicholson.

10 DOWNING STREET

From the Private Secretary

MR. TOLAN
Cabinet Office

ACARD REPORT - EXPLOITABLE AREAS OF SCIENCE

We have discussed your minute to me of 31 October.

The Prime Minister has agreed that her letter to Sir Henry Chilver be printed at the front of part 1 of the ACARD Report.

I attach the letter, amended as we discussed on the telephone, which the Prime Minister has re-signed.

MARK ADDISON
5 November 1985

E.R.

PRIME MINISTER

cf. attached
ppr please.

Earlier this month you wrote to Sir Henry Chilver (copy attached) supporting the conclusions of the ACARD report on exploitable areas of science, and agreeing to Part I of the report being published (Part II is more technical and is the factual basis on which the analysis and conclusions of Part I are based). Cabinet Office think it would add a great deal of weight to the Report if your letter to Sir Henry Chilver were published at the front. There is a precedent for publishing Ministerial responses to ACARD reports. The Cabinet Office proposal seems a good one.

If the letter is published, it would, I think, be better to omit the last paragraph, since this might convey the impression to those not reading the report carefully that Part II has been "suppressed". Sir Henry would be happy for you to re-sign the letter, omitting that paragraph.

An amended draft is attached for your signature.

Mark Addison

MEA

4 November, 1985.

C0440

MR ADDISON
No 10

cc Sir Robin Nicholson

31 October 1985

ACARD REPORT - EXPLOITABLE AREAS OF SCIENCE

Sir Robin Nicholson minuted you on 3 October about Sir Henry Chilver's letter to the Prime Minister on the ACARD report "Exploitable Areas of Science".

2. Subsequently (on 7 October) the Prime Minister wrote to Sir Henry agreeing to publication of the report and to the follow-up action suggested.

3. The report has recently gone forward to HMSO for printing but the view was taken that it would be of benefit in progressing further the work started by the ACARD study to have the Prime Minister's letter published in the front of the report. There is a precedent for Ministerial responses to ACARD reports to be published. A letter from the Secretary of State for Trade and Industry was included in the Government Response to the ACARD Report "New Opportunities in Manufacturing: The Management of Technology" published in September 1984.

4. I would be grateful to know if you see any difficulty in printing the Prime Minister's letter in the ACARD report.

pp L Dolphin

A TOLAN

Cabinet Office
31 October 1985

aant Mach: ACARD P+3

10 DOWNING STREET

From the Private Secretary

SIR ROBIN NICHOLSON

The Prime Minister has seen your minute of 3 october about the report by ACARD on "Exploitable Areas of Science". She agrees with the course you propose and has written to Sir Henry Chilver accordingly. I enclose a copy of the Prime Minister's letter.

7 October 1985

BEMBBO

10 DOWNING STREET

THE PRIME MINISTER

7 October 1985

Thank you for your letter of 9 September and the report of the Council on "Exploitable Areas of Science".

I strongly support the main thrust of the report that United Kingdom R & D must be more exploitable and that we ourselves must exploit it better. As the report points out some other countries do seem able to identify the promising new areas with industrial potential sooner than we do and act on them more quickly. I therefore welcome the proposal in the report for improving the UK performance. I agree that the arrangements should be separate from and funded independently of Government but should, nevertheless, have a major influence on R & D supported by Government. Involvement of both the industrial and scientific communities will be vital if the private and public sectors are both to contribute towards increasing the exploitation of our national effort in science and technology.

Sir Henry Chilver

10 DOWNING STREET

THE PRIME MINISTER

7 October 1985

Dear Sir Henry.

Thank you for your letter of 9 September and the report of the Council on "Exploitable Areas of Science".

I strongly support the main thrust of the report that United Kingdom R&D must be more exploitable and that we ourselves must exploit it better. As the report points out some other countries do seem able to identify the promising new areas with industrial potential sooner than we do and act on them more quickly. I therefore welcome the proposal in the report for improving the UK performance. I agree that the arrangements should be separate from and funded independently of Government but should, nevertheless, have a major influence on R&D supported by Government. Involvement of both the industrial and scientific communities will be vital if the private and public sectors are both to contribute towards increasing the exploitation of our national effort in science and technology.

I agree to Part I of the report being given wider dissemination through publication and that it should be vigorously followed up along the lines which you have discussed with Sir Robin Nicholson.

Yours sincerely

Margaret Thatcher

Sir Henry Chilver.

PRIME MINISTER

EXPLOITABLE AREAS OF SCIENCE

Sir Henry Chilver has written to you (Flag A) covering an ACARD study report on exploitable areas of science. I do not think that you would need to look closely at the report, especially this weekend. A summary is however at Flag B. Sir Robin Nicholson has provided a commentary on the ACARD report and proposes that you should agree to its publication and its further progress along the lines proposed by Sir Henry. If you agree with this approach a draft letter to Sir Henry Chilver is attached at Flag C.

Tim Flesher
4 October 1985

MJ2BER

BCS

DRAFT LETTER FOR THE PRIME MINISTER TO SEND TO SIR HENRY CHILVER, CHAIRMAN OF THE ADVISORY COUNCIL FOR APPLIED RESEARCH AND DEVELOPMENT

EXPLOITABLE AREAS OF SCIENCE

Thank you for your letter of 9 September and the report of the Council on "Exploitable Areas of Science".

I ~~have read the report with interest and~~ strongly support ~~its~~ main thrust to the Report that United Kingdom R & D must be more exploitable and that we ourselves must exploit it better. As the report points out some other countries do seem able to identify the promising new areas with industrial potential sooner than we do and act on them more quickly. I therefore welcome the proposal in the report for improving the UK preformance. I agree that the arrangements should be separate from and funded independently of Government but should, nevertheless, have a major influence on R & D supported by Government. Involvement of both the industrial and scientific communities will be vital if the private and public sectors are both to contribute towards increasing the exploitation of our national effort in science and technology.

I agree to Part I of the report being given wider dissemination through publication and that it should be vigorously followed up along the lines which you have discussed with Sir Robin Nicholson.

Prime Minister

WO680

PRIME MINISTER 3 October 1985

EXPLOITABLE AREAS OF SCIENCE

I have received a copy of the letter of 9 September from Sir Henry Chilver, Chairman of the Advisory Council for Applied Research and Development, drawing your attention to a report by the Council on Exploitable Areas of Science and seeking approval to publish part of the report. You may wish to have further background to this exercise as well as my recommendation for your reply. My comments concern the study itself, the report and the need for further action.

The Study

2. As Sir Henry Chilver has said in his letter, the study was concerned with areas of current scientific research which are exploitable or likely soon to be exploitable for economic benefit. The study was not an easy one for ACARD to mount and its completion was in large part due to the unstinting efforts of Dr Charles Reece who also made available substantial resources from ICI. The group itself was lively, talented and tackled the work with gusto, but as they point out in the first part of their report they have only been able to touch the surface of the subject. However, their view of its importance was unanimous and development of the work on a more substantial basis was considered vital. In my view their approach to the study was right in that they talked to leading scientists, market analysts, corporate planners, technical directors, design engineers, etc in companies and in the public sector but the sample was too small for the type of dialogue and evolutionary development of ideas which the group believes is necessary for the future.

The Report

3. As Sir Henry Chilver points out in his letter, the report is divided into two parts. You have received Part I of the report which presents the case for establishing a process in the UK for developing an overview of exploitable areas of science and makes a recommendation to this effect. I believe that this recommendation is well supported by the consultations made during the course of the exercise. Representations were made by major companies that there is no means in the UK by which a broad view of the inter-relation of developments in scientific knowledge and market trends can be obtained; even a company with the resources of ICI admit that their foresight activities are focussed very much on interests obviously and immediately relevant to company business and would be glad of a wider perspective to give greater confidence in investing. The USA is able to obtain that perspective through the major "think tanks" like Stanford Research Institute , Battelle, etc and Japan has the Nomura Institute with the banks also involved in developing long term perspectives; this is supplemented in both these countries by a network of private consultants and other organisations. France has recently set up Centres d'Evaluation to undertake such activities. The UK approach is much more hit or miss. Thus companies undertake R & D assessments using a variety of techniques, the Research Councils have their peer review system, Government Departments have their advisory committee but all are narrowly focussed and experience difficulty in relating their work to the wider UK and international scenes. Ministers are currently discussing the need for a more concerted effort by Departments to ensure that Government support for R & D contributes more to national wealth creation. The process suggested by ACARD is, I believe, very germane to those considerations.

4. Perhaps I should emphasise some things this report is **not trying** to do:

a. it is **not** about bureaucrats telling scientists what basic research to do; as you are well aware, that is a recipe for disaster

b. it is **not** about "coordination" to remove decision-taking responsibilities from where they properly belong

c. most emphatically, it is **not** about bureaucrats "picking winners"; to forecast exploitable areas of science in a precise or comprehensive way is not possible.

Rather the aim is to provide, through input from people involved in new sciences, new products, new markets etc a reservoir of knowledge which all these people can use to inform them as they make their daily decisions on research priorities, risk assessment, competitive threats and market opportunities. The belief is that an individual is more likely to make correct decisions on new technologies and winning products if he is well informed on the assessments made by experts over the whole range of science and technology and their applications.

5. Sir Henry Chilver has not sent you a copy of Part II of the report which describes some results of applying the process described in Part I, albeit in a very limited fashion. It is not proposed to publish Part II but to use it as a first input into the further work which I describe below.

Further Action

6. ACARD invited the Chairman and myself to consider how the recommendation might be implemented. My advice to Sir Henry was that the activity should be spun-off from ACARD and, indeed, from Government although Government would contnue to be advised by it. Further, to establish independence and authority in the eyes of industry and the technical community as a whole it should not be funded by Government. We have therefore held meetings with several independent institutions capable of accommodating the activity. Our present inclination is towards the London Business School as the best home. It has access to the necessary economic databases, and has computer hardware and wide links through the business and scientific community both nationally and internationally. So far as funding is concerned, which may be in the region of a quarter of a million pounds per annum, the Leverhulme Trust has informally given its enthusiastic support provided the ACARD recommendation is approved by Government and it is likely that others like the Wolfson Foundation, and Welcome Foundation would be willing to contribute. Such funding is, however, viewed as pump priming for the first 3 years or so after which it is

anticipated that the Centre would become self-financing by obtaining contracts from industry and others.

7. The report itself does not in my view require a formal published response by Government. An appropriate way to handle it might be by means of a letter from you to Sir Henry giving approval to publish the report and informing him that you have invited me to progress further the implementationof the ACARD recommendation.

8. A draft letter for your consideration is attached.

RBN.

SIR ROBIN NICHOLSON
Chief Scientific Adviser

EXECUTIVE SUMMARY

1. There is a thesis, widely accepted in the United Kingdom, that basic research cannot be organised to deliver economic return. The thesis is not generally accepted in other countries. They believe that science is now so important to a country's future that some attempt must be made to structure support, and achieve more effective exploitation of science.

2. This exercise is an overview gathered by the Study Group after consulting an incomplete but generally representative series of groups in the United Kingdom. It is therefore limited in depth and completeness. It is set against a backcloth study of the predictions of scientific futures in USA, Japan, France and Germany.

3. The report analyses the prospect for increasing longer term economic return to the United Kingdom of the expenditure on scientific research. It is divided into Part I - Exploitable Science - The Need for a Process, and Part II - An Investigation of Exploitable Science in the UK.

4. We believe that its value lies mainly in the conclusion that some mechanism is needed in the best interests of the country to prioritise and guide a fairly high proportion of that part of the national scientific resource paid for by the taxpayer, and to stimulate its effective exploitation to the benefit of the United Kingdom. It is recognised that the remaining and significant proportion of publicly funded scientific research should be determined by peer judgement of scientific excellence etc in the established way.

5. The study recognises that the past levels of support of UK science has been the desirable result of prosperity and that its fruits have tended to give benefits worldwide rather than to the United Kingdom. However, in the future, national economic success will be built on the foundations of scientific knowledge and capability. From this comes the challenge which we must meet - to use our considerable national investment in scientific ability for the national benefit.

6. We do not have a forum in the United Kingdom where we can manage the process referred to above. It is we believe a matter of national priority that such a forum be established.

WO679

MR ADDISON - NO.10

3 October 1985

ACARD REPORT - EXPLOITABLE AREAS OF SCIENCE.

You asked for my advice on Sir Henry Chilver's letter to the Prime Minister of 9 September enclosing a copy of Part I of the ACARD report on "Exploitable Areas of Science".

2. Attached is

a. My advice to the Prime Minister on the report
b. A draft reply for the Prime Minister to send to Sir Henry Chilver which is based on my advice *
c. A copy of Part II of the report for your files
d. An annex giving an example of the process used in Part II of the report also for your files.

Fold w att. —

3. I do not recommend giving c. and d. to the Prime Minister since they merely illustrate the starting point for a continuation of the ACARD study which is proposed to be "spin-off" to an outside organisation.

4. I have not provided a summary of Part I of the report since there is an Executive Summary in the report already.

RNBW

SIR ROBIN NICHOLSON
Chief Scientific Adviser

Copied to Sir Robert Armstrong.

* See next piece

ANNEX

ACARD REPORT - EXPLOITABLE AREAS OF SCIENCE

A SYNOPSIS OF THE APPROACH BY REFERENCE TO COMMUNICATIONS

1. Part II of the ACARD Report has been arranged round the theme that technology acts as a bridge between science and the production of goods and services which are valued in the market-place. The approach involves selection of a small number of areas and consideration of the primary trends in science, technologies, market needs, economic and social environments in each. Such an analysis sidesteps many complex issues by focussing on broadly defined trends and a more detailed identificiation of strategic promise in science would need to look in much greater detail at developments in particular markets, in the profitability of different technological solutions and the contributions which different services would make to chosen solutions.

2. For each selected area, a schematic representation has been drawn up (see attached scheme for Communications) to illustrate the mutual interactions between areas of science, technology applications, and areas of economic activity. This capsular scheme is used to emphasise the mutual influence of spheres of activity and that developments do not follow a simple linear sequence. The core of each scheme describes economic activities which are currently disernable or possible, surrounded by an inner layer of technology applications broadly relevant to these economic activities, and an outer layer of the scientific areas from which new technologies in the market-place will arise. The schemes are intended to show how commercially valuable technology arises from a combination of market forces and scientific advance.

3. Taking Communications as an example, it is foreseen that at a general level communication technology will permeate practically all human endeavours, and will have a profound influence on the pattern of life, through, for example, basic changes to the production and processing methods of industry, employment and leisure, economic and social development, and even the interaction between nations. The key feature of the so-called information society is the

controlled acquisition of an accumulation of knowledge in communications systems and amplification of the processing techniques with which to use that acquired knowledge. The support of knowledge systems themselves thus becomes a major driving force of economic activity to which the following areas will be particularly susceptible.

- transactions between individuals and groups
- private services sectors and access to information, privacy
- diversification of training, education and employment opportunities
- internationalisation of business opportunities
- video, cable and satellite applications
- impact on paper-based systems of database technology
- networking, databases and global communications
- internationalisation of languages

4. Translated into exploitable science such market forces will drive the need for advances in the acquisition and handling of information which is regarded as a key area of promise in strategic science with large potential technological and economic rewards. The major elements are

a. Acquisition - Sensor technology, solid state physics, electronic engineering, polymer- electro- and software chemistry, molecular electronics.

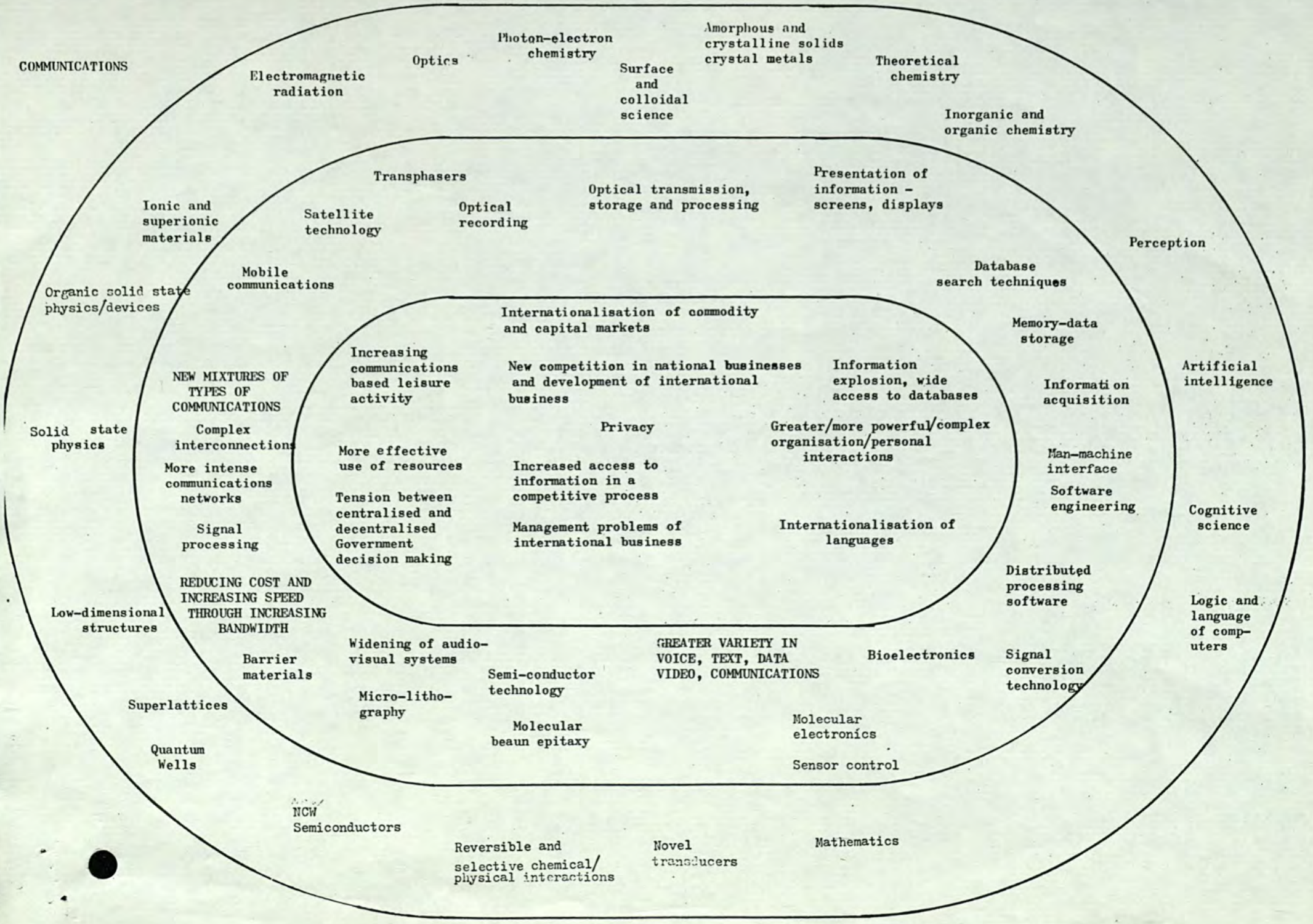
b. Organisation - Memory technology (optical and bioelectronic), photo-electron chemistry, expert systems, artificial intelligence, cognitive science, perception.

c. Processing — Replacement of Von Neumann processes by parallel processing techniques, optical processing, distributed processing architecture, signal conversion technology.

d. Transmission - Optical fibre communications, satellites, remote sensing, navigation.

e. Exploitation - Knowledge elicitation, high resolution optical presentation, holography, oral presentation and synthesis.

5. Other areas treated in this fashion in Part II of the report include energy, environment, transportation, health, housing and building, food and clothing/furnishings, education, leisure.


COMMUNICATIONS
Electromagnetic radiation
Optics
Photon-electron chemistry
Surface and colloidal science
Amorphous and crystalline solids crystal metals
Theoretical chemistry
Inorganic and organic chemistry
Transphasers
Ionic and superionic materials
Satellite technology
Optical recording
Optical transmission, storage and processing
Presentation of information - screens, displays
Perception
Mobile communications
Database search techniques
Organic solid state physics/devices
Internationalisation of commodity and capital markets
Memory-data storage
Increasing communications based leisure activity
New competition in national businesses and development of international business
Information explosion, wide access to databases
Artificial intelligence
NEW MIXTURES OF TYPES OF COMMUNICATIONS
Information acquisition
Solid state physics
Complex interconnections
Privacy
Greater/more powerful/complex organisation/personal interactions
More effective use of resources
Man-machine interface
More intense communications networks
Increased access to information in a competitive process
Software engineering
Tension between centralised and decentralised Government decision making
Cognitive science
Signal processing
Management problems of international business
Internationalisation of languages
REDUCING COST AND INCREASING SPEED THROUGH INCREASING BANDWIDTH
Distributed processing software
Low-dimensional structures
Logic and language of computers
Widening of audio-visual systems
GREATER VARIETY IN VOICE, TEXT, DATA VIDEO, COMMUNICATIONS
Bioelectronics
Signal conversion technology
Barrier materials
Semi-conductor technology
Micro-lithography
Superlattices
Molecular beaun epitaxy
Molecular electronics
Quantum Wells
Sensor control
NCW Semiconductors
Reversible and selective chemical/physical interactions
Novel transducers
Mathematics

SRW

Sir Robin Nicholson

EXPLOITABLE AREAS OF SCIENCE

I would be grateful for any comments you have on Sir Henry Chilver's letter, and for advice on the terms on which the Prime Minister should reply.

(MARK ADDISON)
11 September 1985

SRW

ADVISORY COUNCIL FOR APPLIED RESEARCH AND DEVELOPMENT
70 Whitehall, London SW1A 2AS Telephone: 01-233

The Prime Minister
10 Downing Street
London S W 1

9 September 1985

Dear Prime Minister

Exploitable Areas of Science

Over the past 18 months or so, ACARD has been studying ways in which we can identify more readily areas of science which are economically exploitable, and I am writing to seek your agreement to:

(i) publication of part of a report of an ACARD Study Group on this subject

(ii) endorsement of the proposal to continue the work of ACARD in this area by transferring the process of assessment to other appropriate organisations

Late in 1983, ACARD set up a study under the chairmanship of Dr Charles Reece, ICI's Director of Research and Technology, to survey current scientific developments in order to advise the Council on work which showed commercial potential in the medium to long-term.

The study, which was seen as complementary to the Council's activities in advising Government on the Annual Review of Research and Development, represented a new departure for the Council which has previously regarded its remit as to consider and encourage new technologies, such as robotics and computer-aided techniques, which are ripe for immediate exploitation by industry.

The study was partly prompted by the realisation that the UK does not have a recognised institution whose primary function is to make assessments of the future potential of science and technology. Other countries, notably the USA, Japan and France, have such organisations in the private or public sectors. Private industry itself, and particularly the major companies, have ways of evaluating R & D activities in their own areas of expertise in order to guide their investment decision-taking, although medium-sized and smaller companies do not have access to such a capability. In the public sector the peer review system is used by the Research Councils in selecting priorities for support but the basis of this is primarily academic in nature.

ACARD's interest was therefore in the possibility of obtaining insights into a broad spectrum of science and of presenting some value judgements on the potential of that science for contributing to the economic well-being of the country in the future.

As a preliminary to the exercise, the Council asked the Science Policy Research Unit (SPRU) of Sussex University to advise on how other countries went about the business of considering the potential of science and technology. The findings were published last year by SPRU as a book entitled "Foresight in Science". The major proposal of SPRU was that the UK should attempt to bring its level of longer term foresight activities up to that found in Japan.

The ACARD study, completed earlier this year, was considered recently by the Council. Perhaps the length of time taken for its completion and the size of the report give some indication of the complexity of the task. The report is divided into two parts: Part 1 is concerned with the need for a process in the UK for determining exploitable science priorities; Part II reports the results of a preliminary attempt at such a process. Although with the time and expertise available the study was limited in scope, ACARD was sufficiently encouraged to seek to carry it forward, and it endorsed the main recommendation of Part I which is to establish "a process for identifying exploitable areas of science, which has some certainty of continuity for the long-term economic health of the country". The ABRC also recognise a need for such a process in the UK.

Dr Reece considers it vital that the Group's effort is vigorously followed up and this seems to be the general view of industrialists. ACARD also wished to receive further advice on how the recommendation to "spin-off" this activity might be implemented; I have discussed this with Sir Robin Nicholson, and I understand that he will be advising you separately about this. The arrangements which we have considered are I believe the best possible and should provide a structure which other countries like Japan and the USA already have. The essential requirement is that the process should be credible and authoritative, should win the commitment of those involved so that it is influential, and should be of a long term nature if the results of its activities are to have effect.

The purpose of this letter is therefore to ask for your approval for the publication of Part I of Dr Reece's Group's work as an ACARD report. I hope we may also have your endorsement of the plans to "spin-off" the process begun by ACARD to appropriate organisations outside Government.

Yours sincerely
Henry Chilver

Sir Henry Chilver
Chairman

WO614

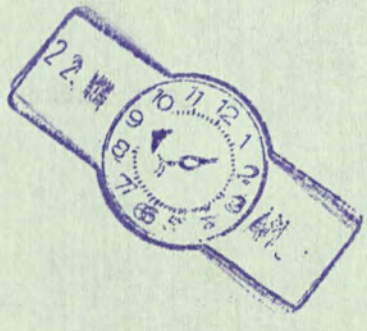
MR ADDISON - No.10

21 August 1985

ACARD REPORT - EXPLOITABLE AREAS OF SCIENCE.

The Prime Minister will shortly be receiving a letter from Sir Henry Chilver asking for her approval to publish the above ACARD report and also for her endorsement of an on-going programme of work. I shall want to put in a minute of my own, when this matter is considered by the Prime Minister, so I would be grateful if you could hold Sir Henry's letter until my return from leave.

pp SIR ROBIN NICHOLSON
Chief Scientific Adviser



CF adop

I think X is probably on the ACARD file. Please p.a.

DMB 20/7

70 WHITEHALL, LONDON SW1A 2AS

01-233 8319

From the Secretary of the Cabinet and Head of the Home Civil Service

Sir Robert Armstrong GCB CVO

Ref. A084/2091

20 July 1984

Dear Andrew,

Machinery for Handling Information Technology Issues

Your letter of 5 July confirmed that your Secretary of State was content for there to be a review of committee machinery for dealing with IT issues and asked to see the proposed terms of reference. 1X

We had not, in fact, envisaged setting formal terms of reference for this exercise. The aim would be, simply, to consider, in conjunction with the Departments principally concerned, whether the present structure of those committees for which Cabinet Office has secretariat responsibility is best suited to the future handling of IT issues, including "tradeable information", and to make recommendations accordingly. We are conscious, for example, that the Official Committee on Information Technology has not met for two years, which must raise doubts about the need for its continuing existence.

I understand that Dr Nicholson has already written to Mr Croft in your Department with some initial thoughts on the matter and intends to hold a meeting of interested Departments in the near future.

I am copying this letter to David Barclay (No. 10), Hugh Taylor (Home Office, Elizabeth Hodkinson (DES), Michael Reidy (DEn), Steve Godber (DHSS), Mary Brown (MPO), Mike Corcoran (Treasury) and Len Appleyard (FCO) and to Dr Nicholson here.

Yours

(R P Hatfield)
Private Secretary

A Lansley Esq

20 JUL 1984

MINISTRY OF AGRICULTURE, FISHERIES AND FOOD
WHITEHALL PLACE, LONDON SW1A 2HH

From the Minister

11 6pm
13/7

Sir Henry Chilver
Vice-Chancellor
Cranfield Institute of Technology
Cranfield
Bedford
MK43 0AL

12 July 1984

Dear Sir Henry

I am writing to let you know that the Government's Response to the Advisory Council's Report on "The Food Industry and Technology" will be published on Monday, 16 July. A copy of the Response is enclosed.

As you will remember, the Report emphasised the importance of the food industry to the national economy and to the consumer, and the need for it to be in the van of technical progress and efficiency. The Response recognises the strategic importance of the food industry, and describes the major contribution which the Government is making to the benefit of the industry and the consumer through its increasing support for food R and D. It also highlights further actions which should be taken by the industry collectively, by individual firms and by the Government to enable the food industry to take full advantage of available and developing technology in the future.

I hope very much that the Response will generate further interest and activity in food research and in the application of technology in the industry.

I am sending copies of this letter and enclosure to the Prime Minister, Keith Joseph, Norman Tebbit, Nigel Lawson, Norman Fowler, George Younger and to Sir Robert Armstrong and Dr Robin Nicholson, Chief Scientific Officer, Cabinet Office.

Yours

MICHAEL JOPLING

DRAFT PRESS NOTICE

GOVERNMENT RESPONDS TO "FOOD INDUSTRY AND TECHNOLOGY" REPORT

The Government today outlined new arrangements for the determination of research and development priorities, the encouragement of innovation and the improvement of uptake of new technology in the food industry. This was in response to the report by the Advisory Council for Applied Research and Development (ACARD) on "The Food Industry and Technology",

The Government response recognises the strategic importance of the food manufacturing industry with its responsibilities for supplying safe, nutritious and attractive food to the consumer, and for processing a large proportion of the country's agricultural production. It describes the major contribution which the Government is making to the benefit of the industry and the consumer through its increasing support for food research and development. It outlines new arrangements for the determination of priorities, the encouragement of innovation and the improvement of uptake of new technology To enable the food industry to take full advantage of available and developing technology in the future, further actions which should be taken by the industry collectively, by individual firms and by the Government are also highlighted.

The ACARD report which was published in 1983, recommended measures designed to harness modern technology more effectively in the food industry; increase the rate of innovation in the food machinery sector; expand research and development; maintain a high level of safety in food products; and improve the efficiency of food processing and the quality and range of the industry's products for markets at home and overseas.

BM

c. Dr. Nicholson
+ Ld Caldecote's file

10 DOWNING STREET

From the Private Secretary

14 May 1984

I am writing on behalf of the Prime Minister to thank you for your letter of 10 May.

Mrs. Thatcher values your comments and was most grateful to you for writing.

(David Barclay)

Viscount Caldecote, D.S.C.

R12

The Fellowship of Engineering

Incorporated by Royal Charter

2 Little Smith Street, Westminster, London SW1P 3DL Telephone 01-222 2688

From the President: Viscount Caldecote, D.S.C., F.Eng.

PPS

10th May 1984

The Rt. Hon. Margaret Thatcher, MP,
Prime Minister,
10 Downing Street,
London SW1.

Dear Prime Minister,

Thank you very much for your letter of 29th March about my retirement from ACARD, and please accept my apologies for such long delay in acknowledging it. I have greatly enjoyed my membership of ACARD, which I believe performs a useful function.

I also enjoyed the work we did in the working party on "New Opportunities in Manufacturing", which drew attention to the urgency and benefits of investment in manufacturing technology. I am looking forward to seeing the government's response to our recommendations, although I believe that the main effort must come from industry itself.

Two major conferences have been arranged to give prominence to the recommendations of this report, one took place in Southampton in April and the second will be held in Cambridge in July. I very much hope that these and other activities will encourage industry to take advantage of the opportunities that these new methods present.

Added emphasis is given to this by the recently published figures indicating that in spite of substantial improvements in productivity last year unit labour costs went up by over 2% due to increased earnings in manufacturing industry. This must be a matter of serious concern, particularly as unit labour costs actually fell in the U.S.A., West Germany and Japan.

It is thus clear that greater investment in new manufacturing technology is of overriding importance if we are to regain our competitive position. There are, I believe, two principal obstacles to this.

The first problem stems from lack of confidence by management that the greatly increased output capacity of the new manufacturing plant and systems will be fully used, for if it is not the high cost of the investment cannot be justified. Some stimulation of demand is for this reason important. I know full well your determination to reduce inflation still further but I hope I will not incur your wrath by submitting that the risk-reward ratio as between inflationary pressure and investment encouragement (which if successful will reduce costs and so be counter inflationary) is so favourable that some risk in stimulating demand is well justified.

The second relates to the first: it is a shortage of suitably qualified engineers to plan and execute competently such investment, which more and more involves systems engineering as well as a clear appreciation of the financial implications referred to in the ACARD report. By and large this shortage of engineers is being tackled by proposals put forward by The Engineering Council, supported by The Fellowship of Engineering and the engineering institutions. But the outcome of these proposals will take some time to become effective so I very much hope the Government will accept them quickly including their financial implications.

Another effective way of creating the number of engineers required relatively quickly is to devote more resources to continuing education, including the use of distance learning techniques, with the objective of retraining traditionally educated engineers and physicists in subjects such as electronics and new manufacturing systems, where serious shortages exist.

As you will see from the attached report of the Southampton Conference, one of the principal conclusions related to this issue. I do submit that these proposals should be followed up as a matter of great urgency for, if we lose this opportunity, our manufacturing base will be so damaged that the slow climb out of recession will peter out with disastrous implications for the future.

With renewed thanks for your kind letter,

Yours sincerely

Robin Calderke

PRESS RELEASE PRESS RELEASE

THE ENGINEERING COUNCIL

RELEASE PRESS RELEASE PRESS

'INVEST OR BUST,' CONFERENCE TOLD

Invest or bust. That was the urgent message given to a conference of industrialists and academics at Southampton University by Sir Basil Blackwell, chief executive of the Westland Group.

"While you might go out of business if you do invest in new manufacturing methods - you most certainly will if you do not", Sir Basil said bluntly. His own organisation has recently introduced new automated techniques for producing the electronic systems and components used in the manufacture of helicopters.

The conference, organised by the Southern Science and Technology Forum, in collaboration with The Engineering Council and the CBI, today endorsed the conclusion of a hard-hitting report published by the Advisory Council for Applied Research and Development (ACARD) last October.

The conference urged companies of all sizes to examine the potential of New Opportunities in Manufacturing (the title of the ACARD report). Too many companies had not yet applied advanced manufacturing technology to their production processes. These companies would become progressively less competitive and many would not survive the next ten years, the conference concluded.

Commitment at board level, together with detailed strategic planning in written form, were confirmed as important requirements by a panel of distinguished speakers. But the importance of stimulating an innovative approach to the manufacturing process from all levels of the company was also emphasised as a top priority for senior management.

more follows ....

Chaired by Viscount Caldecote, chairman of Investors in Industry and president of the Fellowship of Engineering, the panel of speakers included John Fairclough, director, manufacturing and development, IBM (UK) Limited; Derek Roberts, technical director of GEC; Sir Austin Bide, chairman of Glaxo and British Leyland; Robert Malpas, a managing director, The British Petroleum Company plc; J L D Gailey, managing director of Gidding, Lewis Fraser; Malcolm Harker, managing director of Harker & Sons (Engineers); and Sir Geoffrey Chandler, former director-general of the National Economic Development Office.

Viscount Caldecote and Messrs. Roberts, Malpas, Harker and Fairclough are all members of The Engineering Council.

The panel addressed a gathering of over 80 representatives from industry, education and government at the two-day conference.

The conference urged the need for a national awareness campaign for the application of advanced manufacturing technology in British industry comparable to that applied to information technology. If necessary, some funds to implement this could come from a transfer from the information technology campaign.

A dominant theme running through the discussions and conclusions was the importance of relating investment to market needs. One obstacle to the rapid application of these new manufacturing systems was the shortage of certain skills, particularly in systems engineering and in those capable of planning the introduction of new technology.

The conference appreciated that The Engineering Council was tackling these problems but felt that it will take too long if we have to rely on training at undergraduate level. The conference concluded that much greater effort needed to be applied to continuing education of all kinds. This should include appropriate short courses at universities and polytechnics. Perhaps the most effective mechanism was through the Open University since this enabled re-training to take place without long periods away from the place of employment.

more follows ....

The conference therefore urged the Government to make available pump priming funds to the Open University to provide teaching material in the field of manufacturing technology - with the objective that these courses would ultimately become self-financing.

Other recommendations will be published in a report of the conference proceedings which will be available from Paul Barnes at the Southern Science and Technology Forum; Telephone: Southampton (0703) 553404 (direct line) or 559122 extn. 2426.

Issued by The Engineering Council on April 17, 1984.

Media inquiries to Ron Kirby, Director of Public Affairs, on 01-240 7891.

FCCS 84

10 DOWNING STREET

From the Private Secretary

9 April, 1984

The Prime Minister has asked me to thank you for your letter of 30 March. She was glad to learn of the high opinion you have of the Chief Scientist and his staff. She has also noted with considerable interest your views on the difference between the mere "containment of cost" and obtaining better value for money in the public sector.

DAVID BARCLAY

Sir Alan Muir Wood

SIR WILLIAM HALCROW & PARTNERS

CONSULTING ENGINEERS

SHORTLANDS LONDON W6 8BT

(At 3 Shortlands, Hammersmith International Centre)

Telephone: National 01-741 8080
International +441 741 8080
Telex: 916148 (A/B HALCRO G)

Our Ref. AMMW/jmp Your Ref.

March 30 1984

Prime Minister (4)

I will reply. RQ

Dumb
2/4

Rt. Hon. Mrs Margaret Thatcher, PC MP
Prime Minister
10 Downing Street
LONDON

Dear Prime Minister

I appreciate your letter of March 29 marking the end of my extended period as a member of ACARD. I have found this a remarkably interesting experience but I cannot let the occasion pass without a tribute to the very high quality of support that ACARD enjoys from the Chief Scientist and from the cabinet office staff.

As I remarked on the occasion of your visit to the Royal Society on January 9, one of my great concerns both within and outwith ACARD has been to contribute to the development of understanding as to how to combine the containment of cost with the obtaining of value for money. At present I continue to see a great deal of waste by central and local government which arises from concentration upon the former without regard to the latter.

Yours sincerely

Alan Muir Wood

SLH

2

10 DOWNING STREET

THE PRIME MINISTER

29 March 1984

Dear D. Roberts

I understand that you are retiring from the Advisory Council for Applied Research and Development. I should like to thank you for the great deal of time that you have given to the Council and for your contribution to its work. The high standing of the Council in Government and industry is a direct result of the effort put in by its members, and a great tribute to them.

Yours sincerely

Margaret Thatcher

D H Roberts Esq CBE FRS

SLH

SLH

2

10 DOWNING STREET

THE PRIME MINISTER

29 March 1984

Dear Sir Alan,

I understand that you are retiring from the Advisory Council for Applied Research and Development. I should like to thank you for the time that you have given to the work of the Council, in particular for your leadership of the working group on Improving Research Links between Higher Education and Industry. This group's report has, I know, been read with great interest in Government, industry and the academic world.

Yours sincerely

Margaret Thatcher

Sir Alan Muir-Wood F Eng, FRS

SLH

10 DOWNING STREET

THE PRIME MINISTER

29 March 1984

Dear Lord Caldecote,

I understand that you are retiring from the Advisory Council for Applied Research and Development. I should like to thank you for the time that you have given to the work of the Council and in particular for your leadership of the study of advanced manufacturing technology. The resulting report on New Opportunities in Manufacturing has, I know, been read with much interest in Government and is generating wide debate in industry.

Yours sincerely

Margaret Thatcher

Viscount Caldecote, DSC

2

10 DOWNING STREET

THE PRIME MINISTER

29 March 1984

Dear Sir Kenneth,

I understand that you are retiring from the Advisory Council for Applied Research and Development. I should like to thank you for the time that you have given to the Council, in particular with its advice on the Annual Review of Research and Development. The advice is much appreciated by Government. You are, I know, continuing to assist the Council in looking into financial support for innovation.

Yours sincerely

Margaret Thatcher

Sir Kenneth Corfield

10 DOWNING STREET

THE PRIME MINISTER

29 March 1984

Dear Mr. King.

I understand that you are retiring from the Advisory Council for Applied Research and Development, although you will still be contributing to some of its activities. I should like to thank you for the great deal of time that you have given to the Council and its Working Groups. The Council, I know, puts a great deal of effort into its studies and the reports are read with much interest in Government, industry and the academic world.

Yours sincerely

Margaret Thatcher

C S King Esq CBE

10 DOWNING STREET

THE PRIME MINISTER

12 March, 1984

Dear Sir Henry.

Thank you for your letter of 22 February setting out the actions which ACARD proposes to take to follow up my Lancaster House Seminar on Science, Technology and Industry.

I am grateful to the Council for identifying and taking action on these important areas and look forward to receiving the Council's views on how the Government can encourage industry to increase its R & D and stimulate industry's exploitation of innovation.

Whilst the major responsibility for applied R & D and its effective exploitation must lie with industry itself, it is vital that the policies of Government Departments should be supportive to these activities and it is therefore appropriate that Council should have discussions with Mr. Norman Tebbit and Sir Keith Joseph. I look forward to hearing the outcome of these.

Viscount Whitelaw has told me about the excellent debate in the House of Lords on your report with the Chairman of the Advisory Board for the Research Councils. I hope that your next report with Sir David Phillips will address some of the specific issues raised in the debate, with the aim of bringing more of our industry up to the level of those companies which are already effective in using technological innovation to generate wealth.

Yours sincerely

Margaret Thatcher

Sir Henry Chilver, FRS.

GR PL type attached letter for PM's signature
AT 9/3

W.0216 9 March 1984

MR TURNBULL, NO 10

I had delayed offering a draft reply for the Prime Minister to send in response to Sir Henry Chilver's letter of 22 February until Mr Tebbit met ACARD early this week. Unfortunately the Secretary of State had to put off his visit to ACARD at the last moment and we now have a new date in May. Sir Keith Joseph is coming in October.

In the circumstances there is little to say except to welcome Sir Henry's proposals and to try and steer him and his Council to look as much as possible at the industrial scene as distinct from the Government scene, which I hope the draft does.

I have also included a paragraph on the recent House of Lords debate stimulated by the report of Sir Henry Chilver and Sir Alec Merrison. Sir Henry and Sir David Phillips (Sir Alex Merrison's successor at ABRC) are about to start work on their next joint report, and a word of encouragement plus a steer on subject-matter seem appropriate.

RBN

ROBIN B NICHOLSON
Chief Scientific Adviser

DRAFT LETTER FOR THE PRIME MINISTER TO SEND TO SIR HENRY CHILVER

Thank you for your letter of 22 February setting out the actions which ACARD proposes to take to follow up my Lancaster House Seminar on Science, Technology and Industry.

I am grateful to the Council for identifying and taking action on these important areas and look forward to receiving the Council's views on how the Government can encourage industry to increase its R & D and stimulate industry's exploitation of innovation.

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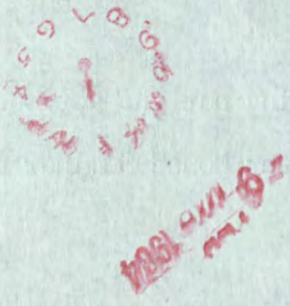
Govt. Machinery: Acad 43



NO ACK

10 DOWNING STREET

From the Private Secretary

DR. NICHOLSON

I would be grateful for any comments you have on Sir Henry Chilver's letter, and for advice on the terms in which the Prime Minister should reply.

23 February 1984

ADVISORY COUNCIL FOR APPLIED RESEARCH AND DEVELOPMENT
70 Whitehall, London SW1A 2AS Telephone: 01-233

The Prime Minister
10 Downing Street
London S W 1

22 February 1984

Dear Prime Minister

ACARD initiatives arising from the Seminar on Science, Technology and Industry, September 1983

The seminar which you chaired last September has stimulated much interest amongst industry, commerce and the financial institutions, and I am sure you will have received reports on the various ideas which are emerging. Investing institutions are now taking much more seriously the opportunities of exploitation offered by science and technology, and Government departments are looking at new ways of encouraging this - as for example through the new initiatives of the Ministry of Defence.

ACARD has been considering how it can help in following up what has proved to be a very important seminar.

The financial aspects of innovation are vital to Britain. We must encourage industry to undertake more R & D, and to exploit more effectively the opportunities which research in Britain already offers. I have asked Mr Robert Malpas, Managing Director of BP and a member of ACARD, to lead some exploratory discussions to identify ways in which we can genuinely achieve progress in these directions. The exploratory discussions are already underway, and, if they prove encouraging, we have in mind setting up a full ACARD working group, late in 1984, to report more comprehensively on ways of developing more industry-based R & D and more effective exploitation of research in industry.

An important related matter, which quite rightly received considerable attention at your seminar, concerns the inflexibilities of existing pension schemes. ACARD has considered this, and will be submitting views to the Secretary of State for Social Services on the subject of 'portable' pensions.

As you know, over the years ACARD has been able to take a broad view of the overall effects of Departmental policies in stimulating the exploitation of science and technology. Following your seminar, it is an appropriate time to draw together ACARD's views on this. I have in mind a report to you on ways in which the various policies might help achieve greater exploitation, and I will keep you informed of our thinking on this. The policies of the Department of Trade and Industry and the Department of Education and Science are vital in this, and we have invited Mr Norman Tebbitt and Sir Keith Joseph to discuss with us how the policies of their Departments encourage exploitation of science and technology.

The Joint Report of the Chairmen of ACARD and ABRC offers a further opportunity to emphasise the importance of exploitation of science and technology. In that Joint Report, we shall also have the opportunity of drawing on the Annual Review of Government R & D, which has been prepared by Robin Nicholson.

In summary, I am planning to report to you during the year on:

(i) overcoming financial constraints on industrial innovation

(ii) ways of increasing industrial R & D and industry's exploitation of science and technology

(iii) the impact of the various policies of Departments on the exploitation of R & D.

You may feel this is already an over-ambitious programme, but if you think there is any further aspect or approach which ACARD should take, I hope you will let me know.

Yours sincerely

Henry Chilver

Sir Henry Chilver
Chairman
ACARD

Ref.A084/202

MR BARCLAY

Annual Review of Research

Cmnd 8591, the Government's response to the 1981 House of Lords Select Committee on Science and Technology report "Science and Government", announced the Annual Review of Research and Development. The first such review is being published on 20 January as the "Annual Review of Government Funded R&D 1983". I attach a copy.

2. I am sending copies of this letter and the Review to the Private Secretaries of other members of the Cabinet.

R P HATFIELD

19 January 1984

(1)

Prime Minister

You have already agreed that the first annual review of research and development should be published. Agree attached draft answer?

Ref.A084/151

MR BARCLAY

Annual Review of Research and Development

DMB 17/1

Your minute of 14 November recorded the Prime Minister's agreement to the publication of the report of the annual review of research and development.

2. The report will be available for publication on Friday 20 January and copies will be circulated to members of the Cabinet in advance. It would also be appropriate for copies to be placed in the House of Commons library and publication announced by an arranged Parliamentary Question. I attach a draft Question and Answer for this purpose.

3. With the current interest in the availability of Government information in mind, the draft Answer draws attention to the fact that the Government has made a decision to publish the material, even though the relevant White Paper made no commitment to do so.

R P HATFIELD

17 January 1984

Friday 20 January 1984

CF

(Answered by the Prime Minister on Friday 20 January 1984)

UNSTARRED Mr Neil Hamilton:
NO. 158 To ask the Prime Minister, whether the first of the annual reviews of research and development announced in Cmnd 8591 has yet been completed, and if it will be published.

The first review has been completed. It has concentrated on the assembly of consistent information on Government R & D expenditures, thus laying a foundation for more detailed analyses in future reviews. Cmnd 8591 contained no commitment to publish the annual reviews but the Government has decided that it would be helpful to do so. The 1983 Review is therefore being published today and copies have been placed in the Library of the House.

File

RW

cc: C.O.

10 DOWNING STREET

From the Private Secretary

14 November, 1983

ANNUAL REVIEW OF RESEARCH

You will have seen a copy of my letter to the Chancellor of the Exchequer on this subject, drawing the attention of all Cabinet Ministers' private secretaries to the Review of Research and to ACARD's views upon it. The Prime Minister would particularly draw the attention of your Secretary of State to the comments of ACARD on the funding of university research.

(David Barclay)

Miss C.E. Hodkinson,
Department of Education and Science

FILE

RJ

10 DOWNING STREET

From the Private Secretary

14 November, 1983

ANNUAL REVIEW OF RESEARCH AND DEVELOPMENT

The Prime Minister has received the report from the first Annual Review of R & 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 on this report.

She has asked that the Review and ACARD's views (copies attached) should be drawn to the attention of members of the Cabinet.

The Prime Minister considers that the Review, apart from the two classified tables on Defence research expenditure, Tables 2c and 2d, could usefully be published and has asked Sir Robert Armstrong to arrange this.

I am copying this letter and attached to the Private Secretaries of other members of Cabinet and to Richard Hatfield.

(David Barclay)

J. Kerr, Esq.,
HM Treasury

FILE

RG

10 DOWNING STREET

From the Private Secretary

SIR ROBERT ARMSTRONG

ANNUAL REVIEW OF RESEARCH AND DEVELOPMENT

The Prime Minister was grateful for your minute of 11 November (A083/3232) covering the first Annual Review of Research and Development.

The Prime Minister agrees that the Report should be circulated to colleagues and then published with the omission of tables 2(c) and 2(d).

The Prime Minister has taken particular note of ACARD's comments on funding of university research.

MR. D. BARCLAY

14 November, 1983

Prime Minister

Agree circulation of the report to colleagues, followed by publication?

ACARD's comments on funding of university research are at Flag A.

DAB 11/11

Ref. A083/3232

PRIME MINISTER

Annual Review of Research and Development

Cmnd 8591 (Government response to the report "Science and Government" by the House of Lords Select Committee on Science and Technology) announced that the Government were instituting an Annual Review of R & D. This exercise would aim to bring together the various elements of Government R & D expenditures in order that the overall balance of expenditure could be examined, overlaps and duplications identified and omissions recognised. The Review would go to ACARD for independent advice and its findings, with ACARD's views, would be a contribution to PES discussions.

2. Responsibility for preparation of the Review rests 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. The first review has now been completed. I attach a copy of the report which was sent to ACARD, and a copy of Sir Henry Chilver's letter to me giving ACARD's reactions. The latter gives a warm welcome to the concept of the Review; similar views were expressed in the Advisory Board for the Research Councils.

3. This first Review concentrated on the assembly of consistent information on R & D expenditures, thus laying a foundation for future analyses. The Secretariat found that Departments were reporting such expenditures on different bases and with different definitions of what constitutes R & D; the preparation of truly comparable expenditure figures has involved considerable effort. Part II of the paper comprises this collection of expenditure data and a summary of departmental R & D objectives. Part I is a commentary on the factual information, in which Figures 1 and 2 summarise the present balance of Government expenditures and contrast with the situation in 1973/74. The main change is the increased proportion of the total accounted for by defence R & D.

The Secretariat were not able this year to make comparisons of expenditure by Government with that by the private sector, or indeed to relate these to the activities of our major international competitors. They have, however, prepared plans for such analyses in the 1984 Review which have been approved by the Sub-Committee of Chief Scientists. ACARD members, with their experience of assessing and managing R & D programmes in the private sector, will be assisting the Secretariat in this exercise.

4. The 1984 Review will be an essential database for a general critique of Government spending on R & D, the urgent need for which the Chief Secretary, Treasury spoke about at your meeting with the Secretary of State for Education and Science on 19 October. I understand that Dr Nicholson is having discussions with Treasury officials on how such a critique should be carried out.

5. Cmnd 8591 contained no commitment to publish the outcome of the annual Review. In future years there will be comments on the situation revealed by the Review, from the Sub-Committee of Chief Scientists and from ACARD, which could be controversial. I would see these as separate from the Review itself, and would not recommend their publication. However, the Review itself, comprising the factual information and the commentary, seems to me another matter. The Sub-Committee of Chief Scientists favour its publication as a means of better informing industry and others of what the Government is doing. I endorse this view and, if you agree, will arrange for the publication of an unclassified version, omitting the two tables on Defence research expenditures, Tables 2c and 2d. The remaining data is in the public domain already but has not previously been brought together or presented in this consistent and helpful form.

6. No formal response to ACARD is called for, but you will no doubt wish to draw the attention of all Cabinet Ministers to the exercise as a whole, and that of the Secretary of State for Education and Science to the comment about the funding of university research. I attach draft Private Secretary letters.

(Approved by
ROBERT ARMSTRONG
and signed in his absence)

11 November 1983

GOV MACH: ACARD: R3

DRAFT PRIVATE SECRETARY LETTER TO THE PRIVATE SECRETARY OF

THE CHANCELLOR OF THE EXCHEQUER

ANNUAL REVIEW OF RESEARCH AND DEVELOPMENT

The Prime Minister has received the report from the first Annual Review of R & 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 on this report.

She has asked that the Review and ACARD's views (copies attached) should be drawn to the attention of members of the Cabinet.

The Prime Minister considers that the Review, apart from the two classified tables on Defence research expenditure, Tables 2c and 2d, could usefully be published and has asked Sir Robert Armstrong to arrange this.

I am copying this letter and attachments to the Private Secretaries of other members of the Cabinet and to Richard Hatfield.

DRAFT PRIVATE SECRETARY LETTER TO THE DEPARTMENT OF EDUCATION AND SCIENCE

ANNUAL REVIEW OF RESEARCH

You will have seen a copy of my letter to the Chancellor of the Exchequer on this subject, drawing the attention of all Cabinet Ministers' private secretaries to the Review of Research and to ACARD's views upon it. The Prime Minister would particularly draw the attention of your Secretary of State to the comments of ACARD on the funding of university research.

ADVISORY COUNCIL FOR APPLIED RESEARCH AND DEVELOPMENT

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

Sir Robert Armstrong GCB CVO
Secretary of the Cabinet
Cabinet Office
70 Whitehall
London SW1A 2AS

3 August 1983

Dear Sir Robert

Annual Review of Research — See separate box.

In its response (Cmnd 8591) to the report 'Science and Government' from the House of Lords Select Committee on Science and Technology, the Government stated that there would be an Annual Review of Research, which would come to ACARD for independent advice. The Council considered the outcome of the first Review at its meeting on 5 July, and I am therefore writing to convey the Council's comments on that document to you.

ACARD appreciate that the first Review had to concentrate on the assembly of a coherent and consistent historical account of Government R & D expenditures, and that there was therefore little opportunity to place these in a broader, national framework. The Council consider that the assembly of such information was in itself a valuable exercise, enabling the distribution of R & D expenditures to be seen in broad terms, and providing an essential basis for the more analytical future phases of the Review process. While recognising, and supporting, the essentially decentralised decision-taking process for the allocation of Government's R & D resources, the Council wholeheartedly endorse the concept of the Annual Review, which attempts to create the total picture that results from these decentralised decisions and to place the national R & D effort in the context of economic and social needs.

In announcing the Review, the Government laid stress on the importance of making the best use of the resources devoted to R & D. The focus of attention in the Review must therefore be the deployment of these increasingly constrained financial and manpower resources in the most effective manner to meet the various policy aims of Departments. The Council look forward to

receiving next year analyses which enable the Government's R & D expenditures and allocations of skilled manpower to be placed in a wider national and international context in order that their relationships with R & D carried out in the private sector and the rest of the public sector may be considered. Council members with experience of developing and managing major research programmes in the private sector will be assisting the Science and Technology Secretariat in the Review, notably by advising on methods by which the output from research programmes might be assessed, to complement the analyses of financial and manpower inputs.

As for the Review just completed, I would single out for comment here only one aspect of the figures presented, namely, that concerning the expenditure of £474 million recorded in 1982/83 for the research component of UGC expenditures. The Council were informed that this, like previous such estimates, was essentially based on a survey of the use of academics' time in 1970, which concluded that 30%, on average, was devoted to research. In their recent report on research links between higher education and industry, ACARD cast considerable doubt on the current validity of this survey. The possible error which results could be significant in current assessments of the national R & D effort. The Council consider that, taking universities as a whole, the research element of general university funding ought indeed to be at the level represented by the 'official' figure. The size and significance of the possible shortfall reinforces the ACARD report's recommendation for a more directly accountably system of funding research through the UGC machinery. I understand that a DES/UGC/NAB study of the problem is underway, and I hope that the results of the study will soon be available.

ACARD consider that the Annual Review process has made a highly promising start. Council members will be assisting in the development of the new Review and the Council look forward to receiving the report from the 1984 Review next May.

I would be grateful if you would convey these comments to the Prime Minister.

Yours sincerely

Henry Chilver

Sir Henry Chilver
Chairman, ACARD

10 DOWNING STREET

From the Private Secretary

MR. HATFIELD
CABINET OFFICE

The Prime Minister has now seen Sir Robert Armstrong's minute of 25 May with which he enclosed the first joint report of the Chairmen of ACARD and the ABRC. The Prime Minister has agreed that permission for publication should be granted and that the report should be published as a Command Paper and laid before Parliament in the Prime Minister's name. You will, however, have seen that the Prime Minister has agreed to Dr. Nicholson's proposal that the seminar on science, technology and industry should be postponed from 8 July until mid-September. This need not, however, delay publication of the report.

T. FLESHER

27 May 1983

Ref.A083/1490

PRIME MINISTER

First Joint Report of the Chairmen of ACARD and ABRC

Sir Henry Chilver has asked me to submit to you the first joint report of the Chairmen of ACARD and the ABRC, which he has prepared with Sir Alec Merrison, ABRC Chairman until last February. The Secretary of State for Education and Science has also been sent a copy. The report stems from the invitation in Cmnd 8591 (Government response to the first report of the House of Lords Select Committee on Science and Technology) to the two Chairmen to produce such reports. It seeks to set the framework for future reports by outlining some of the key issues in science and technology policy and the economic context in which decisions on R&D funding have to be taken. There is no summary, but Chapter 5 contains a brief summing-up of key points. No Government response will be needed.

2. Sir Henry has sought permission for its publication. Cmnd 8591 did not give an express commitment to publication, but this is widely expected and the two Chairmen regard the document as a valuable stimulus to public debate on the issues raised. I suggest, therefore, that permission for publication be granted.

3. Lord Sherfield, Chairman of the Select Committee, has pressed for the report to be formally laid before Parliament, as recommended by the Committee. This would be appropriate, since it is a document requested by the Government, and would best be accomplished by publication as a Command Paper. You may wish it to be laid before Parliament in your name. It can and should be published before your seminar on 8 July*; the report will then be a useful summary of some of the key issues to be discussed on that day.

But see Dr Nicholson's proposal to postpone the seminar elsewhere in the box.

RCA

SIR ROBERT ARMSTRONG

25 May 1983

Prime Minister:

Agree to [illegible] publication?

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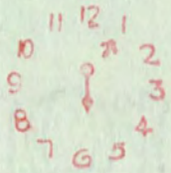

FIRST JOINT REPORT BY THE CHAIRMEN OF

THE ADVISORY COUNCIL FOR APPLIED RESEARCH AND DEVELOPMENT (ACARD)

AND

THE ADVISORY BOARD FOR THE RESEARCH COUNCILS (ABRC)

May 1983

FIRST JOINT REPORT BY THE CHAIRMEN OF THE ADVISORY COUNCIL FOR APPLIED RESEARCH AND DEVELOPMENT (ACARD) AND THE ADVISORY BOARD FOR THE RESEARCH COUNCILS (ABRC)

1. INTRODUCTION

1.1 In its observations (Cmnd 8591, July 1982) on the report "Science and Government" from the House of Lords Select Committee on Science and Technology, the Government asked the Chairmen of ACARD and ABRC to present joint periodic reports commenting on the state of science and technology in the United Kingdom and selectively reviewing scientific opportunities and their implications. We greatly welcome this opportunity to put our views on these matters to Government, as we welcome also the other proposals in Cmnd 8591 for the closer working of ACARD and ABRC. Such recognition of overlap and complementarity in the aims and interests of our two bodies helps to emphasise the way science and technology work upon, and feed, each other.

1.2 Future reports will no doubt reflect the results of the annual "Review of Research", announced in Cmnd 8591, which will be conducted in conjunction with the Public Expenditure Survey (PES) cycle and which will come before ACARD for independent advice. We welcome the Government's decision to have such reviews and to involve ACARD in them. We approve also of the strengthening of the Cabinet Office resources for science and technology matters which will provide extra support for the Chief Scientist, CPRS and for ACARD, particularly in connection with the annual Review of Research. Preparatory work for the 1983 Review is in hand. It will be limited in scope, because there is no previous work to build upon and because of the desirability of completing the Review in time to influence PES decisions in 1983.

1.3 Without the benefit of input from a Review, this first joint report aims briefly to set the general scientific, technological and industrial framework within which ACARD and ABRC operate and to identify major issues in science and technology policy, in order to provide the background against which future reports from the Council and the Board, and joint reports from the Chairmen, may be read. We also outline the current work of our two bodies and invite comment on any of the matters raised.

1.4 We emphasise that we have prepared this joint report in our capacities as Chairmen, but following consultations with our colleagues. The views expressed should not therefore be regarded as statements by ACARD or ABRC, although we believe that our colleagues would in general agree with them.

2 SCIENCE, TECHNOLOGY AND SOCIETY

2.1 Science and technology permeate and shape our present society. Because of them - and their explosive growth in this century, people can expect to live longer, have new ways of earning their living and can travel to almost any country within a few hours. And the pace of change is not slackening. More work will be done by computers and robots; homes, places of work, schools will change in unforeseen ways. Man's understanding and control of the processes of life increases rapidly, as does his destructive power.

2.2 The range of current science and technology work is enormous. At one end of the spectrum is the very purest of pure research. For example, an international team of scientists working at CERN earlier this year discovered a new sub-atomic particle (the W boson). This discovery, for which no application can be seen at present, provides the first supporting evidence for a theory which combines the weak and electro-magnetic forces of nature. Again, the launch in January 1983 of the Infra Red Astronomical Satellite (IRAS), which is a joint USA/Netherlands/UK venture, has already enabled new stars and galaxies to be seen which are not visible at optical wavelengths - and it will this year produce a new map of the heavens.

2.3 At the other end of the spectrum are immediately practical problems, for example, overcoming industrial pollution, providing new and better methods of communications - although even here the need for better understanding of the basic science involved is never far away.

2.4 However large at a superficial level might seem the differences between the more rarified aspects of fundamental science and the day-to-day application of technology, it is important to recognise their interaction

and interdependence. It is discoveries in science that most often lead to new technologies - and to applications not necessarily foreseen by the scientist, whose immediate purpose may have been to test a theory or increase understanding. To take but two examples in the present century: the discoveries of the neutron by Chadwick in 1932 and of nuclear fission by Hahn and Strassman in 1939 led to the exploitation of a wholly new source of energy and to weapons of unimaginable power - yet the time between Chadwick's discovery of the `useless' neutron and Hiroshima was a mere 13 years. And the founding of molecular biology by the analysis of DNA 30 years ago has already led to new industries and to an understanding of the fundamentals of genetics that will certainly affect the way we all live.

2.5 The interaction also works the other way - advances in fundamental science depend increasingly on the major technological advances of recent years. For example, the development of molecular biology has been made possible by the use of radioactive isotopes produced in nuclear reactors, and it is now advancing through the use of synchrotron radiation generated by electron accelerators, the design of which builds on technology developed originally for research in high-energy particle physics. The development of high-speed computers has made possible, among many other advances, detailed studies of the macro-molecules essential to life. These have now revealed the complex structures of viruses and are poised to show how the genetic material is organised in cells.

2.6 The impact of science and technology on present society, and the speed of the changes that result, require and enforce a response from Government in all its policies. Science and technology can solve problems but can also create them; new industries can arise from scientific discoveries, while old industries can die because of new technologies. The economy of a modern industrial trading nation depends critically on the efficiency and speed with which it is able to exploit science and technology. And the part played by fundamental research is crucial in underpinning the nation's long-term ability to produce new technological concepts. Out of such research - speculative and enquiring - can come great rewards.

2.7 The development and mutual reinforcement of science and technology are opening up so many additional areas of promise for study and development that the potential demands on Government increase beyond the rate of growth of national income. But the level of Government support for science and technology must depend on the health of the economy. Resources are finite and hard choices will have to be made. In making those choices, it is important not only for Government to get good advice on the development of science and technology but for that advice to be conceived and received as a whole. We are glad that the Government intends that the two bodies we represent should in partnership continue to play a full part in this process.

3. THE PRESENT SITUATION

3.1 We outline in this section the main features of Britain's trade and economy which are relevant to our discussion of science and technology policy.

Trade and employment

3.2 The decline of the United Kingdom as a manufacturing nation has been charted by many commentators. The UK share of world trade in manufactured goods fell in the decade 1963 - 73 from 15% to 9%. The reasons for this are many and complex, but the fact is that those countries with which we have to compete are maintaining, and sometimes improving, their position. In 1981, for example, our share of world trade was 8.5%, but that of West Germany was 18%.

3.3 It is essential for the UK to be competitive in export markets for manufactures, because trade accounts for such a large part of our Gross National Product. While at first sight the rise in the proportion of exports to total manufacturing production (from 16% in 1963 to 18% in 1980, the latest year for which figures are available) is welcome, of more concern is the tendency for our imports to be more complex, higher value-added products than our exports. A proxy for the complexity and sophistication of manufactured goods is the "unit value". Over a wide range of products, the unit value of UK exports is less than that of the corresponding imports. There is some evidence that the position has improved in recent years, but the gap between the UK and, again, West Germany is still substantial.

3.4 The declining share in world trade and the lower unit value of UK exports by comparison with our major competitors naturally have consequences for our trade balance with the rest of the world. Finished and semi-finished manufactures accounted for 52% of our overseas earnings in 1971, but for only 43% in 1981. Moreover, the trade balance in these categories, while in our favour in both years, rose only from

£3.0 billion to £5.5 billion. Because of inflation in the intervening decade, this represents a fall of more than 50% in real terms. And the decline has continued; for the first time in its history, the UK now appears to be approaching a deficit on manufactured goods and our needs for whole sectors of products based on high technology are wholly or substantially met by imports. The evidence is all around. Video cassette recorders are but the latest and most familiar example; there are now estimated to be 2.8 million VCRs in use; this represents a total import bill of the order of £1000 million. But the UK is also a major net importer of computers and related equipment (terminals, printers, disc drives, etc) and office machinery generally (for example, no typewriters are now made in the UK), sectors in which the market is growing fast and which contain the high value-added goods in which we should excel.

3.5 We believe it is vital for manufacturing industry in Britain to be strong and competitive. But we note also that the contribution of service industries both to economic activity in the UK and to our trade balance has risen markedly in recent years. In 1971, manufacturing accounted for 31% of the Gross Domestic Product; this figure had fallen to 22% by 1981. Moreover, UK service industries have been competitive in the international scene. While the ratio between overseas earnings from services and from manufactures stayed relatively constant in the decade 1971 - 80 (51% in 1971 and 44% in 1980) the trading surplus from services rose from £940 million to £4850 million, ie from 31% to 88% of the manufacturing surplus. The UK has traditionally been prominent in financial services, but non-financial services (consultancy fees, overseas students payments, charges for information services etc) also demonstrated their competitiveness and contributed more than two-thirds of the surplus from services in 1980.

3.6 There is perhaps one further comment we should make, and that is on the importance of our overseas earnings from North Sea oil. This new source of income has in large measure compensated for the decline in our overseas earnings from manufactured goods, but again it would be unwise to regard this as giving us more than temporary respite. In the end we must re-establish our position as one of the world's great manufacturers.

3.7 The changes in the economy outlined above have been reflected in the structure of employment. Manufacturing employment fell from 8.1 million in June 1971 to 5.7 million in June 1982, a decline exacerbated by the effects of the present world recession. As a proportion of total employment, manufacturing fell from 36% to 27%. Moreover, even within engineering and related industries, service-type occupations - design, sales, finance etc - accounted for a rising proportion of the total.

3.8 The general picture, in both economic activity and employment, is of a shift from less competitive manufacturing activities to more competitive private sector service activities and public sector services. But the manufacturing sector remains of crucial importance to the UK economy, and some service activites (banking, broking, design, insurance, etc) are heavily dependent on it. It is vital for its competitive position to be enhanced. This will be achieved in part from the pursuance of well directed research and development, and we turn therefore to a brief survey of Britain's R & D.

R & D expenditure

The national picture

3.9 A comprehensive picture of United Kingdon R & D expenditure is obtained every three years from a Government survey. Results from the 1981 survey will be published during 1983; the most recent available information relates to 1978. In that year, total UK expenditure on R & D was about £3500 million, of which the Government provided £1650 million and private industry the bulk of the remainder. Government therefore finances about half the R & D of the country.

3.10 Total R & D expenditure in 1978 was about 3.1% of GDP, a figure comparable with other advanced industrial countries. But two cautionary comments are needed. First, a large proportion of UK R & D expenditure is related to defence needs; in 1978/9, Government-funded defence R & D amounted to £1060 million, and some private sector financing of defence R & D would also have taken place. Only the United States, among OECD

countries, has such a high proportion of defence-related R & D. Secondly, the per-capita GDP of the UK is now lower than that of competitor countries, and so the sum spent on R & D, even though comparable in proportion to GDP, is lower in absolute terms. The following table is illuminating:

	Per capita R & D expenditure (1978) £	
	Defence	Civil
UK	18	47
West Germany	4	73
France	12	47
USA	27	74
Japan	0	60

Source: NEDO

The need for our civil R & D expenditure, no less then our defence expenditure, to be well directed is very evident, as is the need for effective spin-off from defence R & D expenditure into related civil fields.

Government support for basic science

3.11 The foundations of the UK's support for basic research are the Science Vote, through which the Research Councils are funded, and the support for universities channelled through the University Grants Committee (UGC). In 1978/79 the Science Vote amounted to £240 million (it was £480 million in 1982/83). It funds basic research at the 42 Research Council establishments employing about 7000 scientists. It also supports, in conjunction with the UGC funds, research at universities. The ABRC is responsible for advising the Secretary of State for Education and Science on the distribution of the Science Vote.

3.12 It is a measure of the priority given to the development of science and technology that some parts of Government's financial support for R & D have been relatively protected in recent years at a time when substantial reductions have taken place in other expenditure areas. The Science Vote has remained approximately constant in real terms in the period 1977 - 82 and no decrease is planned. On the other hand, the funds available to the UGC, the main source of finance for universities, are being cut by over 8% over the period 1980/1 to 1983/4 and this will affect the provision of basic facilities for research.

3.13 The grants made to the 44 universities through the UGC cover teaching and research. The amount for research is not identified by the UGC but it has been estimated that it amounts to about 30% of the total recurrent grant - taken with grants for equipment, this would have amounted in 1982/83 to some £400 million. Research is also undertaken in many of the 30 polytechnics - this is mainly applied research undertaken on behalf of industry.

Government support for applied science

3.14 Support of applied research and development is the responsibility of Departments with policy responsibilities, who commission research in support of those responsibilities. In some instances, of course, the policy concerned is one of general promotion of a sector of industry, and the research in question is aimed at the development of new products, proceses etc for that industry. The Ministry of Defence has by far the largest R & D budget in Government; in 1982/3 its total expenditure on R & D approached £1700 million, of which about two-thirds was spent in the private sector. The Department of Industry's expenditure in the same year was about £230 million, of which £120 million was spent in the private sector. Other major research programmes are supported by the Departments of the Environment (£43 million), Transport (£20 million) and Energy (£45 million), the Ministry of Agriculture, Fisheries and Food (£101 million) and the UK Atomic Energy Authority (£194 million).

3.15 There has in recent years been a shift in Government expenditure from

its own research establishments (which still account for a substantial part of the nation's scientific resource) to the private sector. Thus defence establishments accounted for 33% of MOD expenditure in 1977/78 but for less than 30% in 1981/2 while for DOI the corresponding figures are 37% and 31%. We welcome this trend, which locates research closer to the point of application, provided that the national capability for long-term research is not thereby reduced, and the research teams remaining in Government establishments are not so depleted as to become unviable.

Pressures and consequences

3.16 The decrease in Government support for universities is but one of the current pressures affecting the development of science and technology in the UK. The recession is clearly forcing all commercial enterprises critically to examine their activities, to devise new ways of going about them, to cut out those activities that are least profitable and to concentrate on the functions where they have most expertise. Public sector expenditure constraints are causing universities and Government Departments to undertake the same examination.

3.17 The rapid development of technologies, notably those related to microelectronics, is again forcing a re-think of many activites. New products incorporating microelectronics are replacing older electrical or mechanical devices; new control systems are improving quality levels in industrial processes; automated machinery is reducing the cost of manufacture in some fields - for firms that can afford the initial investment. In some parts of the electronics industry, 50% of sales revenues come from products that did not exist three years ago. The need for managements to be alert to new technology, to the implications of developments around the world for their businesses, and to have the technological ability to take advantage of new scientific discoveries, is crucial. Yet it is at precisely this time of rapid change that managements are under greatest pressure to concentrate on the immediate problems caused by the recession, to eliminate the activities that do not appear to contribute to the survival of the company, and to discount heavily the longer-term pay-off. R & D can then appear a luxury and the

threat to long-term industrial survival is obvious. The recent CBI survey of industrial R & D expenditure ("R & D - in recession too?" January 1983) showed a rise in R & D in electronics and vehicles, but a decline in other major manufacturing sectors.

3.18 The Government's role in the support of higher education and fundamental research has long been accepted. Under it the UK has secured a disproportionately large share of the world's scientific honours and established for itself a reputation as a source of new scientific and technological concepts.

3.19 The Government's role in of applied research and development is less well established; it has evolved gradually and has been marked by some significant commercial failures. Yet the pressures of enhanced overseas competition, recession and rapid technological change make that role essential. Government can supplement the private sector's funding of R & D in order to accelerate progress and to stimulate work in areas of relatively high risk and long term rewards. It can also stimulate new markets and can establish an environment in which innovation flourishes.

3.20 In the next section, we discuss in more detail some of the principal questions that arise.

deficiencies that in previous UK performance - lack of attention to markets or to design - may be most effectively addressed in the long term by appropriate changes in emphasis in courses of higher education. We commend, for example, the Teaching Company concept pioneered by the SERC and the joint appointments at professorial level at Salford University between the university and a local firm. Such initiatives will help to strengthen the link between the providers of education and the users of the `product´. More immediately, firms will have a great need for short re-training and familiarisation courses which may most appropriately be conducted in higher education institutions.

4.36 Finally, on a more general educational theme, we must comment that one element of science and technology policy must be to provide a population familiar with scientific concepts and open to technological developments. This does not, of course imply uncritical acceptance of every innovation, but the domestic background against which technological developments take place must be strongly influenced by the level of knowledge in the population. In 1980-81, 28% of UK school leavers had no scientific qualification and there is in general a non-technological emphasis amongst the boardrooms of UK manufacturing companies. We do not expect to see - nor are we suggesting - a wholesale re-alignment of educational priorities, but the non-technological bias in British education and society is considered by many a major element in our industrial decline and some shifts in educational priorities would appear overdue.

4.37 The direct funding of university courses and research in IT-related subjects by the Government is therefore a move in the right direction and we look to more such initiatives. At the school level, it is clearly vital that pressures on the curriculum and on funds do not erode the time or resources available for scientific and technical subjects; indeed we believe that much more attention to these subjects would be justified.

4.33 ACARD suggested in "Technical Change: Threats and Opportunities for the United Kingdom" that more effort should be devoted to this aspect of R & D. Clearly, some of the research into new information technology products is very relevant, since new developments in IT influence both the services that can be made available and the ways in which service functions are carried out. But there does not appear to be the equivalent in service industries (banking, insurance, news and information services, etc) of the advanced thinking towards "products" ten years hence and the establishment of appropriate R & D programmes that may be found in some parts of manufacturing. Such work would probably require a blend of the social sciences with an appreciation of developments in the physical sciences. Given the importance of service industries in the UK economy, the case for devoting more intellectual effort to their long-term development appears strong, but both the areas for investigation and the mechanisms for funding are yet obscure.

(ix) A responsive educational system.

4.34 In times of rapid scientific and technological change, education must be geared to provide the country with the right skills at the right time - and this often means providing new skills for those whose original skills are no longer required. Schools must familiarise our children with the new tools of work - and we commend the Government's initiatives in this area - while continuing to teach the importance of relating science and technology to the social needs of a civilised society. Unquestioning acceptance of new developments without taking account of ethical and environmental repercussions is not required. Moreover, some new developments, in information technology, offer completely different modes of learning for both schoolchildren and more advanced students. The education system must take advantage of these to enable its most expensive resource - skilled teachers - to be employed most effectively.

4.35 While manpower planning in a total sense is neither possible nor desirable in a free society, the education system - and notably higher education - must be responsive to the needs of employers. Many of the

of the elements that has been neglected is design - the development of the `package´ that meets the customer´s functional needs, satisfies aesthetic requirements and poses fewest problems in manufacturing and maintenance. By capturing markets that UK manufacturers once held, overseas competitors have too often demonstrated that technology is only one element in that package.

4.31 The significance of design in market success was highlighted in the ACARD report "Facing International Competition", and the importance of standards in encouraging good design has been recognised by Government. That report drew attention to the importance of support for national standards by public purchasing, and the Council were pleased to note that the White Paper "Standards, Quality and International Competitiveness" (Cmnd 8621) accepted many of the principles set out in that report and the Government´s commitment to the use of British Standards whenever possible in its purchasing specifications. We commend the recent Government initiative on design and would draw attention here to the changes in ACARD´s terms of reference (Annex A) announced in Cmnd 8591, which make explicit the Council´s concern with design.

(viii) R & D for the "services" sector

4.32 We commented in the previous chapter on increasing importance of service industries. The UK has traditionally had a leading international role in some services, notably concerned with banking and finance, but also in the distribution of news and information. While manufacturing will remain for the forseeable future the main source of overseas earnings, we believe that the proportion of earnings arising from tradeable services will increase. There is therefore an a priori case for considering how R & D can contribute to these activites. In addition, the performance of the whole economy could be strongly influenced by improvements in the efficiency of service operations, whether in the public sector or in support of manufacturing. Direct service employment now accounts for 63% of the employed population, while service occupations in manufacturing industries (design, accounts, personnel functions, etc) account for perhaps 8% more. What contributions could R & D make to these?

(vi) The right climate for innovation

4.27 Much has been written in recent years about the conditions in which innovators flourish and new ideas become adopted. ACARD has contributed through its reports "Innovation" and "Exploiting Invention". We are pleased to see the development of new sources of finance for new companies, the acknowledgement by Government of the key role played by individual entrepreneurs in bringing forward products embodying new technology and the changes in fiscal and other policies that have followed. While it is encouraging to see a wider understanding of the importance of innovation, the ability of companies - particularly the smaller ones - to innovate at the present time is seriously inhibited by the general world economic scene, and it will be some time before the full effects of new schemes can be properly assessed.

4.28 But more remains to be done. In particular the linkages between sources of new ideas and their potential exploiters could be improved. The cuts in UGC resources have forced such an examination upon universiies as they seek additional funds from the private sector. ACARD has established a working group on the links between universities, polytechnics and industry, which will report during 1984. In part, the exploitation of defence research referred to in the previous section is a question of establishing effective links between defence-orientated R & D teams and potential civil users of their output.

4.29 Nothing, of course, will influence innovation more than the prospect of a receptive market. But, establishing the right fiscal, financial and regulatory climate for innovation, and ensuring that effective links exist between the originators and exploiters of ideas, will assist greatly, and new ways of achieving such a climate will continue to feature on the agendas of both ACARD and ABRC.

(vii) The importance of design.

4.30 The technological history of the UK since 1945 shows all too well that advanced technology by itself will not command market success. And one

of approach amongst public bodies, but the Government has shown a lead in the introduction of a new general policy for public purchasing. The Treasury guidelines were endorsed by the House of Commons Committee of Public Accounts in November 1981. We welcome the policy and hope that the various internal audit and supervisory bodies, such as the Comptroller and Auditor General's Department, will give balanced attention to the objectives of helping the design, technology and competitiveness of suppliers as well as attending to the value for money issues. A blinkered approach from these guardians of the public purse will in the long run harm the UK's economic interests far more than any losses from the risks inherent in adopting new technology.

4.25 Public purchasing is often directly supported by R & D activity. Indeed, ACARD estimated in its report "R & D for Public Purchasing" that at least 40% and possibly half of applied R & D in the UK was connected with public purchasing. ACARD expressed concern that so much of the work was actually carried out in the establishments of purchasers. It drew up guidelines to govern the disposition of such work which in essence proposed that R & D which could lead to a commercially marketable product within five years should be undertaken in collaboration with, and in some cases under the control of, private sector interests. The extent to which these have been adopted in the public sector is not clear and a follow-up investigation, as recommended in the House of Lords Select Committee report "Engineering R & D", could be justified.

4.26 In any discussion of the role of public purchasing, defence procurement features very large. There has been, and remains, considerable concern that the very large research effort devoted to defence purposes in the UK (about a third of our total R & D effort, although this proportion may be inflated by the definitions of R & D used) is not sufficiently exploited for civil commercial purposes. This remains a major area for debate, although the result of the Strathcona review of R & D, whereby development and project work is concentrated on industry, leaving defence R & D establishments to develop the appropriate science and technology, is to be welcomed. In this way MOD have adopted policies for the location of R & D activity which broadly reflect those recommended in `R & D for Public Purchasing".

4.22 The various "awareness" schemes, for micro-electronics, robots, etc, launched in recent years (which owe at least part of their origin to ACARD reports) are therefore to be commended, both for the contribution that they make to the creation of an educated and receptive market for new technology in the UK, and for reducing - through the consultancy and financial assistance provided - the risks associated with the introduction of such technology. We look to their extension into other technologies when appropriate - and also to the winding up of individual schemes when users are sufficiently familiar with the technology to need no further assistance with it.

4.23 We would also single out for commendation the "Office of the Future" project of the Department of Industry, which aims to encourage the development of new office systems by financing pilot installations from a range of manufacturers in different types of working environment. Those systems will be thoroughly monitored and results exchanged and publicised. This will aid understanding of the potential of new technology. In addition, the very presence of new office systems in an organisation will contribute towards the development of a receptive market in that and related bodies.

4.24 But a more direct approach is also required, and this may be achieved through intelligent use of public purchasing power. The Government is a major purchaser of products incorporating advanced technology and in some major fields is the only purchaser. But substantial markets exist also in local authorities and public corporations, and in the National Health Service. The need therefore is for public authorities, while keeping within international obligations (which are not uniform across the public sector), to liaise closely with potential UK suppliers over future requirements, to be willing to be amongst the first customers for new technology (the magnetic levitation monorail at Birmingham Airport may be cited here), to be prepared to adjust their requirements to suit a wider market (the idiosyncratic nature of many public sector specifications has been well demonstrated in previous studies) and, within their statutory remits, to balance potential short term savings against long term advantage both to themselves and the nation, when such advantage involves initial extra cost. This will require a change

4.20 The Alvey proposals illustrate the long-term nature of much "strategic" research. Government support for such work must similarly extend over a decade or more, and consistency in approach is essential. The development of expertise in depth in technological areas is not a rapid process, nor is it encouraged by abrupt policy changes which affect the continuity of research teams. The sharp decline in UGC funding announced in March 1981 will undoubtedly affect the development of some promising scientific and technological areas within universities. In support for science and technology, a long-term, bi-partisan view is vital, just as defence procurement programmes and related R & D extend well beyond the life of a single Parliament. Identification of key "generic" or "enabling" technologies, development of consensus on those areas in which the UK should aspire to leadership, and consistent Government support over a decade or more for R & D which, in any particular field, moves steadily from basic science to market-orientated development, will be an essential part of the UK's technological future. The enabling technologies will undoubtedly include "expert" computer systems, genetic engineering, aspects of materials technology and advanced manufacturing systems. ACARD, ABRC and other bodies will assist in developing the consensus in these and other fields.

(v) A receptive market

4.21 While a long-term, consistently supported R & D programme may successfully develop a new technology, successful application of that technology requires both that it meets a market opportunity and that the market recognises such an opportunity. Unfortunately, UK industry has often been less ready than its overseas competitors to adopt new ideas, with the result either that the first applications for a UK-developed technology are foreign (the incorporation of liquid crystals in calculators is a classic example) or that successful exploitation is not achieved. While current economic conditions are causing firms to look very closely at opportunities for improving productivity and reducing costs, they are at the same time reinforcing the inherent caution that has marked the British approach.

responsibilities for international links in science and technology. This will, we hope, enable the UK to obtain greater coherence in its policies towards foreign and international R & D programmes, and more rationally to asses the value of overseas technology. But we emphasise that the major responsibility for identifying and exploiting such technology must lie with the private sector.

(iv) Stable co-operation between Government and industry.

4.18 R & D undertaken with an end product in mind is best financed and carried out by the firm that will apply the knowledge gained. Ideally, firms should undertake a portfolio of relevant R & D projects with differing time-spans, in order to ensure their technological competitiveness into the future. Unfortunately, UK industry did not invest sufficiently in R & D in more profitable times to provide it with appropriate products in the 1970's. Consequently, it suffered a decline in profitability, and the resources available to UK industry in recent years have not permitted adequate investment in R & D. The pace at which technological developments are taking place and the scale of the research effort required if major product markets are to be tackled successfully have meant that additional resources, primarily in the form of Government funding, have been necessary. Government now funds between 30 and 40% of all the R & D carried out in the private sector of UK industry.

4.19 Recent funding initiatives by the Department of Industry, notably in areas related to information technology (fibre optics, computer-aided design and manufacture, etc) and biotechnology, are welcome in helping to focus attention on these growth points in technology. But they need to be embodied in a wider framework that emerges from work undertaken in connection with the "selectivity" and "international technology" aspects of science and technology policy. The Alvey report produced one element of that larger framework and we are particularly attracted to its concept of linking universities, Government and industry in a coherent long-term programme of R & D, a concept that the UK has not previously attempted to develop. We welcome therefore the Government's broad acceptance of the Alvey proposals.

priority areas. Clearly there are risks in deciding to rely on imported technology - most evident in relation to defence equipment but also, as the issue of the Siberian pipeline showed, occurring in the civil field. Access may be withdrawn for political or commercial reasons. And the exploitation of a technology is often more effective if conducted in close association with its originators. There is therefore a natural tendency to try to cover a complete technological field within the UK. But the opportunity costs of doing so may be considerable, and the risks inherent in an alternative policy are rarely quantified.

4.15 The ACARD report "Technological change: Threats and Opportunities for the United Kingdom" pointed out that the UK makes less use of imported technology than its major competitors, and recent studies (for example by the Science Policy Research Unit of the University of Sussex) have provided more evidence to confirm this view. This means that the UK could do more to exploit those results of foreign R & D programmes which are generally available. More effort on the identification of appropriate overseas technology for immediate exploitation, on assessing the likelihood that suitable technology will be available when needed in the future, and on gauging the risks inherent in the use of foreign technology, would appear to be needed both by Government and industry. The British Technology Group and the Overseas Technology Information Unit of DOI have roles to play in the identification of technology, but there is also scope for more entrepreneurial activity by private sector research organisations and consultants.

4.16 In considering collaborative programmes, a rational judgement has to be made between the likely profit to the UK of having a share in knowledge available to all participants (and perhaps obtaining valuable industrial business also) and the cost of developing proprietary information in Britain. The proposed European programme in information technology, ESPRIT, is a case whose major UK companies have decided that the benefits outweigh the disadvantages and we expect to see more programmes like this in the future.

4.17 We welcome the extra support, modest though it is, which the Chief Scientist CPRS will now have avilable to assist him with his

selectivity needed, ACARD, ABRC, the Research Councils and other advisory bodies (eg ad hoc committees such as the Alvey Committee) must ensure that their advice is of maximum use to Government in this context, and this may involve considering hard choices and at times recommending the cessation of some activities.

4.12 We make one further comment. Amongst the bodies seeking to offer advice to Government and industry on scientific and technological priorities, the voice of professional engineering and scientific institutions is muted. The UK have a great potential asset in the quality and diversity of its professional bodies and learned societies, with their membership that spans Government, academia and industry. They should be contributing fully to the analysis of priorities but have too often confined their attention to narrower concerns. We hope that they will increasingly address national needs.

(iii) International links

4.13 Science has always been, and we believe must increasingly be, an international activity. The pursuit of knowledge knows no national boundaries, and scientists, through regular contact with their colleagues overseas and the free flow of information, have in a very real sense been members of an international science community. This sense of community has developed for very practical reasons into international programmes which in basic science have enabled the UK to benefit from research which it could not otherwise have afforded. Successful examples include CERN, the Anglo-Australian telescope, the European Space Agency and the International Biology Programme. We endorse the principle of international collaboration while recognising that it necessarily involves long-term commitments that can impact on the UK's domestic science programme by reducing flexibility and making hard choices even harder.

4.14 International links are also crucial to the development of applied science and technology. Just as the UK cannot hope to be pre-eminent in all scientific and technological fields, it can similarly not expect to provide all the technology from within its own resources, even in

National Economic Development Council (NEDC) and its subordinate committees have made major inputs and the House of Lords Select Committee on Science and Technology has recently contributed through its report on Engineering R & D. Moreover, each funding Department of Government has advisory machinery (eg the Requirements Boards of DOI or the Joint Consultative Organisation of MAFF) established following the implementation of the Rothschild "customer-contractor" principle.

4.9 There is, though, a major difference between identifying a broad field for priority funding and recommending such to Government, and choosing within that area the particular research areas to support (and by implication those that will not receive support). We believe that ACARD, NEDC and other bodies have been effective in the former, but all have hesitated to do the latter. Of course, it is not for Government to dictate what firms should or should not do - and successful developments can take place even within `declining´ sectors of industry. But there exists in the UK little consensus on the specific "product families" within a broad field, such as information technology, that as a nation we should pursue vigorously, and as a result we try to spread our resources too thinly across broad "promising" areas and fail to achieve market leadership in sufficient sectors.

4.10 A major contributory factor to this situation has been the unwillingness of UK firms to engage in collaborative research - in contrast, for example, to Japanese research programmes. Clearly, the closer the research is to a marketable product, the more difficult this is. But at an earlier stage, we would wish to see more collaborative research. We welcome therefore the report of the Alvey Committee ("A Programme for Advanced Information Technology" HMSO 1982) and have been encouraged by the wide support that the report has received from industry and Government Departments. It is in areas of longer term applied research, such as `fifth generation´ computing, that the habit of collaborative research may be most easily introduced and where selectivity in Government support may be applied.

4.11 There is, then, a general lesson here for those who seek to advise Government on its support for R & D. If this support is to reflect the

now under pressure, in part for reasons to do with our present economic problems. In this area, there are many individual actions by Government which we welcome, particularly the provision of "new blood" academic posts aimed at supporting important areas of research where a university may well be unable to fund new appointments through its d normal means of finance. But there is no doubt that the effect on research of recent Government cutbacks in the finance of the universities will have to be closely watched.

4.7 The report of a recent joint ABRC/UGC Working Party (Cmnd 8567: 1982) recommended that Universities should channel proportionately more of their funds into research and should concentrate research funds into selected areas. The report recognised that the task of choosing research areas and devising ways of supporting them is a difficult one which would require the creation of new mechanisms in the universities. One such machanism would be the establishment of research committees which would be charged with reviewing research in the university and coming to conclusions about the areas on which the university should concentrate. The research committees would also have the responsibility of ensuring that in the internal allocation process these areas received adequate funds for research along the lines normally associated with the UGC side of the dual support system as well as having at their disposal resources to provide some modest support for bright ideas however and wherever they originated. The future development of this and other mechanisms for selecting university research will be of major importance.

(ii) Selectivity in applied research

4.8 In applied research and the development of new products, the position is more complex. It is clearly for individual firms to decide if they wish to undertake R & D aimed at a particular market. But `strategic´ research, ie research in areas where basic principles are known but the final products have not yet been identified - typically with a ten-year timescale - is often outside the funding capabilities of individual firms; in such situations, collective action - perhaps with Government assistance - is required. Various bodies exist to advise on priorities in applied R & D. While ACARD has a specific national role here, the

priority to:

- engineering and the further development of research in support of industry
- biology, with particular reference to biotechnology
- remote sensing of the earth from aircraft and, particularly, satellites
- information technology
- marine resources
- neuro-science

4.4 Individual Research Councils similarly have identified priority areas and have established special mechanisms for organising coherent programmes of research in these areas. Examples are the polymer and biotechnology directorates of the Science and Engineering Research Council (SERC) and the Medical Research Council's units in universities.

4.5 Options are, of course, always changing. An unexpected insight or observation, or the successful development of a novel technique, can give birth to a new line of research; the needs of industry and society change, and public and political perceptions of future requirements also change. Priorities have to be reviewed and amended - at a pace consistent both with maintining and enhancing valuable expertise and with keeping up with scientific opportunities. Whatever the mechanisms, the choice of priorities in basic science carries an inevitable risk of error - which may not be evident for some years - but it is likely to be most successful if it is based on the judgement of those working in particular fields. This is our present system and we see no cause for fundamental changes.

4.6 Support for university research comes both from general university funds - provided through the UGC and distributed internally by each university - and from external specific fundings provided mainly by the Research Councils but with significant contributions from other sources such as Government Departments, industry and charitable foundations. This is the so-called "dual support" system. This system is basically right but is

4. IMPLICATIONS FOR SCIENCE AND TECHNOLOGY IN THE UK.

4.1 Against the background set out in the previous chapter, we identify - in the sections which follow - aspects of science and technology policy which have to be considered in order to provide a satisfactory scientific and technological base for UK industry and commerce, along with conditions in which scientific and technological developments may be fully exploited.

(i) Selectivity in basic science

4.2 In 1979, the United Kingdom accounted for 6.5% of the GDP of OECD countries and for 5.6% of their combined R & D expenditure. It is clear that, as a single nation, we cannot hope either to be self-sufficient in technology or to devote resources to exploring every possible scientific avenue. In the past, it was possible to maintain a UK presence in the vast majority of areas for scientific enquiry; basic science was - at least by comparison with many applied science areas - a relatively cheap activity. But it is increasingly difficult to do this. The scale on which some fundamental scientific problems must be tackled - fundamental particle physics, for example - means that the UK's resources have to be combined with those of other countries. The extra sophistication of instrumentation and the complexity of much modern research means that the cost of mounting a research project is rising faster than the rate of inflation. Decisions therefore have to be taken, not only on the areas for support, but also on the locations at which research in any subject will take place. The trend to concentrate basic research resources on "centres of excellence" in each field will continue.

4.3 In basic science, responsibility for making the necessary choices rests largely upon the ABRC and the individual Research Councils. Drawing upon the substantial scientific expertise available in universities, research establishments and industry, the Board and the Research Councils have identified key areas of promise for funding priority. ABRC published its 1982 advice in "The Science Budget: A Forward Look 1982" (HMSO). It gave

5. CONCLUSIONS

5.1 We have sketched the main trends in the UK economy and its trading relationships and have indicated what in our view should be the principal issues for continuing discussion and analysis in science and technology policy. These form the background against which ABRC and ACARD will need to conduct their work.

5.2 We have indicated various aspects of innovation and the exploitation of research which require continued attention if the UK is to obtain maximum benefit from its investment in science and technology. These include the need for stability in Government-industry relationships, the creation of receptive markets, in part through the use of public purchasing, providing the right climate for innovation and ensuring that our educational system is attuned to the needs of a technological age.

5.3 We have identified the key issue in science and technology policy as the choice of areas for support. Funds for R & D will always be limited; choices have to be made by the bodies who allocate resources and the people who manage these. How these choices are made should be the subject of continuing study and discussion, because they affect in time substantial parts of the national economy. One important element in such choices is the degree to which the UK should seek self-sufficiency in any area of science and technology.

5.4 We have also pointed out the vital importance of basic research to the long-term scientific health of the nation. The UK must maintain its strength and capacity in basic research which has as its prime motive extending human knowledge and understanding; in such research, excellence by world standards must be the aim but the underlying emphasis should be the benefit to the nation and especially the development of new products and industries.

5.5 The Government's aim in inviting the Chairmen of ACARD and ABRC to prepare periodic reports on science and technology policy issues was to stimulate informed debate on the policies and priorities that the UK

should adopt in order to maintain its record of creativity in science and secure the maximum benefit from scientific and technological advances. We hope that this report, and its successors, will be discussed widely not only in the scientific and technological communities but, more generally, by policy-makers in business and Government. We would like to think that in addition some Parliamentary time could be found for these matters, so crucial to the future well-being of the nation. We welcome comment on the views expressed and proposals for the future work of our two bodies and look forward to the production of the second report in perhaps a year's time.

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* Sir David Phillips FRS succeeded Sir Alec Merrison as Chairman of ABRC in January 1983

ANNEX A

ADVISORY COUNCIL FOR APPLIED RESEARCH AND DEVELOPMENT

Membership (as at 1 February 1983)

Sir Henry Chilver F Eng FRS (Chairman)	Vice-Chancellor, Cranfield Institute of Technology
Dr D V Atterton	Chairman, Foseco Minsep
Viscount Caldecote F Eng	Chairman, Finance for Industry
Sir Kenneth Corfield F Eng	Chairman and Chief Executive, Standard Telephones and Cables
Dr D L Georgala	Head of Laboratory, Unilever Research
Dr W B Heginbotham OBE	Director-General, Production Engineering Research Association
Mr C S King CBE	Deputy Chairman, BL Technology Ltd
Professor Sir Hans Kornberg FRS	Master of Christ's College and Professor of Biochemistry, University of Cambridge
Dr B C Lindley CBE	Director of Technology, Dunlop Holdings
Mr P C Michael	Chairman and Managing Director, Micro Consultants Ltd
Sir Alan Muir Wood F Eng FRS	Senior Partner, Sir Willian Halcrow & Partners
Professor Sir David Phillips FRS	Professor of Molecular Biophysics, University of Oxford and Chairman of the Advisory Board for the Research Councils
Mr D H Roberts F Eng FRS	Director of Research, The General Electric Company
Mr J L van der Post F Eng	Chief Executive, Water Research Centre
Lord Scanlon	formerly Chairman, Engineering Industries Training Board
Professor J M Thomas FRS	Professor of Physical Chemistry, University of Cambridge

In addition, the Head and Chief Scientist of the Central Policy Review Staff, and the Chief Scientists of the Departments of Industry, Energy, Environment and the Ministry of Defence serve as Assessors to the Council.

Terms of reference

The Advisory Council for Applied Research and Development (ACARD) was established in 1976. Its original terms of reference were revised and extended in 1982 and are now:

"To advise the Government and publish reports as necessary on -

i. applied research, design and development in the United Kingdom;

ii. the application of research and technology, developed in the United Kingdom and elsewhere, for the benefit of both the public and private sectors in accordance with national economic needs;

iii. the co-ordination, in collaboration with the Advisory Board for Research Councils, of these activities, with research supported through the Department of Education and Science;

iv. the role of the United Kingdom in international collaboration in the fields of applied research, design and development related to technology".

Functions and mode of working

ACARD advises the Government on the exploitation of research and technology. The full Council normally meets for half a day five times a year, but much of its work is carried out in small Working Groups. The membership of such groups is drawn partly from the Council and partly from non-members who can make a special contribution to the subject under review. Typically, a Working Group will meet monthly for six to twelve months, and will seek both written and oral evidence to aid its enquiry. ACARD reports are submitted to the Government through the Prime Minister with a request for permission to publish. This has never been refused.

Following the report "Science and Government" by the House of Lords Select Committee on Science and Technology, the Government announced (in Cmnd 8591) that ACARD would be asked to advise during a new system of annual reviews of the research programmes and budgets of Government Departments.

Current Working Parties.

At the request of the Prime Minister, ACARD is preparing a report on the links between industry and higher education in research and application. The study is being carried out in collaboration with the ABRC. A working group has been set up, chaired by Sir Alan Muir Wood. The group is reviewing current arrangements for cooperation between higher education institutions, Research Councils and industry to identify examples of good practice and assess the effectiveness of these arrangements in providing benefits to both sides. The group is also examining any institutional, administrative, financial or other barriers and disincentives to the formation and extension of links, and the scope for dismantling the barriers.

A second working group, chaired by Viscount Caldecote, Chairman of Finance for Industry plc, is examining the use made by industry of advanced manufacturing technology in the UK. The group is studying the current state of development of advanced manufacturing technologies, considering their existing potential, their benefits and cost-effectiveness, and identifying the factors which encourage or inhibit their application in the UK. The group will also seek to identify and assess the need for measures to stimulate the development and use of advanced manufacturing technologies.

Reports

The Council's published reports, available from Her Majesty's Stationery Office, are:

The Applications of Semiconductor Technology (1978)	ISBN 0 11 630807 9
Industrial Innovation (1979)	ISBN 0 11 630808 7
Joining and Assembly: The Impact of Robots and Automation (1979)	ISBN 0 11 630810 9
Technological Change: Threats and Opportunities for the United Kingdom (1980)	ISBN 0 11 630812 5
Computer Aided Design and Manufacture (1980)	ISBN 0 11 630814 7
R and D for Public Purchasing (1980)	ISBN 0 11 630815 X
Biotechnology (1980)	ISBN 0 11 630816 8
Information Technology (1980)	ISBN 0 11 630818 4
Facing International Competition: The Impact on Product Design of Standards, Regulations, Certification and Approvals (1982)	ISBN 0 11 630783 8
The Food Industry and Technology (9182)	ISBN 0 11 630822 2

The report `Exploiting Invention' (1981) is available from ACARD.

ANNEX B

ADVISORY BOARD FOR THE RESEARCH COUNCILS.

Membership (as at 1 February 1983)

Professor Sir David Phillips FRS (Chairman)	- Professor of Molecular Biophysics, University of Oxford
Professor Sir Hermann Bondi KCB FRS	- Chairman, Natural Environment Research Council
Dr A A L Challis CBE	- Chief Scientist, Department of Energy
Sir Henry Chilver F Eng FRS	- Vice-Chancellor, Cranfield Institute of Technology and Chairman, Advisory Council for Applied Research and Development
Dr G A H Elton	- Chief Scientist (Fisheries & Food) Ministry of Agriculture, Fisheries & Food
Professor A P M Forrest FRSE	- Regius Professor of Clinical Surgery. University of Edinburgh and Chief Scientist, Scottish Home and Health Department
Sir James Gowans CBE FRS	- Secretary, Medical Research Council
Dr M W Holdgate CB	- Director-General of Research, Departments of the Environment and Transport
Professor J F C Kingman FRS	- Chairman, Science and Engineering Research Council
Sir James Lighthill FRS	- Provost, University College, London
Professor Sir Ronald Mason KCB FRS	- Chief Scientific Adviser, Ministry of Defence
Mr J R S Morris F Eng	- Chairman, Brown and Root (UK)
Dr R B Nicholson F Eng FRS	- Chief Scientist, Central Policy Review Staff, Cabinet Office

Sir Edward Parkes	- Chairman, University Grants Committee
Professor Sir Desmond Pond	- Chief Scientist, Department of Health and Social Security
Mr M V Posner	- Chairman, Social Science Research Council
Dr R Riley FRS	- Secretary, Agricultural Research Council
Mr O Roith	- Chief Engineer and Scientist Department of Industry
Professor Sir Peter Swinnerton-Dyer FRS	- Master, St Catherine's College, University of Cambridge

Terms of Reference

The Advisory Board for the Research Councils was established by the Secretary of State for Education and Science in 1972 with the following terms of reference:

i. To advise the Secretary of State on his responsibilities for civil science with particular reference to the Research Council system, its articulation with the universities and Departments, the support of postgraduate students and the proper balance between international and national activity;

ii. To advise the Secretary of State on the allocation of the Science Budget amongst the Research Councils and other bodies, taking into account funds paid to them by customer Departments and the purpose to which such funds are devoted;

iii. To promote close liaison between Councils and the users of their research.

Functions and mode of working

ABRC advises the Secretary of State for Education and Science on his responsibilities for civil science and in particular on the allocation of the Science Budget among the five Research Councils, the Royal Society and the British Museum (Natural History). Each year, ABRC asks the Research Councils to prepare plans for the next three years and to identify those areas of scientific promise on which work sould be begun or to which additional resources should be allocated. These plans are then discussed in detail - the Board investigates particularly the possibilities for redeployment of resources - i e what existing work can be stopped or reduced to make way for new priorities.

In 1982 ABRC for the first time published its advice (`The Science Budget: a Forward Look 1982´). It concluded that the swing away from "big science" which had been taking place since the early 1970s had gone as far as it could if Britain was to maintain a stake in the high energy physics and astronomy. The Board gave priority to:-

- engineering and the further development of research in support of industry;
- development in biology, with particular reference to biotechnology;
- remote sensing;
- information technology;
- continued study of marine resources;
- new developments in neuro-science.

Working Parties

A Working Party, chaired by Mr J R S Morris, is studying the support given by the Research Councils to in-house and university research. The Working Party is enquiring into the distribution of Research Council resources between research in their own establishments and in universities and polytechnics and will make recommendations to the Board early in 1983. The study is a follow-up to the recent report of the joint ABRC/UGC Working Party on the support of university scientific research (Cmnd 8567) which stated that the balance of Research Council expenditure between support for university research and for the work of Councils´ own institutes warranted further examination.

The Board is also collaborating with the Advisory Council for Applied Research and Development (ACARD) in its study of the links between industry and higher education in research and its application.

Reports

1st Report of the Board	Cmnd 6533	(June 1974)
2nd Report of the Board	Cmnd 6430	(March 1976)

3rd Report of the Board	Cmnd 7467	(February 1979)
*Report on Taxonomy		(Published March 1979)
ACARD/ABRC/Royal Society Joint Report on Biotechnology		(Published April 1980)
*Report on Energy Research		(Published November 1981 an update of a report originally published in 1974)
Report of the Working Party on Postgraduate Education	Cmnd 8537	(April 1982)
Report of a Joint Working Party on the Support of University Scientific Research	Cmnd 8567	(June 1982)
*The Science Budget: A Forward Look 1982		(Published October 1982)

*Available from the Department of Education and Science

ANNEX A

IND POL : ACARD Study : June 82

Advisory Council for Applied Research and Development

in collaboration with

Advisory Board for the Research Councils

IMPROVING RESEARCH LINKS BETWEEN HIGHER EDUCATION AND INDUSTRY

June 1983

FOREWORD

1. In June 1982 ACARD were invited by the Prime Minister to prepare a report in collaboration with the Advisory Board for the Research Councils (ABRC) on the links between industry and higher education institutions in the field of research and its application. A Working Group was set up to undertake the study; members of the Working Group were:

* Sir Alan Muir Wood FEng, FRS (Chairman)	Senior Partner, Sir William Halcrow and Partners
* Dr D V Atterton CBE FEng	Chairman, Foseco Minsep Ltd
Dr S L Bragg FEng	formerly Vice-Chancellor, Brunel University
Dr J B Butcher	Head of Microelectronics, Middlesex Polytechnic
Mr P G Davey	Department of Engineering Science, University of Oxford
** Mr J R S Morris FEng	Chairman, Brown and Root (UK) Ltd
Dr J Spreadborough	Managing Director, John Spreadborough and Company Ltd
Professor R Whittenbury	Department of Biological Sciences, University of Warwick

* ACARD member
** ABRC member

2. The terms of reference of the Working Group were -

i. To review current arrangements for co-operation between the universities and other relevant higher education institutions, Research Councils and industry in the fields of research and its applications; and identify examples of good practice.

ii. To assess the effectiveness of these arrangements in providing benefits to both parties.

iii. To examine any institutional, administrative, financial or other barriers and disincentives to the formation, progress and extension of links and the scope for their dismantling.

iv. To consider the implications for Britain of arrangements in other countries.

v. To make recommendations.

3. The Working Group sought evidence and opinion from all universities, polytechnics and other relevant higher education institutions in the UK, from a wide selection of industrial companies and from learned societies and other institutions. In total, 240 written submissions were received. In addition, nearly 60 people were interviewed during visits undertaken by members of the Working Group and its Secretariat.

4. The Working Group's report received the broad agreement of the ABRC in April 1983 and was endorsed by ACARD in May 1983. It was submitted to the Prime Minister, and is now published to draw attention to the recommendations and to stimulate public discussion.

5. ACARD and ABRC gratefully acknowledge the support provided in preparing this report by the ABRC Secretariat in the Department of Education and Science, the Central Policy Review Staff and the ACARD Secretariat in the Cabinet Office.

CONTENTS

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

1. The links between industry and higher education institutions (HEIs) in research and its application can contribute significantly to the economic health of the UK. Indeed they must do so, if this country is to benefit from its strong base of science and technology. This is a matter of vital long-term importance.

2. Such links make available to industry the knowledge, expertise and facilities in the institutions and so enhance its capacity for innovation and improvement. They also benefit academic researchers who can participate in the application of their ideas and may thereby be pointed towards other research areas of national importance. This may provide them with a wider range of challenges and can enrich teaching, through experience of current industrial practice.

3. While there are outstanding exceptions, progress in establishing productive links has been slow. Attitudes are changing - in favour of more collaborative work between industry and HEIs, but there is still a certain reluctance for the partners to come together. We see four themes as providing the key to progress -

a. Individual institutions differ one from another, each being excellent in particular subject areas or ways of working. Such differentiation should be encouraged. In our view, HEIs themselves should go further than hitherto in deciding what are their strong points in research, and should be given sufficient financial flexibility to follow their chosen path of development.

b. Many of the fundamental investigations carried out in HEI departments in the UK are of the highest intrinsic merit and must continue; we have no desire to undermine excellent research or scholarship of any kind. But it must be admitted that some work may be of less urgency, importance or even interest. Such work, together with an increasing teaching load, has pre-empted resources which might otherwise have been devoted to areas of research which are both academically worthwhile and have industrial relevance. We aim, through a reallocation of research effort within HEIs, for a better balance between basic and more applied research.

c. There must be a corresponding change in the practice and attitudes of individual industrial companies towards collaboration with HEIs. Universities and polytechnics in the UK have knowledge and expertise which can strengthen existing enterprise and generate new business ventures. Foreign firms are well aware of this, and are taking advantage of it.

d. The Government and public sector bodies have an active role to play. They should actively promote collaboration between HEIs and industry, both by providing practical encouragement to each partner and by organising themselves in ways which facilitate cooperation.

4. We conclude that, given the steps they are already taking, the initiative in forging new and productive links should lie mainly with the HEIs. Industry will need to match this with a constructive response and initiative of its own. The institutions will need some financial headroom to undertake this task. The first of the recommendations listed below seeks to strengthen HEIs which are already successful in collaborating with industry, as reflected by their income, and the second recommendation aims to bring others to a similar level of success.

5. Our principal recommendations (with reference to paragraph numbers) are -

i. The Government should establish an 'industrial seedcorn fund' to support the infrastructure and basic research that will complement effective, industrially-financed applied research. The fund should equal 25% of the money earned by HEIs through contracts, consultancies and investigations from the private sector and the public trading sector (excluding contracts for teaching and training). This would initially require about £10M pa. HEIs should receive allocations from the fund equal to 25% of their eligible earnings. The fund should be established for 5 years in the first instance. Its size should be adjusted annually in order to remain equal to 25% of eligible HEI earnings. (4.17)

ii. A minimum of £5 M pa should be earmarked by the Department of Industry (DOI) for an initial period of 5 years to be used for projects proposed by HEIs that contribute significantly to the infrastructure for academic-industrial co-operation. This scheme should be managed jointly by DOI and the Science and Engineering Research Council (SERC). Pump-priming funding should be conditional upon evidence of serious intent by HEIs to adapt to industrially-oriented work, notably through appropriate conditions of academic appointments. (4.18, 4.19)

iii. Bodies on which industry is represented at a high level - CBI, BIM, NEDO, local Chambers of Commerce and Industry, the Royal Society, Fellowship of Engineering and learned societies - should urge firms to show initiative commensurate with that of the HEIs in establishing and maintaining academic-industrial links, notably by bringing together firms with a common interest in a particular activity, discipline or HEI. Building upon what already exists, the Royal Society for the Encouragement of Arts, Manufactures and Commerce (the RSA), with a membership and objectives highly relevant to this issue, should foster and co-ordinate these activities; the Royal Society of Edinburgh is well-placed to promote such activities in Scotland. (4.25)

iv. DOI and SERC should collaborate more closely in supporting both joint activities carried out by industry-HEI partners and industrially-oriented work in HEIs (we see SERC's directorates as a model); DOI should provide most of the funds for new initiatives in this area, although SERC might administer the schemes; and other Research Councils should consider with appropriate Government Departments the introduction of joint schemes for supporting academic-industrial collaboration. (4.36)

v. The Department of Education and Science (DES), the University Grants Committee (UGC) and other relevant bodies should take action -

a. to agree an appropriate average level of research activity in universities, each university proposing the level which it wishes to adopt;

b. to assure adequate support for research by means of an identified proportion of the UGC grant;

c. to ensure that funds intended for research are used for that purpose;

d. to ensure that research funds are effectively managed by universities by means of Research Committees (as advocated in the Merrison Report) or equivalent bodies. (4.15)

6. Other recommendations are -

vi. The Government should mount a campaign, with active Ministerial involvement, to improve awareness of the benefits of academic-industrial collaboration and of the measures available to encourage it. (4.32)

vii. Senior executives of industrial companies and their staffs should seek and accept appointment to bodies through which they can establish links with academics and learn of academic capabilities, and that they should actively follow up the academic contacts so established. (4.26)

viii. DES in consultation with the Department of the Environment (DOE) and other appropriate bodies should take action to provide -

a. a clearer definition of the role of polytechnics with regard to research, notably that supportive of industrial contacts;

b. an identified amount for research activity, analogous to UGC support of universities;

c. an amendment of the law in order to allow polytechnics to negotiate contracts and undertake consultancies. (4.23)

ix. SERC, in collaboration as appropriate with DOI and others, should establish a national database of HEI research capabilities, accessible to the public by means of viewdata. The DOI and SERC should jointly set up a national system of regional brokers as an adjunct to the national database and to promote the support available for innovation and academic-industrial partnerships. Other public sector organisations should be enabled to employ the brokers part-time as agents for their own regional activities. (4.38, 4.39)

x. DOI should give special treatment in its support schemes to those projects of appropriate merit which involve academic-industrial co-operation. (4.29)

xi. HEIs should normally have the direct responsibility for ensuring that inventions arising from publicly-funded research are exploited. Any proceeds accruing to the institution, whether from royalty income or joint ventures or whatever, should remain with it and not be offset by any clawback arrangement, overt or covert. (4.27)

xii. DOI should establish a scheme whereby academics can take extended 'exploitation leave' in small companies with a guaranteed right of return to their institution, with DOI paying for a substitute member of academic staff during their absence from the institution. SERC and the Royal Society should more vigorously promote their Industrial Fellowship scheme for mobility between firms and HEIs and other bodies well-placed to promote mobility should establish similar schemes. (4.31)

xiii. The Research Councils should review their procedures for making post-graduate training awards in order to ensure they contribute in the most effective way to concentration and selectivity in research. (4.21)

7. We have also made a number of other suggestions and comments which may call for action:

a. HEIs should only charge for their services at less than full economic rates if there are special academic reasons for doing so. (3.14)

b. Those who change job should retain pension rights commensurate with their own and their employer's contributions. (3.18)

c. There should be greater flexibility in the conditions of employment of academics. (3.19)

d. Industrial work should be a factor in academic promotions. (3.22)

e. DOI should ensure that business advice is available to academics. (3.27)

f. A study of the creation of successful new firms around Cambridge should be commissioned. (3.28)

g. The objectives of science parks and the means of achieving them should be clearly established and published by those involved. (3.32)

h. SERC should assess its Integrated Graduate Development Scheme in consultation with the Engineering Council. (3.34)

i. More attention should be paid to the industrial definition of PhD projects and to part-time PhD work. (3.35)

8. We believe that there is the potential for a substantial strengthening of links between HEIs and industry in this country and that action should be considered as a matter of urgency.

1. INTRODUCTION

Research, knowledge and society

1.1 The UK possesses great strength in the quality and breadth of its academic research, and in the ability of academic researchers. Research contributes to knowledge, which is then accessible worldwide either through professional contacts or through publications and conferences. The nation's industrial effort needs to be able to exploit the practical applications of this research, which underpins the innovation needed in any thriving industry.

1.2 The Working Group's main premise is that knowledge generated by research in science and engineering should be effectively applied to benefit the society which sustains the research effort. Occasionally, (eg in the case of vitamins and antibiotics) the benefits from new discovery are so spectacular and obvious that links to production and widespread availability are purposefully forged. More generally, the pathways between the advance of knowledge and its practical application are less obvious. Clear signposting is required to provide well defined lines of communication between researchers and industry. There can never be an entirely tidy correspondance between discipline-oriented researchers and mission-oriented industry.

1.3 Our remit focusses on higher education institutions (HEIs) as one major source of advances in knowledge, and industry as the agent by which these can be converted into products or services which meet the needs of society and for which society is prepared to pay. Universities and polytechnics are not, of course, solely concerned with research, but in practice the research and teaching functions are strongly related and much research is carried out against the background of a close and valuable interaction with teaching.

Academic-industrial links in research and its application

1.4 This subject is especially topical because both industry and the higher education sector are seeking to maintain scientific and engineering capability in stringent financial circumstances. Both, therefore, stand to gain from better links. At the same time, improved exploitation of technology can contribute significantly to economic prosperity, and thereby increase the resources available for supporting science and technology within both industry and higher education.

1.5 Links between industry and higher education carry two-way traffic. In one direction, they assist the development and exploitation of research results; provide opportunities for researchers to be involved in the use of their ideas; and offer a much wider reservoir of expertise to companies than they could otherwise afford. In the other direction, academic-industrial links help to direct researchers towards areas where benefits to society might appear, without loss of academic merit; provide researchers with a wide range of challenges and experience; and enrich teaching by providing access to current practice. Through such links, industry can use the results of existing research more effectively and can contribute to the identification of areas of future work.

1.6 We are not, of course, the first to consider this subject. Of particular note are the study by the Confederation of British Industry and the Committee of Vice-Chancellors and Principals published in 1970 (the Docksey Report) and the report in 1976 by the House of Commons Select Committee on Science and Technology. However, with certain notable exceptions, the record of achievement in the past 15 years has not been good and further initiative to improve matters is needed.

The scope of this study

1.7 This study considered two complementary questions -

a. how to help mutually sympathetic partners to work together; and

b. how to inculcate and encourage attitudes favouring the development of co-operation.

The first question involves 'marriage broking' to find productive partnerships and maximise their productivity. The second may involve persuasion or even coercion to provoke changes in practice and to widen the experience of those on both sides, thereby changing attitudes and also affecting a wider climate of opinion. In addressing both questions, we have considered what barriers and disincentives exist and how to dismantle or overcome them.

1.8 We have not considered the teaching role of higher education institutions except as it directly affects research and its application. We acknowledge that a major service which HEIs provide to industry is the supply of educated and trained manpower. But that subject - though vitally important - is beyond the scope of this study.

1.9 Most of our evidence concerned research in the natural sciences and in engineering. Medicine and agriculture, in the UK as in other countries, have tended to evolve their own distinctive means for linking research with application, and teaching with practice. We are also aware of links in the social sciences. But we believe that, even though our attention may tend towards engineering, the measures we propose in Chapter 4 will benefit academic-industrial links across the spectrum of academic and industrial activities.

1.10 The second chapter of this report summarises the present UK arrangements for academic-industrial collaboration in research and its application. The third presents our analysis and discussion, and the fourth our conclusions and recommendations. A summary of the main points in the written evidence we received is in Annex 1. Some noteworthy overseas arrangements are described in Annex 2. A list of contributors to the report is at Annex 4.

2. CURRENT HIGHER EDUCATION - INDUSTRY LINKS IN THE UK

2.1 Industry, higher education institutions (HEIs) and other interested parties have devised many kinds of links for the purpose of undertaking research and promoting its application. Individual academics and industrialists have set up many arrangements themselves, but a number of schemes are promoted by third parties. Pre-eminent examples are the schemes run by the Science and Engineering Research Council (SERC) but other Councils have some similar schemes. Others involve the British Technology Group (BTG) which incorporates the formerly independent National Research Development Corporation (NRDC). In this section of the report, we review the principal academic-industrial links - dividing them into direct contacts and third party measures.

The general context

2.2 In 1978 (the latest year for which complete figures are available), some £3,500M was spent on R and D in the UK. Private industry funded about 36% (£1,280M) and carried out 59% (£2,060M) of the work, most of the remainder coming from the government. Of private industry's £1,280M, £1,180M were spent in its own establishments, £60M in Government establishments, £15M in Research Associations, £6M in HEIs and £17M elsewhere. In addition to £6M from private industry, HEIs also received £6M from public corporations and £8M from overseas, making some £20M in all. Their total funding for R and D was £317M. (More details are given in Table 2.1.)

2.3 Of course, not all industry-HEI contact is concerned with R and D, and there are difficulties with surveys: R and D surveys in industry probably only relate to formal R and D departments; the total HEI R and D expenditure is an estimate based in part on a 12 year old survey of how university staff spend their time. But the figure of about £20M out of £317M does indicate the scale of work for industry in 1978. Our own best estimate of HEIs' overall industrial receipts in 1981/82 is £35-40M. This is based on returns submitted to us by HEIs with the addition of major projects known to us but not covered by the returns.

Table 2.1

Research and development related to science and technology in each sector according to source of finance[1] - 1978

	£ million							
	Sector carrying out the work							
Sector providing the funds	Government	Universities and further education establish-ments	Public corporations	Research associations	Private industry	Other	Total performed in the United Kingdom	Research carried out abroad
Government	646·7	247·1	3·4	13·7	662·6	77·9	1,651·4	164·2
Universities[2]	—	28·4	—	—	—	—	28·4	
Public corporations	2·9	6·1	203·1	7·6	39·9	—	259·7	..
Research associations	—	—	—	8·2	—	—	8·2	..
Private industry	60·8	6·1	0·7	15·0	1,184·5	17·1	1,284·2	..
Overseas	26·5	8·1	5·3	6·3	173·9	2·5	222·6	..
Other	21·2	21·5	—	—	—	13·1	55·8	..
Total cost of research and development performed	758·1	317·3	212·5	50·8	2,061·0	110·6	3,510·3	..

[1] Research in the social sciences is excluded
[2] Including also further education establishment

Source: Economic Trends, August 1981 (HMSO)

Direct contacts

2.4 The most productive interaction between HEIs and industry occurs through direct personal contact. In specialised research areas related to innovative industries, academics normally know the firms to which their research is particularly relevant and, conversely, industrialists normally know where to obtain academic expertise in their main field of interest. Many of the third party schemes are aimed at fostering existing contacts and making new ones. Direct contacts can produce the two-way exchanges of ideas, expertise and facilities which benefit both parties and the results of academic research can thereby be translated into products and services.

2.5 Industrial companies and HEIs can take steps to foster productive contact between individuals. In addition to the traditional ways, for example endowing academic fellowships or chairs, industrial companies can help institutions by providing advice on technical, research, curricular or business matters; supplying lecturers or other staff; and making available industrial premises or equipment for university research or teaching. In return, HEIs can provide industry with consultancy or contract research facilities, specialist advice and facilities, and special training courses to meet industrial needs. Joint activities such as research programmes with work in both industry and academic institutions, joint seminars, joint appointments, and joint supervision of, for example, sandwich course students can bring individuals together, as well as being productive in their own right. They also provide opportunities for mixed careers in industry and HEIs. Such linkages bring benefits, provided that a single industrial liaison does not so dominate a department's research programme that it unbalances it.

Liaison bureaux and industrial units

2.6 Most universities, and a number of polytechnics, have an industrial liaison unit of some kind, serving particular academic departments or the whole institution. The most modest unit consists of one or two people - full-time or part-time - who handle the administration of academic-industrial collaboration, and provide information to industry on request. Others have more active involvement with marketing the institution's wares, and placing industrial work with appropriate academics.

2.7 Another arrangement is for the unit to operate almost independently of the HEI, having research and workshop staff of its own to undertake elements of industrial work. Such elements might, for example, involve development further downstream than an academic research group would normally go, or work to a timescale not readily accommodated within the HEI's general activities. Such units do not undertake production work nor, by virtue of the institution's charitable status, can they distribute a surplus. Their staff are employees of the HEI and paid on academic salary scales but there is scope for considerable flexibility in providing performance-related rewards as well.

2.8 In a number of HEIs, the industrial liaison unit takes the form of a company - usually limited by guarantee and wholly owned by the institution. By this means, the unit can operate in a fully commercial profit-making environment with corresponding freedom over staffing and conditions of service. The companies may operate primarily as an interface between industry and their institutions, for example, in arranging and managing contracts. But in at least one case, the company is an entirely free-standing contract R and D organisation: it is under no obligation to use solely institutional consultants and applies no pressure on academics to use the firm for development and exploitation of their ideas. Such wholly-owned companies need to spin off subsidiaries when outside equity participation is called for, for example in a particularly high-risk venture, or in production work where a different business approach is required from that in a contract R and D organisation.

2.9 Many of the units were set up with pump-priming funds from the Wolfson Foundation, or under the schemes operated in the late 1960s and early 1970s by the University Grants Committee and the former Ministry of Technology. In a number of cases, though, the industrial demand was such that no third party support was needed.

New enterprise projects

2.10 One form of new enterprise project is variously known as a science park, technology park or innovation centre. The idea of science parks has been imported from the United States where significant industrial developments have grown up near particular universities. In the UK

there are about 10 science parks already existing or being implemented, and others are planned. In general, the concept is for the provision of a site very close to an HEI, where science-based firms can easily interact with the scientific community. The park can also provide 'nesting boxes' for new small enterprises set up to develop and exploit academic ideas.

2.11 The success of these projects has been - and will probably continue to be - variable. In some actual and planned cases, the park is simply a convenient and attractive use for a piece of property owned by the HEI or others, and not necessarily sited close to the institution. On the other hand, the UK has what appears to be the only fully operational science park in Europe to be located on a university campus (Heriot-Watt Research Park). In addition, concentrations of industrial activity are beginning to emerge adjacent to some HEIs or on the campus - at Reading University and Cranfield, for example - but are not being called 'science parks'. In some cases, firms in the park may use common office services and have the use of the social and technical facilities of the academic institution.

2.12 The parks have been initiated variously by HEIs, local authorities, commercial enterprises and (in one case) a central government agency. The funds to establish the park may well come from non-academic sources, particularly if the local authority makes a point of fostering new businesses.

The Science and Engineering Research Council (SERC)

2.13 The Research Councils have a number of schemes to encourage HEI-industry links in operation or planned. Within its broad responsibilities for supporting research and advanced training in higher education institutions in physical and biological sciences and in engineering, SERC has several schemes for increasing academic-industrial interaction. These naturally relate more to engineering than science but are available in both. For the development of industrially-relevant technology, SERC has established four directorates and 18 specially promoted programmes since 1977. These relate to areas of technology where a concerted attack was likely to produce worthwhile results of national benefit. The objectives of these programmes are defined in consultation with industry, government Departments and active researchers

in the field. Two key elements of these programmes are: first, that they are closely managed through the appointment of Directors or Co-ordinators whose functions are to ensure that an appropriate portfolio of research projects is generated and properly managed; and, secondly, that industry is directly involved in the prosecution of the research and is therefore well placed to take up the results. Current SERC expenditure in these areas is about £18M pa.

2.14 The six SERC schemes directly aimed at supporting HEI-industry links are as follows:

- Cooperative Grants which support cooperative research carried out in HEIs with a financial contribution from industry;

- Cooperative Awards in Science and Engineering which support postgraduate training though research jointly supervised by an academic and an industrialist;

- Collaborative Training Awards which support short-term training projects of 12-15 months duration related to the problems of industrial production in smaller companies;

- the Integrated Graduate Development Scheme which enables new graduate recruits to manufacturing industry to receive intensive induction training organised jointly by their employer and an HEI;

- the Teaching Company Scheme which pays for high calibre graduates to work in an industrial company to solve problems in manufacturing, under the joint supervision of the firm and the HEI;

- the Royal Society/SERC Industrial Fellowship Scheme which supports academics seconded to an industrial environment for up to 2 years to undertake a project related to the company's R and D programme, and coversely provides funds for industrialists to undertake research or course development in an HEI.

We now describe these schemes in more detail.

2.15 SERC introduced its Co-operative Grants Scheme in 1978 in order to encourage direct industrial involvement in academic research work at an early stage. Under the terms of the grants, the SERC's contribution may be up to three times that of the industrial partner in terms of direct costs. A firm that contributes financially, or through effort or equipment, at least half the resources needed by an academic project receives the rights in the development work, with some small percentage royalty on subsequent sales going to BTG. The scheme has some 180 projects already in progress, to which SERC contributes about £1.5M pa, and a wide variety of firms is involved. In a majority of projects, the firms are contributing well over the required share of the costs; the knowledge that the firm will obtain the exploitation rights is thought to provide a considerable incentive to this level of support. Co-operative grants are often a preferred, and sometimes a required, mechanism for subjects covered by directorates or specially promoted programmes. The Medical Research Council is introducing a similar scheme for the universities in 1984.

2.16 The Co-operative Awards in Science and Engineering (CASE) Scheme offers a type of research studentship where an industrial organisation joins with the university or polytechnic in defining a project, and supervising the student's progress. The company also agrees to make its own facilities, including appropriate training in laboratory work, design and manufacture, available to the student for a part of his total training period. This is a method of giving the student a new perspective on the significance of his research in an industrial context, the project being selected jointly by university and industry. It leads to a type of training directly relevant to the industry's interests and training for its staff. In addition, the resulting contact between academic and industrial supervisors can generate new interaction. 760 new CASE awards were made by SERC in 1981, representing about one-third of all its PhD awards. So far, most CASE projects have involved collaboration between an academic department and a research laboratory of one of the larger industrial organisations. The Medical Research Council has a similar scheme. In 1979, SERC introduced the Collaborative Training Awards Scheme to support short-term training projects of 12-15 months which were more related to the problems of design and

production and more relevant to the needs of smaller companies. The number of projects launched, however, has been small. In addition, the Integrated Graduate Development Scheme provides financial support to enable new graduate recruits to manufacturing industry to undergo in their early years intensive induction training organised jointly by the participating companies and a designated university or polytechnic. The training comprises alternating periods in the companies and university, blending academic tuition with practical industrial experience at factory level.

2.17 The Teaching Company Scheme is supported jointly by the Department of Industry and SERC, which contribute equally to its funding. The aims of the Scheme are to develop active partnerships between HEIs and manufacturing companies in order to raise manufacturing performance by effective use of academic knowledge and facilities, to improve manufacturing methods by the effective implementation of advanced technology, to encourage able graduates to train for careers in manufacturing, and to develop and retrain staff both in HEIs and the companies. Under the scheme, high calibre graduates are paid to work full-time in a company to solve problems in manufacturing, under the joint supervision of the firm and the HEI. Since the inception of the scheme, more than 95 partnerships have been supported; annual expenditure is about £2.2M.

2.18 The Royal Society/SERC Industrial Fellowship scheme was launched in 1981 to enable academics seconded to an industrial environment to undertake a project lasting from 6 months to 2 years related to the company's R and D programme, and to enable industrialists to undertake research or course development in a university or polytechnic. The fundamental aim is to improve understanding of the problems of conducting R and D in the other environment. In the first 18 months, only 21 applications were received and 15 awards made, but it has been a general experience that all such schemes take time to gather momentum. The Medical Research Council is introducing a similar scheme for its own establishments in 1984.

2.19 To assist in promoting the schemes outlined above, particularly with smaller and medium-sized companies, SERC has appointed some Regional Brokers on an experimental basis. Their function is to introduce the help that "local" universities and polytechnics in the region can provide with research, technical services and training through SERC schemes. The four Brokers operating in the South-West, South-East, North-East and Eastern regions have made contact with over 600 companies in the last two years.

The British Technology Group (BTG)

2.20 The BTG was formed in 1981 by merging the operations and management of the National Enterprise Board and the National Research Development Corporation. A major role of BTG is to undertake the commercial exploitation of academic inventions. Under the Development of Inventions Act 1967, BTG is required to balance its books, and therefore has to take a view on the probability of successfully licensing any inventions taken on.

2.21 Academic researchers are normally free, subject to the terms of their funding, to offer inventions and ideas to BTG if they wish, in return for licensing fees and funding. Where, however, work has been funded by one of the Research Councils, there is an obligation for the inventor to give BTG right of first refusal for his invention. BTG can provide the inventor with technical and commercial assessments, expertise in patenting and licensing, development and other project funding, and revenue-sharing arrangements. BTG also acts as a channel by which firms can be kept informed of academic inventions which are offered to it. BTG helps in setting up new companies itself to commercialise inventions from HEIs or elsewhere - this has occurred for computer software and biotechnology.

2.22 In the past 33 years, BTG and its predecessor have been offered over 20,000 inventions from public sector sources (about half the academic inventions were offered voluntarily), of which 7,000 were accepted for commercialisation. Over 1000 have been revenue-earning; about 30 have each earned more than £100,000, several over £1M, and one over £100M.

Charitable foundations

2.23 Several charitable foundations provide funds to encourage the application of HEI research to industry. Pre-eminent among these is the Wolfson Foundation which, over the period 1976-80, provided a total of £6.2M to 29 academic institutions for university research with application to industry. Much of this was used to establish units within universities to undertake industrially-oriented work. Since the Foundation's activity started in 1968, 124 projects have been selected for funding; many of the units have become self-financing and have continued to thrive after the expiry of their grant.

Other measures

2.24 There are numerous ad hoc measures started at various times by interested parties. In addition, two competitions which are of relevance have recently been launched. The BTG's Academic Enterprise Competition was designed to encourage academics who were involved with establishing companies to commercialise their inventions. The £230,000 prize money in 1981 was distributed to 12 winners. The Education in Partnership with Industry or Commerce (EPIC) awards, sponsored by the Department of Industry, distribute about £60,000 pa to those HEI teams which can demonstrate the most successful partnership with industry.

3. ANALYSIS AND DISCUSSION

3.1 A summary of the written evidence we received is at Annex 1. In this chapter we present our interpretation of that and the evidence we received through interviews with individuals; and we offer some guidelines and examples of practice which industry and higher education institutions may find helpful.

Objectives and preoccupations of firms and higher education institutions

3.2 Higher education institutions (HEIs) are much concerned with the activities typically summarised in the charter of a university: the accumulation, interpretation and transmission of knowledge. 'Transmission' is generally taken to mean teaching and the exchange of research results with other researchers through conferences and publication in learned journals and books. This interpretation may be contrasted with the typical 'mission' of French researchers, established by statute, which is defined as the development of knowledge, its transfer to industry and society, its popularisation and administration, and the education of young and old. The French definition represents a wider formal interpretation of the 'transmission hof knowledge' than applies in the UK. On the other hand, the objective of industrial companies is to create wealth and foster the required innovation. These objectives (of HEIs and industry) were not adopted or designed to be complementary, and the 'natural' degree of alignment between them is small. But such alignment of objectives is acknowledged to be productive, and the evidence we have received suggests that if it could be increased, and the mechanisms for interaction better defined, there would be benefits to both sides.

3.3 There is clearly a good deal of interaction between higher education and industry, but performance is variable. There are some examples of excellent interaction and others of indifference. There are, in addition, differences between different sectors of industry and between academic disciplines. Some companies in the electronics, pharmaceutical and chemical industries - particularly the larger companies - claim to have closer and more extensive links with HEIs than other sectors of industry. This may arise because the companies have substantial research and development programmes of their

own, including work with a long timescale, and are well-placed to collaborate with HEIs as equal partners. Some smaller firms, particularly in electronics, also have good links through taking up commercially some of the more specialised products or services originated by HEIs; the instrumentation field offers many example.

3.4 All companies can potentially draw upon a worldwide base of academic knowledge and expertise, and larger firms will be able to seek out the best, wherever it may be found. However, companies frequently find it easier to collaborate with HEIs in the country and the region where they have their own industrial research facilities and from which they recruit their graduate staff, and industrialists in the larger firms informed us that the environment for such collaboration is as good in the UK as anywhere in the world. It is clear, though, that more needs to be done to persuade a wider range of firms to benefit from this environment.

3.5 Attitudes play a crucial part in determining progress with HEI-industry relations. While some firms and HEIs providing evidence to us did criticise the other party, about a third of respondents to our enquiries were genuinely self-critical. Firms were, though, not particularly hopeful that much more could be done to increase the overlap between their interests and those of HEIs, although nearly all agreed that links between industry and HEIs were a good thing and no respondent felt that there should be less contact between HEIs and industry.

3.6 We feel there are several reasons for firms' pessimistic view. First, industrial managements - if they are familiar with HEIs at all, and many (especially in smaller firms) are not - will remember them as establishments which taught them some years ago, or currently teach their sons, daughters or junior staff. HEIs are not, for many firms, obvious research contractors - nor (according to memories) are individual academics. Secondly, bad news travels faster than good, not least because firms will tend to keep quiet about any academic goldmines they find (though they are ready to complain publicly about failures), and academics may well be reticent about publicising their industrial work in case of disapproval from their peers. Lack of appreciation

of the potential value of academic contacts is consistent with the Finniston Report's view of the level of technological literacy and general education among industrialists - the UK comparing badly with Europe, and Europe with Japan.

3.7 In contrast to industry, HEIs were more hopeful that problems involved in industry-HEI co-operation could be overcome. In part, HEIs are looking for external funds to make up for the cuts in funds administered by the University Grants Committee (UGC). But there is a genuine feeling on the part of some HEIs that industrial exposure informs teaching (with benefits to the students) and provides a worthwhile outlet for research work which is an alternative to papers in learned journals.

3.8 Some academics, however, have fears about collaborative work. They think, first, that the free exchange of knowledge will be impeded by commercial confidentiality. We feel it reasonable that the provider of funds should control the publication of results that might directly affect his commercial interests, but in many industries the normal delays in academic publication provide adequate safeguards. Secondly, some academics fear that the balance between basic and applied research will be swung too much towards the latter. This could come as much, for example, from large numbers of SERC CASE awards as from direct industrial work. This is a risk, but we consider it a distant one in most HEIs where the current emphasis is the other way. Indeed, many firms - particularly the larger ones who make the greatest financial contributions to HEIs - emphasised to us the importance of maintaining the long term capability of HEIs to undertake top quality fundamental research. Thirdly, some academic staff have reservations about individual industrial companies benefitting commercially from publicly-funded research. The National Research Development Corporation was established partly to meet this concern but has not gained the respect of firms and HEIs. In our view, the return to the nation for its involvement in publicly funded research comes from the taxes paid by successful enterprises (and their employees) exploiting academic inventions, and from the employment which such enterprises create. Finally, some academics believe that their principal duty is towards scholarship and intellectual enquiry which has little in common with the concerns of industry. Such attitudes, where they exist, reflect the way in which industry and the academic world have failed to come together in the UK compared, for example, with the United States.

3.9 In the past few years there has been an awakening in the academic world that industry matters to them, and many academics and HEIs are setting out to see how problems can be solved and work undertaken in partnership with industry. Indeed many more HEIs are looking towards partnerships with industry as a significant and valuable part of their work. We hope that industry will respond in an equally constructive way. Informed experience is the best teacher in these matters - 'informed' in the sense that each party must understand the primary motivation of the other and must expect to have to work at the partnership if it is to be successful. The links established by third parties can help promote greater mutual understanding. These include particularly the SERC schemes, marketing or broking arrangements, and contacts established through teaching.

Links involving third parties

3.10 In Chapter 2, we outlined the various schemes which foster contact between industry and HEIs, either directly or as a by-product. We consider that there is scope for rationalising them. The schemes sponsored by the SERC are valuable, but there is a discontinuity between them and the measures to support industrial innovation promoted by the Department of Industry (DOI). This seems to arise from differing objectives. SERC supports good science, while, in some areas, favouring work with industrial relevance; DOI supports industrial innovation. In practice, DOI aims to support R & D done by those who will exploit it, that is companies themselves, whereas SERC can only provide direct support for HEIs, and these cannot usually exploit the results of research commercially. This difference of operation is, we feel, incompatible with the existence of the spectrum of HEI-industry partnerships which third parties should do their utmost to foster and which will require a corresponding flexibility in funding and exploitation arrangements. Set-piece schemes based on differing underlying philosophies may well not be the best way forward. DOI and SERC must come closer together to remedy this and in Chapter 4 we make recommendations to this end.

3.11 Formal academic-industrial liaison arrangements are established in nearly all HEIs, but seem to vary in their effectiveness. Industrial liaison officers must be of high calibre if they are to be acceptable to industry and must receive support, esteem and co-operation within their HEI. We would see them fulfilling three functions: to market the HEI's capabilities, to act as "facilitators" in the conduct of HEI-industry activities, and to pull together the necessary ingredients within the HEI. But - like good parents - they should be aware of the need for changing relationships and not strive to keep others dependent on them. It defeats their purpose if they are anything but a catalyst or transparent interface: any attempt at monopoly or excessive profit-taking for their own purposes will deter rather than encourage co-operation. Furthermore, unless the institution is squarely behind its industrial liaison effort, any fall-off in business may well be met by retrenchment rather than more aggressive selling. Where contributing to industrial success is a clearly-stated objective of the institution, the situation is healthier and more stable. Without a clear objective of this kind, the tension between scholarship and utility appears more of a problem than it really is.

3.12 We have been told that academic industrial liaison officers do pass on to counterparts in other institutions industrial enquiries which they cannot deal with themselves. Apart from this, the only wider broking scheme is that operated experimentally by the SERC with high calibre brokers who are demonstrating the need and effect of such a service. There is a need for an effective national information and signposting service, using a computerised database, to let firms know where particular academic expertise could be found. We welcome the pilot scheme being developed at Manchester for the DOI, and other similar schemes. Smaller firms who might benefit most from, yet know least about academic advice or consultation are in the greatest need of help. There could be scope for providing this through the DOI's small firms information service, but the efforts of all agencies must be co-ordinated if confusion and waste are to be avoided.

3.13 A parallel type of broker operates in a more entrepreneurial way, becoming financially involved in the HEI-industry venture and usually taking a management interest. BTG (NRDC) and Technical Development Capital Ltd (a subsidiary of Finance for Industry plc) are two examples. Others include those involved in new enterprise projects, eg the Industrial and Commercial Finance Corporation or the Scottish Development Agency, who have respectively taken an interest in the property and management of different science parks. The DOI has also provided selective financial assistance for some of these ventures.

3.14 Research Associations (RAs) and independent contract research organisations (CROs) see a role for themselves in bridging the gap between academic research and the firms which they serve. Their performance in this respect varies very widely. HEI research is usually discipline-based whereas many RAs are based on industry sectors. RAs and CROs may be able to act as the agents by which HEI work can be selected and adapted for use in industry sectors.

3.15 HEIs are seen by some research organisations as publicly-subsidised competitors. We are aware that some HEIs do charge less than full economic cost for their services. They should not do so unless there are special academic reasons for charging on a marginal basis, for HEIs may be prejudicing the quality of their scholarship if funds intended for that purpose are used to subsidise work for industry. In terms of contract work, provided HEIs do not unfairly undercut the research organisations, we see no reason why they should not exist in competition with one another.

3.16 Within many HEIs, there are autonomous units, institutes, or wholly-owned companies (many established with Wolfson Foundation aid) which exist to serve particular departments or the whole institution for industrial work. We see a need to identify clearly the role which these organisations play. Their job of disseminating information and awareness should not be compromised by an over-riding urge for commercial success at any price. They can engage in cross-disciplinary work, more difficult to organise within academic departments; they are decoupled from traditional academic timescales; and they can act as staging posts for academics and industrialists who are interested in the work of the other sector. We commend them to HEIs as useful means of working with industry.

Mobility

3.17 The best method of technology transfer is held to be people transfer. The same is true of spreading understanding and awareness of other subjects. For example, people who have worked for a time in either the higher education or the industry sector before moving to the other tend to have a greater appreciation of the interdependence of the two than those who have had a single career path. In addition, the methods and disciplines of one sector can benefit the other.

3.18 A major impediment to transfer between employers is the different treatment of employees who move by different pension schemes. In some cases the mobile pay a heavy penalty while, in others, there is none. A member of the University Superannuation Scheme (USS) moving to another employment in the public sector will be able to take his full pension rights with him. A move from HEI to the private sector will usually be more complicated. In some cases he will be able to transfer his pension rights to his new employer's scheme with little or no loss; in others he will have to leave them in the USS, to provide him with a preserved pension on reaching the USS retirement age. (This preserved pension will be revalued in line with inflation). Greater problems are likely for people moving from a private sector employer into HEI employment (or indeed from one private sector employer to another). Some employers do not pay transfer values; and while in this case they must preserve the leaver's pension entitlement in their own scheme, they are under no obligation to revalue it to take account of inflation. In short, in many cases mobile employees will suffer a loss of pension rights as compared with stayers. The Occupation Pensions Board have already proposed remedies and we hope these will be implemented soon: they would help to foster further interchange between industry and HEIs.

3.19 Short term transfers, ie secondments or part-time appointments, are more difficult to arrange where there is no tradition of them, particularly when times are hard. The best people are too valuable to lose, even temporarily, and guaranteed return tickets are increasingly hard to come by. We are aware of the historical origins of academic tenure, in the sense of lifelong entitlement to a particular job. In science and engineering, where

knowledge advances rapidly, it is essential that opportunities are offered to tenured staff to re-train and gain new experience. The need for re-training and varied experience has long been recognised in industry, where mobility within a firm, and between firms, is very much greater. We would therefore argue for greater flexibility in the conditions of employment of academics to enable them to obtain easier secondments or part time employment, for improved management within HEIs to facilitate transfers and for greater industrial awareness on the part of teachers and researchers. The following suggestions represent possible arrangements for new members of staff -

- more flexibility for academics to concentrate on particular types of activity, whether traditional teaching, research and administration or work for industry;

- industrial experience as a condition of appointment to a tenured post in industrially-oriented departments;

- contracts of employment of indefinite duration but with 3 or 6 months notice on either side, as tends to be the case in industrial companies;

- more untenured short term (5 year) appointments at higher pay to make up for lack of security and perhaps with a gratuity at the end of the term;

- the buying-in of more teaching staff from industry and commerce (for example, in medicine and architecture, teachers are frequently practitioners);

- the option for academics to work part-time outside the HEI, for example in their own enterprises, without breaking their HEI links. For example, an academic might give his institution an equity share in his business in exchange for the right of return to the HEI should the business fail;

- more joint appointments; for example, integrated chairs on the Salford University model, whereby an individual has substantial professional responsibilities in the university at the same time as exercising a senior managerial role in a firm or other corporate body. One of the main benefits envisaged is the generation of joint programmes of research and development;

- the appointment of industrialists to temporary senior posts in HEI, topping up their HEI salaries as appropriate.

Such measures would increase diversity in types of appointment and job.

Incentives and disincentives

3.20 There are other disincentives to university-HEI interaction. Some in industry may see it as a loss of face to go to an HEI for help by way of contract or consultancy. Their employers may in addition feel that they are paid to solve problems themselves, not to incur extra expenditure by involving others. This is less significant for large firms who are in a position to regard HEIs as an extension of their own innovative research capability. But, whatever the size of firm, the "not invented here" syndrome is powerful and the cure may involve difficulties which top management alone has the power to overcome. Good HEI-industry interaction is dependent on explicit support by top management.

3.21 For academics, there are significant disincentives to industrial involvement (although there are, of course, notable exceptions who have not been deterred by them). In the past, HEIs who gained significant income from non-exchequer sources were liable to have their recurrent grants cut in proportion. This, we suspect, arose from misguided notions of 'fairness' whereby the successful were held back so as to help the weaker. This practice penalised those who demonstrated excellence which private funding bodies - whether firms or foundations - were prepared to support financially. In our view, excellence should be built upon, not constrained to zero growth, andinitiatives encouraged which lead to the strengthening of high quality work, in particular that which is valued outside traditional academic peer groups. We therefore applaud the firm undertaking of the UGC not to cut universities' grants if they obtain outside finance, and we would argue that they should increase support to those whose standing has thus been demonstrated.

3.22 The primary basis for assessing academic promotions has in the past been the quality (and number) of publications. But this is only one criterion. Another is the willingness of industry to pay for the services of the academic. In the arts, where output other than papers is limited, the traditional basis may be the only reasonable one. But in some areas of science, and in engineering, it is entirely possible for excellent work of timeliness and promise to result not in a publication in a learned journal but in a patent or an artefact which makes a significant contribution to the industrial economy. It is therefore problematical whether all academics should be judged on a common base (publications) which ignores some factors, or whether alternative promotion routes should be available. We feel that industrial work should be taken into account in academic promotions. In addition, industrially-oriented academics should be able to benefit personally from their industrial work - even if this gives rise to parallel breeds of wealthy lecturers and impecunious (but academically esteemed) professors; those of the highest abilities, of course, may achieve both wealth and fame.

3.23 In terms of cash rewards, academics who undertake private consultancy work outside their institution generally retain their earnings - subject to any charge for the use of institutional facilities. We suggest to HEIs that academics should be enabled and encouraged to carry out practice outside the HEI in parallel with their duties within the HEI. This benefits both sides, and increases the quality and effectiveness of teaching. This applies widely in the United States where the reputation of a teacher and researcher depends substantially on his ability to hold his own as a professional practitioner. In the USA, 50 days per year is the norm for consultancy and a survey in 1969 showed that 40% of all US academics (65% for engineers) then undertook paid consultancies. The figures are now believed to be much higher. We feel this level of effort is justified by the benefits, though higher levels might affect HEI duties to the point where the academic should seek to reduce his HEI employment to a part-time basis.

3.24 Consultancy should be regarded as the seedcorn from which more substantial university-industry links grow. A recent survey in the USA of a large number of collaborative projects found that three-quarters grew from previous consultancies. HEI administrations must ensure that the tensions between contracts to the university (which include overheads) and individual consultancies (based on private profit) do not cause the latter to be stifled.

3.25 Various arrangements apply to the licensing revenue received by HEIs from the BTG. We are attracted by methods which divide BTG receipts between the academic inventor, his department and the HEI's research fund. The latter is then distributed at the discretion of the Research Committee, a body already existing in certain universities and advocated for all in the Merrison report 'Support of University Scientific Research' (Cmnd 8567, 1982).

3.26 A few HEIs adopt a resolutely neutral attitude to industrial interaction and exploitation by their staff. This is coupled, in some cases, with contracts of employment which neither encourage nor unduly restrict external professional activity by academics. While the onus is on individuals to show initiative, institutions should be supportive: resolute neutrality may have a negative effect on industrially-oriented academics who feel in need of reassurance from the institution that what they are doing is proper and worthwhile.

New firms

3.27 The encouragement of academics to start up their own companies is generally outside HEIs' arrangements for industrial liaison. Small firms of academic origin have the same need for financial and advisory services as other small firms. Experience in a big firm is not a fully adequate substitute for familiarity with a successful small business. We suggest that the DOI take steps to ensure that academics are fully aware of the advice and support available to small businessmen. Spinning off firms from HEIs, especially in fast growing high technology areas, can permit flexible employment opportunities for academics, quite apart from the obvious financial benefits. Success breeds success by example, and it is noticeable that in several locations a few good business starts encourage others. Some universities eg, Loughborough, provide appropriate 'project support' for new ventures, and this or similar services should be expanded. The DOI Small Firms Service can help here.

3.28 In the Cambridge area, there has been a very marked growth in small, high technology firms, particularly in the computing and electronics sector. These have used very diverse premises generally within cycling distance of the colleges, and have certainly not been confined to the Cambridge Science Park. The local management of Barclays Bank identified the trend at an early stage and appear to have played an important part in developing a special relationship with these companies. It is the closest parallel that we found to the 'Route 128' developments surrounding the Massachusetts Institute of Technology and there is no reason why it cannot be replicated elsewhere in the UK. A published study of the "Cambridge phenomenon", bringing out the examples of good practice by university staff, postgraduate students, bankers and others could be of great benefit and we hope that an agency concerned with innovation will commission it.

3.29 There has been much popular interest in science parks which are seen as vehicles for academic-industrial interaction of a kind which could bring national and local economic benefits. They appear to provide the opportunity for small firms to start in low cost accommodation (with the possibility of sharing some common services) and close enough to an HEI for ready interation between industrial and academic staff, to the benefit of both. The extent to which science parks in the UK conform to this image was considered in the report 'Helping small firms start up and grow' (HMSO, 1982) prepared by Job Creation Ltd for Shell (UK) Ltd and DOI. Our own view of science parks largely supports that report, and we outline the main elements below.

3.30 We consider individually the aspects of the popular view of science parks. First, the parks do provide accommodation for small firms. But these are more likely to be growing enterprises than start-up companies. The latter seem to prefer 'garage' type premises in the early days or small (500-1000 sq ft) 'incubator' accommodation which may or may not be located on the science park. Second, some science parks offer landscaped, low density premises with correspondingly premium rents - this has tended to be the US model. The UK parks do, however, include lower cost premises with lower specifications. There are also both high and low cost examples of incubator schemes in the UK; the cheaper ones with lower specifications seem to have

attracted more tenants, but some new high technology firms may need prestige premises in keeping with the high value of their products and to attract high quality recruits. In this respect, expensive premises may cost-effective in management terms. Science parks are seen as providing common services, but these are more commonly provided to the tenants of incubator accommodation than to other tenants on science parks. Again, the lower cost services are most used, and some firms prefer to arrange their own office support. A further common service might consist of financial and business advice of which (as we said above) small firms have a particular need. Finally, proximity to an HEI is not a sufficient condition for interaction between the institution and firms on the science park. This needs to be actively managed. We note elsewhere in this report that both parties need to work at academic industrial collaboration, so as to ensure that HEI expertise and facilities are made available to firms and that firms contribute to HEI research and teaching.

3.31 As the report by Job Creation Ltd emphasises, effective management of science parks is the key ingredient for their success in establishing HEI-industry links. This involves consideration of the kind of tenants for which the park should be designed, how to attract them, and how the HEI should interact with them. Professional management expertise is likely to be required. A second important ingredient concerns marketing - market research before the scheme starts, and continuous marketing of the scheme once in operation, both to potential tenants and within the HEI.

3.32 It is too early to make a final judgement about the success of ventures such as science parks in the UK. Where all the right ingredients are present, we see no reason why they should not succeed as means for academic-industrial collaboration and for the establishment of new firms. These ventures are, however, relatively slow developing and need a reasonable time (up to 10 years) in which to prove themselves. Local authorities and the institutions providing finance will need to have this in mind and should not seek an early return on their investment through, for example, the early reversion of unoccupied science park accomodation to office use. We would urge that, where ventures are in place or being planned, those concerned should consider them in the light of our comments, and establish clearly the objectives of the venture and the means of achieving them.

Students

3.33 Teaching and students provide means of communication between HEIs and firms, as well as of productive co-operation. HEI teachers who have awareness of industry and business acumen are likely to help students to fit more quickly into an industrial and commercial environment, while students, particularly those on sandwich courses, provide a route by which industrial concerns become known to the HEI. A model is provided by medical schools - indeed by the whole concept of the teaching hospital where the teachers are themselves practitioners and teaching is intimately connected with practice. The SERC/DOI Teaching Company scheme is modelled on this medical analogue.

3.34 Short courses and seminars have, as a useful by-product, the creation of contacts between industrialists and academics, but there must be a readiness on the part of teachers and participants to talk to each other about problems and remedies. Sustained contacts may well be more effective than the casual contacts derived from short course teaching and we were attracted by the new Integrated Graduate Development course being run at Warwick University in conjunction with British Leyland, Rolls Royce and Lucas. This teaches new graduate entrants to these companies to Masters level and includes a 4-month project within the parent company, which is jointly supervised by an academic and an industrial supervisor. For many applied subjects, this model would seem preferable to the traditional, academic MSc and we hope that funding agencies such as SERC, in consultation with the Engineering Council, will assess its value and give it appropriate priority in future.

3.35 We are also attracted to the arrangements in the West German technical universities whereby industrial companies suggest PhD projects - often to be undertaken by their own employees - to academics with an appropriate interest. The Fraunhofer institutes in particular supply industrially oriented environments in which PhD work can be done. In the UK, SERC's CASE awards already permit the industrial specification of projects, and the CNAA and certain universities award external PhDs. We suggest that SERC should opt for more industrial orientation in its postgraduate training especially in engineering subjects. A PhD provides training in research disciplines, as well as a means by which knowledge is generated. Other things being equal,

we would wish the knowledge to be applied sooner rather than later - hence the industrial specification of projects. In addition, we feel more opportunities should be given for part-time PhD work, which represents a good return in terms of training and industrial partnership at little outlay.

3.36 Sandwich courses are valuable as an undergraduate training mechanism, with the side benefits of making HEI - industry contacts and broadening the industrial awareness of teacher and student. Public spending cuts have recently resulted in fewer sandwich courses in HEIs, and firms, finding themselves under financial pressure, have found it increasingly difficult to provide placements during the industrial phases of sandwich courses. We are concerned at these trends, both of which serve to reduce HEI - industry contact. Part time post-graduate courses are also a direct way of feeding academic experience to those already working in industry but the public funding available is negligible compared with that spent on full-time courses.

Special factors affecting polytechnics

3.37 Nearly all of what we say about HEIs affects both universities and polytechnics. But there is a special factor affecting polytechnics which universities do not experience: the overseeing power of local authorities. By statute, local authorities have power over all polytechnic staff appointments and promotions; they are the legal entities which sign contracts affecting the polytechnic, and they have a right to all cash receipts. It must be said that many authorities commendably delegate these powers to the polytechnic governors and administration so that the polytechnic has almost as much autonomy as a university, but some do not. This greatly inhibits those polytechnics' freedom of action in working with and for industry.

3.38 We understand that polytechnics and polytechnic teachers because of their local authority base - are in an ambiguous legal position in undertaking work which is thought not to relate to their primary (teaching) function. Work of assistance to industry might be considered to be in this category. This problem, and the influence of local authorities, can conspire to make polytechnic-industry links difficult if the local authorities do not take an enlightened attitude. Furthermore, while the universities have a notional

provision of funds for research additional to that for teaching, the polytechnics have none. We feel that these factors work directly against the Government's original principle that 'it will be necessary to make the provision for research (in polytechnics) which is essential to the proper fulfilment of their teaching functions and the maintenance...of close links with industry... so as to promote the rapid application of the results of research to its problems' (circular AM 8/67, DES, 1967).

Practical problems in academic work for industry

3.39 Much was said to us about the different timescales on which academics and industrialists work. Part of the difficulty arises from the different purposes of academic and industrial enquiry: academics seek rigorous, intellectually satisfactory understanding of problems, while industrialists need solutions to problems sufficient only to get their product or process to the market. These aims are not necessarily mutually exclusive. Some aspects of industrial work require rigorous solution in order to understand product or process parameters. Furthermore, if academics and industrialists each understand the natural inclinations of the other and the work in prospect carries real mutual benefits, an accommodation can nearly always be found. The most satisfactory arrangement is a jointly arranged programme of work (in which both firm and HEI can participate) which meets the long term interests of both sides, and satisfies the more immediate needs of the firms as well. This takes good will on both sides, and we would wish to see more firms willing to try this approach.

3.40 There may also be some difficulty in relating an industrial problem to the academic calendar. The natural academic periods are those of a one or three year postgraduate course, or a few days consultancy. In addition, non-urgent, lower level work might be taken up as student projects. The difficulty arises where a company thinks a job will last six months and wants it started fairly quickly. This is where HEI-owned companies or industrial units score. Their staff are decoupled from the traditional academic timescales, being as free to take up work as any contract research organisation but benefitting from close contact with academic research groups. Relatively short term work of this kind can only be done well if it is underpinned by a core of high

quality research work which both helps to provide answers to industrial problems and may lead to questions about the basis of industrial technology. It must be noted that such units are not a substitute for a top-line research group doing high quality research, but complement them by, for example, facilitating multidisciplinary work.

3.41 The commercial confidentiality of industrial research when carried out in an academic environment was also held by some contributors to be a problem. Again, provided academic and industrialist understand the aims of the other (typically, the academic to publish, the industrialist to remain ahead of the competition) this need not be a difficulty. But there are variations with industry sector and academic discipline. For example, the pharmaceutical industry depends heavily on proprietary products, and confidentiality at the research stage is crucial. But in engineering, success depends more on the effective use of technology than proprietary rights to it. The publication of work fully funded by industry must be understood from the outset to be at the discretion of the firm, but publication may well be useful free advertising for a new product or process. On the other hand, acceptance of confidentiality need not prevent the work of academics coming to the notice of their peers, because the output of a research group - even if unpublished and not directly attributed - may well be recognisable to the cognoscenti. Furthermore, to see their work used may in itself be an alternative reward for some academics, especially engineers. Young academic scientists seeking to make their mark may be inhibited in not being able to publish quickly, but equally scientists in industry have to compromise between professional peer recognition and the confidentiality which is likely to be a condition of their employment. We hope that, in the academic environment, confidentiality will become less of a problem when industrial work is more generally accepted as a criterion of worth, as discussed in paragraph 3.22.

3.42 A related matter is patenting (and consequential licensing) versus publication. Firms may well require patent cover before they take up an academic invention, or wish to have a right to intellectual property generated by work which they have funded (in whole or part). Most of the difficulties that have arisen in the past arose principally because arrangements were inadequately formalised: people did not know where they stood. The essential steps are to negotiate, to agree, and to put in writing (before work starts) the agreement covering patents, rights, royalties etc even if the need for such agreement appears unlikely at the outset. The Committee of Vice Chancellors and Principals issued in 1979 a report by a working party on patents and the commercial exploitation of research results which sets out further guidance on these essential steps.

Intellectual property rights, know-how and the British Technology Group

3.43 At present, the BTG has the right of first refusal on inventions arising from work funded by a Research Council. This does not stimulate HEIs to take responsibility for exploitation, though academics feel free to criticise BTG roundly if exploitation is not achieved even if for sound business reasons. As a consequence, the BTG and its predecessor NRDC have been widely criticised as inefficient and rapacious, an obstacle to industry-HEI co-operation and a barrier to the exploitation of academic inventions. Our view accords with the ACARD report "Exploiting Invention" that BTG's right of first refusal should cease. Many complaints would lose much of their force if BTG were no longer monopolistic.

3.44 The trade in intellectual property capable of legal protection (by patent or copyright) has hitherto been over-emphasised at the expense of trade in know-how, although there are variations between sectors. A considerable (and perhaps increasing) amount of research output is not readily patentable, and is best exploited in exclusive deals between the HEI and a firm. BTG has in the past gone for patentability, and the lapse of its right of first refusal would encourage greater exchange of know-how between HEIs and industry. Such increased exchange is to be encouraged since much process technology has traditionally not been proprietary, success coming to the firms who made best use of generally available knowledge.

4. CONCLUSIONS AND RECOMMENDATIONS

Introduction

4.1 We are convinced that the overlap of interest between industry and higher education institutions (HEIs) is productive, and that benefits would accrue to both sides by increasing the area of overlap. Industry (of all forms) survives only by innovation. This entails a long-term view of a continuous and evolving chain from research to exploitation, requiring both intellectual and practical skills at every stage. Industry and HEIs between them can muster these elements. Indeed they must do so, to make the best of the UK's science and technology. Some of the most rapidly advancing industries have already seized the opportunity.

4.2 Previous chapters have shown the extent to which Government is involved in the creation and maintenance of HEI-industry links - through its financing of university research, its support of Research Council schemes, its responsibility for the BTG etc. It follows that Government policies towards such links, and the research which is the reason for their existence, should have a similarly long-term perspective. The creation of scientific knowledge in HEIs, and its application through engineering in the industrial economy, is too important to our national well-being to be the subject of short term political fashion or financial expediency. We would liken this to national defence, which enjoys significant political and financial continuity. With the long-term importance of the subject in mind, we see four principal themes as providing the key to progress.

Principal themes

4.3 HEIs differ one from another, each being excellent in particular subject areas or ways of working. We consider that such differentiation should be encouraged more than it is at present, building on excellent features of each HEI. In our view, HEIs themselves should be given sufficient financial flexibility to follow their chosen path of development. The aim would be to strengthen quality - thether of basic research, applied research, or teaching.

4.4 We have no desire to undermine excellent research and scholarship of any kind. Many of the fundamental investigations carried out in HEI departments in the UK are of the highest intrinsic merit and this work should continue. Moreover, much apparently speculative research subsequently reveals the germs of important applications. But it must be admitted that some work may be of less urgency, importance and even interest. Such work, in our view, has pre-empted resources which might otherwise have been devoted to industrially-oriented activities by researchers willing and able to carry them out. Reductions in public spending have left HEIs with fewer staff and, unless teaching methods are adapted accordingly, the increased teaching burden will further pre-empt research resources. It is not in our remit to advise on HEI teaching methods; we are considering the factors which encourage or inhibit research links between HEIs and industry. In this connection, we see the need for a more balanced allocation of research resources within HEIs by enabling researchers who wish to do so to undertake more industrially-oriented work. This will encourage others to move their talents into areas of research which are both academically worthwhile and have a ready industrial relevance. We envisage such work as being of strategic value to industry, not simply solving immediate problems. In summary, HEIs need to reallocate research resources away from worked-out areas of research towards areas that retain potential for further advance and are likely to benefit from the stimulus of applied research allied to them. Research and teaching carried out in partnership with industry can be just as challenging and rewarding as traditionally more academic activities, and indeed is often more difficult. Moreover, it can expose deficiencies in basic understanding and point the way to further fundamental research.

4.5 There must be a corresponding change in the practice and attitudes of industrial companies towards collaboration with HEIs. Universities and polytechnics in the UK have knowledge and expertise which can strengthen existing enterprise and generate new business ventures. Foreign firms are well aware of this, and are taking advantage of it. There must therefore be commensurate industrial initiative from British firms alongside the reallocation of academic research effort and increasing differentiation of HEIs. This implies a willingness on the part of industrialists to explore with academics the exploitable research available in HEIs, and to consider what further work they might do in partnership to the benefit (financial and otherwise) or both.

4.6 The Government, with public sector bodies, also has an active role to play. It should actively promote partnerships between HEIs and industry, both by providing financial incentives to each partner and by organising itself in a way which facilitates co-operation. Furthermore, Government departments and agencies should set an example by paying attention to the interests of their academic partners when entering into partnerships with HEIs.

Responsibility for initiative

4.7 We are aware that our subject represents very well-trodden ground - the volume of literature is fearsome. But, accepting that some progress has been made, still more needs to be done by way of practical achievement. There has undoubtedly been an increasing realisation that industry and HEIs can work together for the benefit of both, but action has been slow in coming. The UK, with its excellent record of science and technology, has much to gain over its economic competitors if it can act coherently and effectively.

4.8 We are not assigning blame for poor past performance, although we do of course applaud past initiative. Instead, we have sought ways of making progress. We believe a pragmatic approach is needed, using whatever levers of influence exist. The strongest lever is money - to reward achievement and foster initiative - building upon excellence and encouraging the ordinary to become excellent. We have therefore paid more attention to HEIs, simply because their funding from public sources provides mechanisms for encouragement and reward. Moreover, HEIs have the privilege of considerable freedom of action, and it must be balanced by an equal degree of responsibility.It can be argued that they have a duty (like the French legal definition mentioned in paragraph 3.2) to disseminate the results of their work to all those in a wider society who might apply it, in a form which the recipients can understand.

4.9 This does not, of course, relieve industry of its responsibility to be intelligent, active and far-sighted in cooperating with HEIs. It is industry, as well as society at large, that will benefit from successful cooperation and those in industry must work for the respect and confidence of their academic partners. Companies have much to offer HEIs in terms of experienced people, advanced facilities and business acumen.

4.10 Both HEIs and industry still show a certain reluctance to get together. Our recommendations should assist towards recognition of far greater common interest between the two parties. But for the moment we need to give the responsibility for taking the initiative, with appropriate opportunity for reward, to one side. From the views expressed to us, and bearing in mind the examples of excellent practice which have drawn to our attention, we conclude that it is HEIs which should mainly take the inititaive in forging the links.

A principal conclusion is that the initiative in forging new and productive HEI-industry links should lie mainly with HEIs. Industry will need to match this initiative with a constructive response and initiative of its own.

4.11 The recommendations which follow will take different times to affect the problems identified in this report. In the light of previous reports on this subject and the lack of subsequent action, we suggest that actions be monitored for effectiveness, and the results reviewed after an initial three year period. Other corrective mechanisms may be suggested in this process.

Differentiation among HEIs and the re-allocation of research resources

4.12 The dual support system for university research was reviewed in the Merrison report "Support of University Scientific Research" (Cmnd 8567, 1982). Two of the report's conclusions were that, as a longer term objective, universities should channel proportionately more of their funds into research, and that, to achieve high quality and proper support, research funds would need to be concentrated into selected areas. We endorse these conclusions. The report also recommended that universities should establish Research Committees to allocate within the institution the funds available for research. Some have done this. But we see a logical extension of these principles, which we now set out.

4.13 Our general view is that university-industry partnerships have not been well served by the dual support system in recent years because of the strains it has been under. The Merrison report discussed these in some detail. Partnerships would be encouraged by a differentiation of aims and purpose between the universities, and the development of research capabilities properly balanced as between the fundamental and that with a more ready

industrial relevance, both being of similar quality and standing. The size and balance of research capabilities in particular institutions should be management questions for the universities themselves. This requires information to be available to the university administrations about the funding intended for research, and about the ways in which their resources are deployed. We have already remarked, in paragraph 4.4, that financial pressures on universities have been accommodated through reductions in research activities and have not led to a re-appraisal of teaching methods. This process has gone largely unmonitored and unmanaged. The Research Committees advocated in the Merrison report, with the management information outlined above, should monitor the effects of spending cuts on university research and take remedial action.

4.14 We recognise that it is difficult for academics to identify precisely the proportions of their time spent on research, teaching, administration etc. But we understand that estimates can be made for some departments in some institutions. There are, however, other elements of university expenditure which we consider can be apportioned - technician time, instrument use, materials etc; this should be done for management accounting purposes. Similar difficulties and opportunities would apply in identifying the research component within the UGC block grant to the universities. However, for the purposes of management within the universities, some indication should be given about the proportion of UGC funding which universities could expect to devote to research.

4.15 Despite the difficulties of identifying the proportion of his time an individual spends on research, we feel that agreement is needed on the proportion of academic time which should be spent on research in the universities as a whole. Official statistics assume that on average 30% of the UGC grant is spent on research. This figure arose from an enquiry conducted in 1969/70 by the Committee of Vice-Chancellors and Principals (CVCP) into the use of academic staff time. The Merrison report considered, however, that the fraction was now smaller and anecdotal evidence given to us strongly supports this belief. We consider such a divergence between theory and practice to be unacceptable. We believe, therefore, that the research

component of UGC funding as a whole should be identified. A reasonable national average for the proportion of academic staff time spent on research might well be 30% - the proportion which was found in 1969/70. To encourage differentiation, each university should indicate to the UGC the proportion of funds that it wishes to devote to research; we believe that some universities may well decide upon a figure for academic staff time spent on research below 30% . The UGC should then undertake to allocate, as an identified component of its grants to universities, funds for research that take into account the chosen level of research activity and should then ensure that such funds are used for that purpose.

A principal recommendation is that DES, UGC, CVCP and other relevant bodies take action -

a. to agree an appropriate average level of research activity in universities, each university proposing the level which it wishes to adopt;

b. to assure adequate support for research by means of an identified proportion of the UGC grant;

c. to ensure that funds intended for research are used for that purpose;

d. to ensure that research funds are effectively managed by universities by means of Research Committees (as advocated in the Merrison report) or equivalent bodies.

4.16 We recognise that the pruning of block grants has caused difficulties in universities. But this pruning has forced a number of universities to address issues of resource management and accountability with a degree of vigour; this is a welcome and necessary trend. We are, though, concerned at the effect of the recent UGC cuts on the science and technology capability of HEIs, their ability to market their wares, and their ability to co-operate with industry. First, there is evidence that the cuts may have borne more heavily

upon research in science and technology than had been intended. Since academic scientists and engineers tend to be more mobile than others, their ranks have been selectively depleted in those universities which met the cuts by leaving vacancies unfilled. Secondly, there is a tendency for financial stringency to result in retrenchment of marketing activity rather than in more aggressive marketing. HEIs have not in the past been good at selling themselves (to industry or indeed to society at large) and retrenchment is a step in the wrong direction. Thirdly, the increased teaching load following the cuts means less research time and less headroom for accommodating those co-operative activities which take time and effort to set up. Some financial headroom will be needed for HEIs to build upon their chosen excellences and move towards work of high quality and utility. In this connection, we applaud the UGC's commitment that recurrent grants to universities will not be abated because of university receipts from other sources.

4.17 We therefore see a need to provide extra funds to HEIs to provide more staff time for more industrially-oriented work, and to underpin it. This would help prevent talent being drawn away from the longer range work that is needed as the basis for future collaboration, and research time being further eroded by the demands of setting up and managing partnerships with industry. The best indicator of this need is the sum which HEIs earn from the private sector and the public trading sector through contracts, consultancies and investigations (earnings from teaching and training would be excluded). We envisage an 'industrial seedcorn fund' being established amounting to 25% of HEIs' industrial receipts (which are currently about £40 M pa). DOI might contribute half of the fund, other industry-sponsoring departments about £1m each, and DES the balance. None of the contributions should come from within existing provision for HEI research. The fund would be divided among HEIs in proportion to their industrial receipts. A code of practice should be provided to help HEI governing bodies to determine the wise use of such funding, based on the following principles -

i. the fund is intended to support the infrastructure and the basic research that will complement effective, externally-financed applied work; it must not be used to subsidise tenders for external work;

ii. it is to pay for staff and such items of equipment as are not covered by the UGC capital equipment fund or its polytechnic equivalent;

iii. HEIs should decide the balance between appropriate development of current work, and new expertise which may provide a basis for industrial work in the future; but, other things being equal, departments which earn industrial money should receive a pro rata share of the HEI's allocation from the fund;

iv. HEIs should control the use of their portions of the fund by means of research committees as recommended in the Merrison Report, and assure reasonable balance between short term and longer term applications;

v. inter-disciplinary working should be encouraged in order to meet increasing demands for such work from industry.

The target for eligible earnings would be £100M pa in 5 years' time. This should be seen against the present fraction of their grant and fee income which HEIs are thought to spend on research, and which amounts to about £400M pa. The allocations from the fund should be spread over rolling periods of 3 years to enable proper planning by HEIs. The SERC might administer this scheme, which would apply to universities and polytechnics, on behalf of the Government.

A principal recommendation is that the Government establish an 'industrial seedcorn fund' to support the infrastructure and the basic research that will complement effective, industrially-financed, applied research. The fund should equal 25% of the money earned by HEIs through contracts, consultancies and investigations from the private sector and the public trading sector (excluding contracts for teaching and training). This would initially require about £10M pa. HEIs should receive allocations from the fund equal to 25% of their eligible earnings. The fund should be established for 5 years in the first instance. Its size should be adjusted annually in order to remain equal to 25% of eligible HEI earnings.

Further suggestions about the operation of this scheme are contained in Annex 3.

4.18 The preceding recommendation emphasises our primary purpose: to build upon success in industrial co-operation. But we recognise that measures will be needed to enable other HEIs, not at present much engaged in industrially-oriented research, to engage in partnerships with industry. We believe that modest pump-priming funds are needed to create the right infrastructure, and that DOI might appropriately provide them. In our view they should be allocated selectively, fostering the initiative of those prepared to reallocate research effort towards industrial collaboration. HEIs receiving substantial allocations from the 'industrial seedcorn fund' would need a particularly strong case to justify pump-priming support as well. We consider these pump-priming funds might be best managed jointly by DOI and SERC. This pump-priming scheme would cover both universities and polytechnics. We would expect that any particular allocation from this fund would be for a limited period, on the assumption that it would result in industrial contracts which would attract allocations from the industrial seedcorn fund.

A principal recommendation is that a minimum of £5M pa be earmarked by DOI for an initial period of 5 years to be used for projects proposed by HEIs that contribute significantly to the infrastructure for academic-industrial co-operation. This scheme should be managed jointly by DOI and SERC.

Examples of relevant projects might include additional industrial liaison posts in HEIs at senior level; the acquisition by HEIs of professional advice on legal, contract, patent and other business matters; the provision of management and marketing functions for ventures such as science parks and measures to promote mobility and interchange of staff with industry.

4.19 We would expect applicants for these pump-priming funds to demonstrate a serious intention and ability to make whatever changes might be needed in HEI administration to establish and build upon industrial contacts. In particular, we would see a willingness to redirect resources and to adopt a variety of flexible conditions of appointment - such as we set out in paragraph 3.19 - as evidence of serious intent.

We therefore recommend that pump-priming funding be conditional upon evidence of serious intent by HEIs to adapt to industrially-oriented work, notably through appropriate conditions of academic appointments.

4.20 The relatively small sums of money recommended in paragraphs 4.17 and 4.18 do not reflect the volume of academic effort to be redirected; they are the means by which a substantial volume of academic effort may be redirected. The size of the 'industrial seedcorn fund' reflects our assessment of the additional effort required to undertake collaborative work with industry, together with our estimate of the incentive required for HEIs to collaborate more.

4.21 Earlier in this chapter we endorsed selectivity and concentration in research as contributing to the support of excellence. Similar arguments can be applied in other spheres of academic activity, notably post-graduate training. We are not convinced that the Research Councils have done all that they might to apply to awards for post-graduate training the principles of selectivity which they apply to research grants.

We therefore recommend that the Research Councils review their procedures for making post-graduate training awards in order to ensure that they contribute in the most effective way to concentration and selectivity in research.

Polytechnics

4.22 We are persuaded that over-detailed control by local authorities and the lack of central provision for research support inhibit industry-polytechnic interaction. First, although many local authorities take an enlighted view regarding their polytechnics, we feel that measures are needed to guarantee all polytechnics a sensible degree of autonomy and flexibility - without disturbing the delegated authority which many polytechnics already enjoy. But they should have it as of right, not by the grace and favour of the local authority.

4.23 Second, polytechnics are inhibited in their work for industry by the lack of any direct funding for research analogous to UGC research support of the universities. This is essential if polytechnics are to have the foundation and

flexibility required for industrial work. We would emphasise, however, that as with universities, polytechnics should build only upon their particular strengths. They should not be encouraged to imitate the universities; nor should they aim at a research activity in every field. For this reason, we would not expect to see public funds used to build up centres of excellence in subjects already catered for adequately elsewhere or to create 'well-found' laboratories where these did not already exist. Third, the legal ambiguity about polytechnic work for industry needs to be resolved. Polytechnic research and consultancy should be a service which can be provided (and which polytechnics are encouraged to provide) to industry.

We therefore recommend that the DES in consultation with DOE and other appropriate bodies take action to provide:

a. a clearer definition of the role of polytechnics with regard to research, notably that supportive of industrial contacts;

b. an identified amount for research activity, analogous to UGC support for universities;

c. an amendment of the law in order to allow polytechnics to negotiate contracts and undertake consultancies.

We emphasise that the financial measures proposed in paragraphs 4.17 and 4.18 would cover polytechnics as well as universities.

Industrial perspectives

4.24 It is essential that industry takes its own initiatives commensurate with those under way in HEIs. Industrialists must make themselves aware of the opportunities presented by work in HEIs, the potential for partnerships, and the constraints under which their academic partners would be working. It is our considered view that the work which HEIs undertake for firms (whether UK or foreign) gives them expertise and experience which firms in the United Kingdom are singularly well-placed to draw upon. If the academic resources put at the disposal of British industry are to be world-class, academics must be enabled to learn from worldwide industrial experience. Many academics expressed regret that much of their industrial work was for foreign

companies. It is vital that British firms, in their own commercial interests, take up the opportunities offered by HEIs before their foreign competitors do. We have already remarked (in paragraph 3.3) that some of the larger companies recognise this and have extensive links with HEIs, at least in the disciplines traditionally of interest to them. But many other firms still need encouragement and help to establish such links, and the following paragraphs are addressed principally to them.

4.25 Personal contacts between top academics and industrialists are important in establishing collaboration between firms and HEIs. We see a spectrum of activities through which these contacts could be encouraged, particularly by the formation of clubs, analogous to the export clubs which have grown up in the UK, largely through the Chambers of Commerce and Industry. In these clubs, firms which export to a particular market share their experience with firms who do not. For HEI-industry links, we envisage a diversity in types of club. These might well be organised on a regional basis but would probably focus on a particular HEI, discipline or industry sector. Their activities would range from conferences and seminars to enable senior people to exchange information, views and cultures, to small consortia of technical people coming together to commission pre-competitive research projects with HEIs. A good deal of this sort of activity is already under way and its value should not be lightly dismissed by those in industry or HEIs who imagine that their own relationships with their counterparts could not be improved. Some of the most valuable assocations of this nature may well be across disciplines, and these require effort and deliberation to cultivate.

A principal recommendation is that bodies on which industry is represented at a high level - CBI, BIM, NEDO, local Chambers of Commerce and Industry, the Fellowship of Engineering, the Royal Society and learned societies - should urge firms to show initiative commensurate with that of the HEIs in establishing and maintaining academic-industrial links, notably by bringing together firms with a common interest in a particular activity, discipline or HEI. Building upon what already exists, the Royal Society for the Encouragement of Arts, Manufactures and Commerce (RSA), with a membership and objectives highly relevant to this issue, should foster and co-ordinate these activities; the Royal Society of Edinburgh is well-placed to promote such activities in Scotland.

4.26 Evidence suggests that it is a good investment of company time for senior staff to serve on academic and other committees - such as those of Research Councils. Members get to know, in a cost-effective way, both senior academics and their work, and can soon build up a set of front-line contacts through whom a wide range of others can be made. These would serve firms' immediate interests by way of research and manpower and help to increase the responsiveness of the higher education system generally. To follow up personal contacts, the technical directors of companies should have the task of obtaining information about academic capability and ensuring that academic industrial contacts are followed up. They should also encourage their less senior colleagues to become similarly involved. In this way firms should seek to have a 'mirror image' of the marketing work of HEIs.

> We therefore recommend that senior executives of industrial companies and their staffs should seek and accept appointments to bodies through which they can establish links with academics and learn of academic capabilities, and that they should actively follow up the academic contacts so established.

4.27 A number of particular steps can be taken to improve the directness of links between HEIs and industry, besides the greater staff flexibility advocated in Chapter 3. For example, we endorsed there the recommendation in ACARD's report 'Exploiting Invention' that BTG's right of first refusal to Research Council inventions should lapse. This was strongly supported by the evidence we received. Our view is that HEIs should be overtly and explicitly responsible and accountable for the exploitation arising from Research Council funding, and should retain the profits from exploitation. Indeed, we would go further and say that this responsibility should extend to all research funded by Government in HEIs unless the exploitation rights were explicitly withheld by the terms of the grant or contract. Innovation is a difficult process that in general works best with direct contact between inventors and those who seek to apply the inventions. The mandatory involvement of third parties can easily hinder it. The return to the public purse should be through the national benefits accruing from wealth creation rather than through a levy at the start of the innovation process. It is instructive to note that the USA has taken just this line recently in the legislation - the 1980 Bayh-Dole Act (Public Law 96-517) - which is described in Annex 2. HEIs should be enabled to

exploit their inventions through British or foreign firms, although HEIs might be expected to offer inventions to UK firms first and to approach foreign companies only if no suitable UK firm was interested. As we mentioned in paragraph 4.24, academics regret that overseas companies are more willing than UK firms to collaborate with them, but we reiterate that UK firms must take their own initiative in establishing productive contacts with HEIs, for their own commercial benefit.

We therefore recommend that HEIs should normally have the direct responsibility for ensuring that inventions are exploited. Any proceeds accruing to the institution, whether from royalty income or joint ventures or whatever, should remain with it and not be offset by any clawback arrangement, overt or covert.

4.28 We see two options for the future of that part of BTG which deals with the exploitation of inventions should its right of first refusal be revoked: to disband it, or to allow the market for its services to decide its future. We favour the second course of action. HEIs (and others) will continue to need professional services to ensure the exploitation of their inventions; BTG could provide some of these in the regions, on a fee-paying basis, operating no longer from a privileged position. The regional activity of BTG might sensibly be associated with the system of regional brokers which we discuss in paragraph 4.39.

4.29 We feel that the DOI is uniquely placed, through its technology support schemes, to encourage the involvement of HEIs in the applied research and development which it funds with industrial contractors. It already regards the cost of work subcontracted to HEIs as an eligible for financial support under its sponsorship schemes. But it might, for example, provide an enhanced grant (say 50% instead of 33 1/3%) to firms undertaking R&D in partnership with an HEI. This would not be aimed at coercing firms to commission extramurally R and D which would be better done in-house, but would make up for the uncertainty and extra management resources involved in a joint project and recognise the likelihood of further joint activities which might well not need public support. We are also attracted by the idea of a

'mirror image' of the SERC's Co-operative Grants Scheme. Under such a new arrangement, a firm wishing to sub-contract part of a research project to an HEI would be able to apply to DOI for a $33\frac{1}{3}$ % grant towards that element to be undertaken by the firm and 100% of that to be done by the HEI. (Under the Co-operative Grants Scheme, an HEI applies to SERC for about half the cost of a project to be undertaken in the HEI, with a company providing the balance; but the firm must bear the cost of any work it undertakes itself.)

We recommend that DOI give special treatment in its support schemes to those projects of appropriate merit which involve academic-industrial co-operation.

4.30 The corporate tax system offers one means of encouraging companies to undertake particular types of activity, but we consider that it is not an appropriate instrument to encourage HEI-industry collaboration. First, tax incentives might bias industrial R and D effort towards HEIs when some work might best be done in-house. Secondly, such measures would bear very unevenly on companies because of their widely differing tax structures - a large number of firms pay no corporation tax. Thirdly, HEIs coexist alongside other organisations undertaking contract research for industry and the competition between them must be fair.

4.31 We have identified problems in establishing collaboration between industry and HEIs. In part these are attitudinal, but we are convinced that there are other elements as well. First, in some areas, academics and industrialists are unable to formulate the problem on which they could collaborate. For example, an academic department may have considerable understanding of an 'ideal system' whereas the system on which a company needs help is not 'ideal'. Neither party finds it easy to define the problem in terms which the other can understand. This kind of conceptual difficulty could be overcome if each party could, for a while, breathe the culture of the other.

We therefore recommend that SERC and the Royal Society more vigorously promote their fellowship scheme for mobility between firms and HEIs and that other bodies well-placed to promote mobility establish similar schemes.

The second, administrative difficulty concerns the conditions under which an academic could take an extended period of leave in industry to see an idea through to commercial application in a firm, perhaps one that he himself has helped to found. The key feature seems to be to provide an element of financial security while trying out such a venture.

We therefore recommend that DOI establish a scheme whereby academics can take extended 'exploitation leave' in small companies with a guaranteed right of return to their institution, with DOI paying for a substitute member of academic staff during their absence from the institution.

The role of Government

4.32 We have indicated how the Government can give financial support to links between HEIs and industry. But we feel that more needs to be done to improve awareness among both academics and (more particularly) industrialists of the benefits of collaboration, both to the parties concerned and to the nation. In the past, Government 'awareness campaigns' with strong involvement by Government Ministers have been powerful instruments of change.

We therefore recommend that the Government mount a campaign, with active Ministerial involvement, to improve awareness of the benefits of academic-industrial collaboration and of the measures available to encourage it.

4.33 We are concerned that much of our evidence revealed a gap which still exists between the interests of DOI and SERC. (The same will apply to other Departments and Councils). Their policies and practices do not match well enough. Their respective criteria for assessing projects are fundamentally different, and this can lead to turgid administrative procedures when funding is sought from both bodies for an apparently meritorious joint academic-industrial project. There is a continuous spectrum of possible academic-industrial partnerships but no commensurately flexible arrangement by which they can be funded. Many people found the present assortment of schemes

confusing. Only the Teaching Company scheme is designed to provide support from both DOI and SERC for collaborative work, and its success shows how productive joint activities can be. The acceptance of the Alvey report's proposals on information technology is a further step in the right direction. But more is still to be done. The Cooperative Grants Scheme (for example) should be two-way, enabling the industrial partner to receive financial encouragement to carry out its share of a genuinely joint project, and we recommended a mechanism in paragraph 4.29. SERC's directorates, with DOI representation on their management committees, go some way to bridging the gap and there is a need for a wider development of such schemes across disciplines; but we have heard that cross-representation by officials between DOI and SERC committees is somewhat ineffective.

4.34 The difficulties over project funding reflect a more general question: the basis on which DOI and SERC draw the dividing line between them. This appears to be drawn on the basis of where work is carried out. In 1981/82, DOI spent only £2M in HEIs out of a total science and technology budget of £212 M; SERC spent none of its £217M directly in industry. We understand that present DOI policy reflects the Department's role as a 'proxy' customer for R and D on behalf of industry; it has few regulatory or procurement activities, and commissions little research for its own purposes. It has chosen to reinforce market forces through industrial members of Research Requirements Boards who appraise proposals for work from Research Associations, Government Research Establishments or (notably) from firms themselves. But we see no reason in principle why DOI, as a proxy customer for R and D, should not include HEIs in the range of bodies who might approach it with proposals likely to benefit industry.

4.35 As a result of this division of responsibilities, there is a significant body of research, which HEIs are well equipped to carry out, which DOI considers too 'basic' and SERC too oriented to a specific industrial problem to merit support. Much of this might be described as 'enabling science' - work needed to improve basic understanding in defined areas so that products or processes can be optimised for subsequent industrial development. Without the enabling science, progress would not be possible; with it, there is a

chance of progress. The research in such areas needs to be of high quality and elegant, but other things being equal, a hard-pressed Research Council will tend, quite reasonably, to support research proposals which offer new horizons and the prospect of new fields of endeavour rather than (equally high quality) proposals which primarily fill gaps in understanding. Funding of this type of work, we feel, is appropriate to DOI through a mechanism incorporating advice from SERC.

4.36 SERC has, in recent years, identified and funded a good deal of industrially-oriented work in HEIs, and this activity should continue. But we feel that SERC should not extend its funding further in this direction; such initiatives as SERC and DOI might jointly devise in future for the support of industrially-oriented research in HEIs (or indeed joint projects between firms and institutions) should be funded primarily by DOI, although SERC would be well-placed to administer the schemes. We have particularly in mind the establishment, in areas of national importance, of specially promoted programmes and directorates, largely funded by DOI, to promote R and D carried out both in firms and HEIs.

A principal recommendation is that DOI and SERC should collaborate more closely in supporting both joint activities carried out by industry-HEI partners and industrially-oriented work in HEIs (we see SERC's directorates as a model); that DOI should provide most of the funds for new initiatives in this area, although SERC might administer the schemes; and that other Research Councils should consider with appropriate Government Departments the introduction of joint schemes for the support of academic-industrial collaboration.

4.37 In summary, we conclude that SERC's efforts in supporting industrially-oriented work in HEIs has not been matched by other agencies or by industry and that, in consequence, the associated fundamental work - for which it is the major sponsor - may be under unreasonable pressure. SERC would be justified in expecting that funds for the support of new initiatives in academic-industrial collaboration would largely come, first, from DOI and other industry-sponsoring departments and, secondly, from industry itself as the influences

of this report, the Government awareness campaign and the 'industrial seedcorn fund' are felt. The consequence for DOI would be an increase in its science and technology budget, through accepting the support of industrially-oriented work in HEIs and contributing to the 'industrial seedcorn fund'. We would expect DOI to transfer the necessary money from its present support provisions for traditional industries. We would see such a transfer from 'sunset' to 'sunrise' industrial activity as being entirely consistent with the Department's published strategic aims.

4.38 As an associated concern, there is clear evidence that improvements are needed at all levels in the supply of information and marketing of academic capabilities to industry. First, a comprehensive national data base is needed, itemising the expertise, services and research programmes available in HEIs, classified according to technology or product area, as well as institution, and aimed at facilitating contact between individuals. The database should be comprehensive, accurate and promptly updated. It should be publicly accessible (possibly by Prestel) with a modest charge per 'page' of information, any deficit being met from SERC or DOI funds. SERC might assume management responsibility for the scheme, with its setting up and operation contracted out to a private sector company. The database might also include the information on public sector capabilities currently available through the DOI's Technical Advisory Point.

> We therefore recommend that the SERC, in collaboration as appropriate with DOI and others, establish a national database of HEI research capabilities, accessible to the public by means of viewdata.

4.39 A logical adjunct to the database would be a national system of regional information and awareness brokers on the present SERC model. Their task would be to provide advice where needed on the expertise identified by a search of the database, and to promote a simplified package of support schemes for innovation and academic-industrial partnerships. The cost of the

broking system might be borne by DOI and SERC jointly. Other organisations such as BTG (as mentioned in paragraph 4.28), the Design Council and local authorities may wish to associate staff with the brokers or to employ them part-time as agents. We envisage the broker himself being of high calibre and wide experience in industry, capable of dealing with firms, HEIs and other organisations at top level; he would have a small unit of seconded professional staff to support him and to provide regionally such professional services as HEIs demand or public sector bodies wish to supply. At regional level, groups of HEIs might choose to market their capability jointly, in collaboration with their regional broker.

We therefore recommend that the DOI and SERC jointly set up a national system of regional brokers as an adjunct to the national database and to promote the support available for innovation and academic-industrial partnerships. Other public sector organisations should be enabled to employ the brokers part-time as agents for their own regional activities.

4.40 Finally, we stress again the urgent need for action to encourage productive links between industry and HEIs. We consider that the measures advocated in this report will encourage links, to the benefit of HEIs, industry and society.

ANNEX 1 - SUMMARY OF UNITED KINGDOM WRITTEN EVIDENCE

INTRODUCTION

1. As a part of their enquiries, the Working Group sought views and opinions from the polytechnics, universities and Scottish Colleges of Technology, a broad spectrum of interested third parties, and over hundred and fifty companies who had made enquiries about joint research or development funding to the Science and Engineering Research Council (SERC).

2. The enquiry request consisted of a letter from the Chairman of the Working Group to the head of each organisation asking about -

- their general views on co-operation between industry and higher education, the advantages and disadvantages, problems and opportunities;

- any barriers or disincentives to the formation and extension of co-operative arrangements and the scope for their dismantling;

- what should happen in this field of co-operation and how to bring it about.

In addition, firms and higher education institutions (HEIs) were asked about the extent of their co-operation, in terms respectively of their annual outgoings to higher education and industrial receipts, and any special arrangements for co-operation which they made or participated in.

3. These approaches were not designed to constitute a complete national survey but to identify the main aspects of industry-education links today and perceptions about them. Over 240 responses were received, of varying length and detail. (Respondents are listed at Annex 4). The responses were analysed for the Working Group by the Technical Change Centre, London whose report was an important input to the Working Group's thinking.

4. 201 submissions were included in this analysis, others arriving after a cut-off date being dealt with separately. Among those included were 57 from universities and university colleges (85% of those approached), 28 polytechnics and Scottish central institutes (76% response), 85 industrial companies (56% response) and 31 from interested third parties including the Research Councils and the learned and professional societies.

5. This annex contains an abridged version of the Technical Change Centre's report. The balance of presentation may therefore be somewhat different from the Centre's report to the Working Group, but we hope this has been redressed in discussion elsewhere in this report.

SUMMARY OF THE TECHNICAL CHANGE CENTRE'S REPORT

Advantages of HEI-Industry Links

6. There was unanimous agreement from all respondents that HEI-industry links are beneficial to both parties, and while the benefits might vary through time, both parties gain in the long-run from working together. The general advantages concern the input and outputs of both the industrial and HEI systems. Industry gains useful ideas, access to experts and to unique resources and future employees, while HEIs also gain useful ideas, stimuli, and enhancement of teaching.

7. Financial advantages could be identified by both parties in terms of generating revenue for universities but not so for polytechnics, and of giving industry access to high quality, low cost research facilities and expertise. However, HEIs also saw disadvantages in industry using their facilities because of their 'low cost'. It was not stated if higher charges would discourage industry from using them, or if, because of little demand, low prices had to be charged to attract partners.

8. Interested third parties suggested that HEI-industry links were improving (information on special arrangements made by both HEIs and other parties tended to corroborate this), and that such links were vital for both industry and HEIs as joint partners, and also for the economy as a whole.

Disadvantages of HEI-Industry Links

9. Four areas of general agreement exist as regards the disadvantages, barriers, disincentives, and problems of HEI-industry links. First, the structure of HEIs in particular was seen as inappropriate to undertake many forms of industrial work. This barrier could be overcome with the development of specialist units, by the release of staff to undertake research work full-time, and by the recognition of the validity of industrially-oriented work for appointments and promotion.

10. Second, the problems to which industry seeks solutions are frequently of a short-term and practical nature, and may not easily be placed within a long-run research perspective. Furthermore, industry seeks rapid, workable solutions, not perfect answers. This approach militates against academic excellence. It was seen as vital not to allow either the teaching or the basic research work of HEIs to be compromised by engaging in increasing amounts of industrial work. While, it was generally agreed this was a barrier to greater HEI-industry links, it was not seen as insurmountable. HEIs were well suited to undertaking specific types of research.

11. Third, poor communication and misunderstandings between industry and HEIs was seen as a major barrier by both parties. Each carried misconceptions of each other, yet in those cases where collaboration did exist any misconceptions had soon been dispelled. In particular it was felt that there is a need to identify HEI expertise and facilities which could be used by industry and actively to promote this information via the SERC's regional broker scheme. Similarly, it is important that the needs of industry be identified and communicated to HEIs. Incentives must exist, however, for both parties to ensure that such a 'marriage broking' service works.

12. Fourth, it was generally agreed that the existing monopoly role of the British Technology Group is in urgent need of revision - this monopoly acts at present as a disincentive to HEIs, and to industry. However, it was also generally agreed that there is a role for the BTG though at present it is not readily apparent what this role should be. If a more strategic approach to research funding was undertaken at a national level a role for BTG might emerge.

13. No common agreement emerged as regards confidentiality. The HEIs suggested that confidentiality was a problem in some cases, whilst in others it was not so. Not only did this depend upon the nature of the problem being tackled, but also the company involved. A number of HEIs indicated that North American and European companies were less worried about confidentiality than their UK counterparts. The validity of this assertion is open to doubt and cannot be verified by the available data.

14. The disadvantages indicated by HEIs and industry were not seen as insurmountable, and in numerous cases what appeared to be a problem in one instance was not so in another. How real many of the problems were and how often they had been encountered could not be identified from the available data. It appeared though that with commitment and a positive attitude on both sides no problems or barriers existed, though disincentives (especially financial) would probably remain for the present.

Financial Extent of HEI - Industry Links

15. The data are neither comprehensive nor detailed enough to allow a true measure of HEI-industry links. The sums involved are considerable and it would appear that the HEIs receive around £35-40 M per annum from industry. On average each polytechnic received nearly £80,000 per annum from industry, while the comparable figure for universities was over £600,000. These two averages relate to the most recent years for which data are available which are 1981 and 1982. A detailed analysis of the links between HEIs and industry, if they could be quantified, would probably reveal that the extent of funding is well beyond the £40 M level indicated above. Not included in this figure are the provision of materials, equipment, and staff time. Also excluded are large donations (non-research specific funds) for research laboratories.

Nature of Existing Arrangements for HEI-Industry Links

16. Most HEIs have now established some way of liaising with industry, which ranges from institution wide liaison units to specific subject-based units. These arrangements have been greatly enhanced by the activities of the SERC via its schemes for Collaborative Awards and Grants, the Teaching Company Scheme, and the Regional Broker Service. Enough examples and experience have accumulated to allow further modifications and developments to current practices to be made. Despite the provision of both new units and departments in HEIs and the promotion of collaboration by the SERC, the most effective means of liaison was via individual consultancies and existing teaching programmes. Without individual commitment and trust on both sides, the provisions indicated above would make little impact.

17. Within industry few formal arrangements have been made for liaison with HEIs for research purposes. It is much more common to find graduate recruitment officers who will co-ordinate the sponsorship and recruitment of new graduates. Only in the largest firms is the organisation of the work with HEIs sufficiently large to warrant a full-time member of staff. Time is also a major constraint within industry, preventing greater collaboration with HEIs the recent cutbacks in industry which have not only reduced the time timescale of research still further, but have also cut across many well established personal links.

Proposals for Improving HEI-Industry Links

17. The proposals put forward by each of the four categories of respondents: - universities; polytechnics and the central institutes in Scotland; industry; and third parties - are of two main types: the general, and the specific. The proposals put forward by all parties can be put under six headings: finance, liaison mechanisms, staffing, national R&D structure, communications, and the SERC.

19. Finance: It was generally agreed that the existing funding arrangements for HEI research need to be reorganised, and to operate on a more coherent and strategic basis. In particular, greater involvement of the Department of Industry is needed, especially if specific opportunities emerging from existing research work are to be built upon. Greater involvement of the Department of Industry was also seen as a means of promoting strategic research (by expanding its present involvement with the directorates of the SERC) and of identifying research priorities.

20. In order to enhance existing research relationships, new financial incentives should be introduced. Few specific suggestions were made, but it was felt that the exploitation of HEI ideas for the benefit of the HEIs (not BTG) and any company concerned would help, and so would tax and VAT concessions on joint industry-HEI research work.

21. Liaison mechanisms: Existing mechanisms should be developed, in particular by the liaison unit system and/or by science parks or innovation centres. Science parks or similar schemes were not mentioned by any of the industry respondents. They may require substantial financial commitment and the co-ordination and support of a third party. The plan of the Scottish Development Agency is to harness the resources of the Universities of Glasgow and Strathclyde at the West of Scotland Science Park. The Agency is also involved with similar work at the Universities of Aberdeen and Heriot-Watt. There is no equivalent to the Agency in England to perform a similar co-ordinating function.

22. Staffing: All parties agreed it is important that there should be staff exchanges between industry and the HEIs. These could be facilitated by sabbaticals for industry and HEI based staff. Exchanges would also be made easier if the career structures in industry and HEIs were similar.

23. National R & D structure: While some industry respondents felt that there should be less direct Government involvement in R & D, the weight of opinion from both the HEIs and the third parties was that existing investment requires much greater co-ordination. A common policy is needed for each of the parties involved, i.e. BTG, Departments of Industry and of Education and Science and the Research Councils. It is important that a coherent policy be established and that complementary (not competing) strategies be developed.

24. Communications: By far the greatest area of agreement was on the need for an improved means of communicating between industry and the HEIs. The means most frequently suggested was the establishment of an active resource register (data-base) to provide a way of matching HEI-based ideas, resources and experts with the needs of industry.

25. The exchange of staff (noted above) was also seen as a potent means of communicating and of sharing the understanding of each others' worlds.

26. SERC: The SERC was seen as already having an important role in establishing and developing links between industry and the HEIs. Particular mention was made of the Collaborative Awards and Teaching Company Schemes both of which should be expanded. The Regional Broker Service should also be expanded and might be able to take on the development and operation of the data base scheme to enhance communications (see above).

ANNEX 2 - SOME OVERSEAS ARRANGEMENTS FOR ACADEMIC-INDUSTRIAL COLLABORATION

The Federal Republic of Germany

1. There was a strong tradition of links between universities and industry in engineering until the 1960s. University teaching posts were only available to people who had spent some time working in industry, and this provided a good personal basis for contacts at a later stage. The increased demand for university teachers caused by the expansion of the universities in the 1960s meant that this requirement had to be dropped and the tradition has now to some extent been broken.

2. There is a general feeling that more should be done to improve contacts between industry and universities: particular areas of difficulty are seen as:

- the traditional independence of a German professor means it is difficult for his employer, the university, to force him to become involved in such activities;

- the institutional structure of German universities makes it difficult for them to take on contract work for industry;

- there is a feeling that universities should be engaged only in fundamental and not applied research.

3. Efforts have therefore recently been made to involve universities with local industry in their areas:

s have set up contact offices to help industry get in touch with their experts and to assist with the arrangement of joint research projects;

- other technology transfer agencies (eg those associated with chambers of industry and trade) have similarly tried to mediate between universities and industry;

- the Research and Technology Ministry has tried to involve appropriate university departments with industry in research and development consortia.

4. Many of these measures are too new for their success to be assessed, but some aspects of industry/university interaction appear to be functioning well. Examples are:

- the interaction of the older technical universities with large industry in traditional areas of technology. (The good relationship of the Technical University of Aachen with heavy industry in the Ruhr, and the Munich Technical University with Siemens are good examples.);

- The Fraunhofer Society Institutes are often successful in drawing on knowledge in university departments. The relatively high status of engineers means that such managers can often also take leading positions in firms.

5. But there are other less satisfactory aspects:

- universities have not been good at grasping the industrial significance of some new technologies (eg biotechnology) and carrying their knowledge in these areas into industry;

- in spite of the contact offices many small and medium sized firms still do not consider universities as a source of useful knowledge;

- universities often have difficulties arising from institutional constraints in carrying out joint research with companies.

France

6. In July 1982 the French law for research and technology was adopted by the National Assembly. The law was based on the report of a national colloquy on research and technology held the previous January. The law is essentially concerned with technology, and one of its main objectives is to 'open up' French science to industry. The key provisions of the law in this respect are:

- the creation of regional committees for research and development which will have their own budget and a degree of autonomy to develop regional science policies;

- the creation of a new legal category of organisation, "etablissements publics a caractere scientifique et technologique", which will be applied to organisations such as CNRS. The formula will give these bodies an explicit duty to attempt to apply their work, to publicise their research and to train and educate researchers;

- a second category of organisation, "groupements d'interet public", is created to allow such bodies as CNRS, for a limited period, to form profitable liaisons with industry;

- in a kind of inclusive job description, the "mission" of a researcher is defined as the development of knowledge, its transfer to industry and society, its popularisation, the education and training of young and old and administration;

- all government researchers will become "fonctionnaires", giving them the envied security of civil servants which, hitherto, only university staff have enjoyed.

7. The following are the chief means by which university/industry links are encouraged in France:

- French firms pay a payroll tax to the Government in respect of training (taxe d'apprentissage). However this money may be retained by the firm if an individual is trained in-house, or paid to a public research institute if the training is undertaken there;

- a firm may pay a publicly-funded institution to undertake some problem-solving research (usually short-term) or for the use of the institution's facilities (eg for testing equipment);

- a firm may contract with an institution to finance longer term work which may be to start a new line of research to look at a sideline of an existing programme, or simply to work on an interesting idea/project suggested by an academic. More likely than not the contract will be used as a means of funding postgraduate students or fellows (students who already have a third cycle doctorate and no longer qualify for a state grant). The contract will also cover running costs, materials, and perhaps travel.

- CNRS contracts: an academic may interest a firm in a university project, and the firm signs a contract with CNRS to fund the work. The research laboratory spends the money and publishes with the sponsor's permission.

- State aid for industrial projects: an institution and an industrial partner obtain government funding for a large project. This provides three-quarters of the university's costs and one-half of the firm's costs. Running costs and research students' grants are included. This is a previous DGRST scheme and it is not clear how it will operate under the Research Ministry.

Japan

8. University research does not seem to have the same status or role as a source of innovation as is the case in the USA and Europe. Only a modest proportion of Japan's universities enjoy a reputation for high grade research which is relevant to industrial innovation. Firms do not generally look to universities for their ideas, the larger and more important of them preferring to carry out their own basic research. (Some university professors in Japan have accused firms of suffering from a 'not-invented-here' syndrome).

9. A further factor is that the Ministry of Education, which directly employs university staff (unlike the equivalent situation in the UK) actively discourages direct links between academics and companies. Consultancies are forbidden in state universities (although not in the smaller private ones) in case these lead to nepotism in obtaining appointments.

10. The most effective channel for university/industry collaboration in Japan is through informal personal links. Compared with other countries, Japanese graduates stay in closer contact with each other throughout their professional careers. This leads to valuable relationships between academics and industrialists, particularly in research. This is reinforced by the role university professors play (as employees of the Ministry of Education) in the establishment and implementation of national research programmes, for example, the VLSI project and the 5th Generation Computer project. These national programmes, which are normally under the direction of MITI or the Science and Technology Agency, have extensive industrial participation. The presence of academics in the controlling bodies means that research results are effectively exchanged between companies and universities.

11. As direct Government employees, university staff in Japan are not allowed to profit from the commercial exploitation of their ideas. This acts as a considerable disincentive to taking out patents and promotes dissemination of results through open publications. Currently academic researchers are being encouraged to take out more patents and at least two universities have set up special offices to arrange this (Tokyo Institute of Technology and Tohoku University). The outcome of this could be to make research results more attractive to firms, which can take licences.

12. Although direct links between companies and university staff are discouraged for the reasons mentioned above there are many cases of informal collaboration. For example, the Electronics Department at the University of Tokyo has currently 5 visiting researchers from well known Japanese electronics companies for periods of 1 or 2 years. Also the Department receives grants from at least 10 companies which are used for purchasing equipment. The arrangement for visiting researchers from industry has some similarity to the UK's Teaching Company Scheme, but the emphasis seems to be on the industrialist working in the university rather than the other way round.

13. Collaboration between companies and university departments is also helped by the practice of using universities as shop windows for new equipment (often given or sold at very low prices). Through this firms receive feedback on the operation of new equipment and often valuable suggestions for modifications and extensions. Instances of this practice are computers (Fujitsu), telecommunication receivers (NEC) and Rankine cycle turbines (Mitsubishi).

14. In addition to these general collaborations there are limited examples of university developments being directly commercialised by companies. This has been the case in Tokyo University's robot developments (Toshiba) and in some biotechnology developments. These activities are promoted (although not necessarily in the examples quoted) by the Research and Development Corporation of Japan which has a similar role to the NRDC with comparable funding. However, it does not have any direct right to the exploitation of inventions by academics. Currently about half (123) of RDCJ's portfolio of projects concern the development of university research.

15. As in many countries the Japanese Government is encouraging closer working relationships between universities, industrial firms and Government institutions though the research park type of development. The so-called 'Science City' at Tsukuba was established some 10 years ago and now houses half of Japan's Government research institutes and 2 universities. So far companies have been slow to set up research facilities at Tsukuba, possibly because it is some distance outside Tokyo and road and rail communications are not very efficient. Time will tell whether this experiment will have the same success as Stanford, Boston and Cambridge.

16. In summary, university/industry links in Japan are fairly strong and operate mainly through personal relationships and involvement in national research programmes. Universities are being encouraged to patent their research but direct financial ties with companies are not permitted by the Ministry of Education. The practice of having visiting researchers from industry in university departments for periods of more than one year is a strong factor in ensuring that company and university research are closely linked.

United States of America

17. The overall scale of university-industry collaboration in the United States has been described in a recent report by the National Science Board (Fourteenth Annual Report) which identifies academic institutions as the performers of 9% ($6,600 million) of the nation's research and development ($69,000 million) in 1981. Returns available to the National Science Foundation indicated that approximately $250 million (3.5%) of academic research and development budget was provided by industry. This percentage has been fluctuating but the cash sum has doubled in real terms since the mid-1960s. The National Science Foundation speculates that the true percentage might be over 6% when donated equipment, undeclared sums and the research share of philanthropic gifts ($780 million from corporations in 1980/81 of which about a third is earmarked for research) are taken properly into account. Of the top 200 academic research institutions, 25 had industrial support totalling more than 10% of their research and development budgets.

18. Because of the size and diversity of the United States higher education system, virtually every type of university-industry collaboration can be found. One general feature is that faculty staff are allowed and encouraged to undertake consultancy for pay. One day a week is generally held to be compatible with faculty duties. In addition, the widespread practice of basing salaries on the teaching terms, amounting to 9 months of the year, leaves the academics free to bid for research money from the university or national agencies, or to undertake business activities, for the remainder of the year. A recent study of nearly 500 sizeable company-academy collaborations (carried out by the Centre for Science and Technology Policy, New York University and published by the National Science Foundation) found that three-quarters were based on previous consultancies. In the overwhelming majority of cases, the cooperative research programmes were initiated by the academic partner though the first, consultancy, contact may have come from the companies.

19. The most spectacular results of university-industry links are provided by the economic success of regions where they are strong. The chain of new

companies, founded in relatively cheap premises around Route 128 in Boston, started with graduate students and ex-faculty members from the Massachusetts Institute of Technology providing services for the university itself and then broadening into nationally competitive companies. The electronics industry that originally "spun-out" of Stanford is another example where graduate students, assisted by their faculty staff working part-time or on consultancies,have played a major role in operating new industry which in its turn has encouraged the relocation of existing companies into what is now the world's centre for microelectronics.

20. More recently, a number of very large, existing companies, often in the health products sector, have made long-term arrangements to support university research. Hoechst, the West German pharmaceutical company, will invest approximately $65 million over the next ten years in a new research department at the Massachusetts General Hospital. DuPont will be putting approximately $6 million over five years into a new genetics department at the Harvard Medical School. Monsanto and Rockefeller University have agreed a $24 million programme over five years based on photosynthesis and related subjects. A consortium of electronics and computing companies have formed the Semiconductor Research Co-operative which will place research contracts valued at approximately $20 million in selected universities over the next two or three years. Exxon and the Massachusetts Institute of Technology have agreed a $10 million programme in combustion research.

21. Most of the big partnerships are based on non-exclusive licensing. The companies have the right to second staff to the research centre, thus ensuring transfer of the know-how, and there is typically the possibility of a one or more month delay to publications to allow the companies to file patents and to check for the possible disclosure of proprietary information. The practice has grown up of the partners publishing the terms of their agreement to help forestall uninformed criticism of constraints on academic freedom. Indeed, the big partnerships seem to give a high degree of freedom to the research leaders. By backing a good team on fundamental studies in an important area, and by enhancing the ability to recruit graduate students and to second company staff, the industrial partners believe that they are laying down a sound medium to long-term investment.

22. The National Science Foundation has three principal schemes which foster university-industry links. The Industry-University Co-operative Research Programme (IUCR) is a variant on the standard NSF grants scheme whereby the funding to a joint university-company project may cover all the normal university research costs plus up to 50% of the collaborating company's costs of participation (or 90% if it is a small business). The projects need joint sponsorship within NSF by the appropriate subject Division (eg chemistry), which conducts a normal peer review evaluation, and by the Division of Industrial Science and Technological Innovation. The award can be made to the company or the university, with the award holder subcontracting to the other party. It is left to the co-operating partners to reach their own agreement on the disposition of patent rights prior to submitting a proposal. NSF expenditure on the scheme in 1981 was $8 million.

23. There are currently half a dozen Co-operative Research Centres operating. Some pump-priming support, and a brokerage/advisory service, is given by NSF to interdisciplinary research centres whose main funding will ultimately come from a consortium of companies. The NSFs funding is phased out within 5 years. The intellectual property rights stay with the centre but all members of the consortium are given non-exclusive and royalty-free licences. Publications may be delayed by up to one year. A major benefit for the companies is the recruitment of graduate students from the centres. The NSF sees its long term role as establishing the canons of good practice which lead to successful centres, with the hope that they will be emulated independently. The current NSF budget is currently around $2 million per annum.

24. The Small Business Innovation Research (SBIR) programme is specifically aimed at research and development within small (up to 500 employees) companies. Each project is expected to have three phases -

Phase I -contract for six months for a feasibility study. Contracts are awarded competitively against NSF's statement of requirements and are up to $50 k;

Phase II -main contract, typically over 1 or 2 years and up to $500 k, awarded to most promising feasibility study which also demonstrates company's competence and commitment of venture capital for subsequent commercial exploitation of R&D;

Phase III -commercial exploitation entirely funded with private capital.

NSF Programme Directors put out a "Programme Solicitation" each year with descriptions of the areas in which they wish to see research done. The applications are first screened by NSF staff and then go to a peer review process for the technical and scientific merit to be ranked. The 1982 approval rate was 1 in 8. Approximately $20 million has been put into SBIR by the NSF since 1977 and the private follow-on money is already estimated at $47 million, of which $41 million is associated with the $5.3 million programmes which have passed through phase II. Thus the multiplier appears to be a factor of 8. The companies concerned have shown a 125 per cent increase in employment since 1977. Because successful bids to the SBIR programme depend on the research itself being of merit, the programme has encouraged existing small businesses to use academics as part-time employees or consultants and has also encouraged the growth of new businesses out of campus skills.

25. There has been a series of new legislative steps over the last four years in order to encourage innovation. The Economic Recovery Tax Act (1981, Public Law 87-34), for example, aims to stimulate increased R&D expenditure above historic levels. The credit is also given for extramural expenditure (though only 65% of costs are allowable, to take out the non-R&D overheads of the contractor). There are also provisions for increased allowances on donated equipment and a faster depreciation (3 years instead of 5) on installed research equipment. Uncertainties about the formation of research consortia have been clarified by the Antitrust Guide Concerning Research Joint Ventures which the Department of Justice published in 1980. However the two main steps of interest to the ACARD study are the Uniform Federal Patent Policy Act (1980, Public Law 96-517, known as the Bayh-Dole Act) and the Small Business Innovation Development Act (1982, Public Law 97-219).

26. The Small Business Act requires that the ten federal agencies with the major share (99%) of the Government's R&D budget should spend at least 1.25% of their respective R&D budgets through contracts to small businesses. Most will reach this level over three years though Defence, with the largest budget, has four years to achieve the target. By 1987, approximately $500 million per annum will be in the programme. The approach is modelled on the pioneering SBIR programme which the NSF has been running since 1977 and will include the same three phases. On the one hand, the national legislation could be expected to reduce the direct funding into universities because the small business funding may in part come from other extra-mural spending, but on the other it is also expected to increase company-academy links because the former need to exploit the skills of the latter in order to join the small business programme. Thus consultancies, joint ventures, and spin-off companies are all likely to be encouraged.

27. The Bayh-Dole Act is based on studies carried out over a number of years. In 1974, the President made a statement on Government patent policy which stressed the need to exploit better the inventions arising from research funded by Government. A national committee on University Patent Policy then reviewed the various practices in the Federal handling of intellectual property rights and recommended (July 1975) that -

> "executive agencies be advised to adopt policies and regulations recognising that the public interest will normally best be served by allowing educational institutions with a technology transfer programme meeting the general criteria [see below] to retain title to inventions made in the course of or under any Government research grant or contract. These policies and regulations should require the use of Institutional Patent Agreements with the educational institutions."

The proposed general criteria for a suitable technology transfer programme included -

- a formal patent policy administered on a continuous basis by an officer or organisation responsible to the institution;

- assurance that university employees would be legally obliged to assign inventions, made under Government funding, to the institution;

- a programme for licensing and marketing inventions (expected to be normally non-exclusive unless it would seriously prejudice exploitation and then licences to be for fixed duration);

but the subsequent legislative enactments did not require an Institutional Patent Agreement over and above a fairly straightforward set of conditions attached to federal grants and contracts.

28. The main outcome of this activity, and parallel developments elsewhere on stimulating innovation and small businesses, was the 1980 Bayh-Dole Act, which, inter alia, established uniform patent procedures for all Government-funded R&D carried out in universities, other non-profit making organisations, and small businesses. Such contractors however may elect to retain title to inventions. There are certain exceptions (eg in contracts to run a Government facility or on grounds of national security); there is a requirement to disclose inventions to the funding agency; and there are sundry "march in" rights whereby title can be forfeited (eg when there has been no attempt at exploitation). There is a clause on "preference for United States industry" which says that there shall be no exclusive licence to a third party unless that party agrees to the products being "manufactured substantially" in the USA. There is a waiver, however, if reasonable but unsuccessful efforts have been made to find a licensee who would manufacture domestically.

29. The implications for universities will be far-reaching. All the largest research institutions have hitherto had their own arrangements for handling patents and licences, as there is no national agency such as NRDC, but much greater emphasis has now been put on this as a mechanism for technology transfer. The Corporate Relations officer is a new and respected colleague on many campuses. Increased commercial discipline and a better general awareness of the value of intellectual property amongst faculty staff, as well as better exploitation, will be encouraged by the legislation.

ANNEX 3 - DETAILS OF THE INDUSTRIAL SEEDCORN FUND

1. In paragraph 4.17 of the report, we recommend that the Government establish an industrial seedcorn fund to be divided among higher education institutions (HEIs) in proportion to their eligible earnings. We also proposed guidelines for HEIs in using their allocations from the fund. In this annex, we suggest some further details about the operation.

Eligible earnings

2. HEIs' earnings from the private sector and the public trading sector in the UK and overseas contracts, consultancies and investigations would be eligible. Earnings from teaching and training would be excluded. Gifts, endowments and grants would also be excluded. Eligible sources of earnings include private industry and commerce, nationalised industry and public corporations, but exclude Government departments, Research Councils, charitable foundations and other non-trading public sector bodies.

3. Only cash earnings would be eligible. This would permit both partners to subject the transaction to their own financial control and management procedures. It would, of course, be open to the partners to reach an understanding that the cash should be used by the HEI for a particular purpose, such as the purchase of equipment. Where payment might otherwise have been made in terms of industrial staff time, support might be sought under the SERC/Royal Society Fellowship or other schemes.

4. Earnings by companies wholly-owned by the HEI would be eligible, but allocations from the fund would be made to the HEI, not the company.

Size of the fund

5. We consider that HEIs should receive from the fund 25% of their eligible earnings. The target for earnings should be £100m pa in 5 years time, compared with £40m pa at present. The size of the fund should increase with earnings so that HEIs continued to receive 25%.

Operations

6. HEIs would declare their eligible earnings at the end of each year. In the subsequent financial year, they would receive an allocation from the fund of 25% of those earnings to be paid in three equal instalments (8% each) spread over the year in which the allocation was made and the two succeeding years. This would serve to smooth out some of the fluctuations in earnings and provide some continuity for management purposes. It would also permit a gradual build-up of new activity at the start of the scheme.

Feedback

7. At the time HEIs declare their eligible earnings, they would be asked to report how their last allocation from the fund had contributed to links with industry. This would be useful to the Government in drawing lessons for the future and identifying examples of good practice. The market would monitor the effectiveness with which allocations from the fund were used - HEIs which did not use them to underpin industrial collaboration would be unlikely to prosper in that field in the longer term. Accountability and financial propriety in the use of allocations would be open to scrutiny in the same way as UGC grants.

ANNEX 4 - ORGANISATIONS AND INDIVIDUALS SUBMITTING EVIDENCE

INDUSTRY AND RAs

Airtech Limited
Alcan International Ltd
Amersham International plc
Anderman and Ryder Ltd
Automatic Systems Laboratories Ltd
B & W Loudspeakers Ltd
Babcock Power Ltd
Bell and Howell Ltd
Bentley Engineering Co Ltd
Blue Circle Industries plc
British Aluminium Co Ltd
British Gas Corporation, Research and Development Division
British Petroleum
British Railways Board, Research and Development Division
British Robotic Systems Ltd
British Ship Research Association
British Telecom
BSC Sheffield Laboratories
Building Services Research and Information Association
Cambridge Electronic Design Ltd
Cambridge Mass Spectrometry Ltd
Castrol Ltd
CDRA - Federation of Technology Centres
Chloride Technical Ltd
Cole Polymers Ltd
Control Laser Ltd
Corah plc
Cosworth Research and Development Ltd
Courtaulds plc
Crystallox (1982) Ltd
Dalgetty Spillers Ltd
English Clays Lovering Pochin & Co Ltd
Era Technology Ltd
Fairey Aviation Ltd
Ferranti Computer Systems Ltd
Fisons plc, Scientific Equipment Division
Foraky Ltd
Forestry Commission
Fulmer Research Ltd
Gallaher Tobacco Ltd
General Electric Company plc
Genzyme Biochemicals Ltd
GR-STEIN Refractories Ltd Searle Research and Development
Hall-Thermotank Products Ltd
Hazleton Laboratories Europe Ltd
Impact Finishers Ltd
Imperial Chemical Industries plc
Inco Alloy Products Ltd
Job Creation Ltd
Jones and Shipman plc
Kent Process Control Ltd
LK Tool Co Ltd
Loughborough Consultants Ltd

Lucas Group Services Ltd
Mars Group Services
May and Baker Ltd
McClelland Geotechnical Services Ltd
Merck Sharp and Dohme Ltd
Micro Consultants Ltd
Mineral Industry Research Organisation
Muirhead plc
Myson Copperad Ltd
National Coal Board
National Nuclear Corporation Ltd
Netlon Ltd
Newmarket Microsystems Ltd
Oxford Applied Research Ltd
Oxford Instruments Group Ltd
Oxford Lasers Ltd
Perkin Elmer Ltd
Permali Ltd
Pfizer Ltd Central Research
Philips Electronic and Associated Industries Ltd
Pilkington Brothers plc
Pirelli Ltd
Plessey Company plc
Porth Textiles Ltd
QMC Industrial Research Ltd
R B Hawkins and Associates Lintech Instruments Ltd
Racal-Decca Defence Systems (Radar) Ltd)
Redfearn National Glass Ltd
RHM Research Ltd
Roche Products Ltd
Rockware Glass Ltd
Rolls Royce and Associates Ltd
Shell (UK) Ltd
Shirley Institute
Short Brothers Ltd
Standard Telecommunication Laboratories Ltd
Textile Research Council
Thorn EMI Central Research Laboratories
Thorn EMI Flow Measurement Ltd
Timber Research and Development Association
Transfer Technology Ltd
Turnright Controls Ltd
United Biscuits (UK) Ltd
Upjohn Ltd
Vacu-blast Ltd
Yorkshire Imperial Alloys Ltd

UNIVERSITIES AND COLLEGES

University of Aberdeen
University of Bath
Queens University of Belfast
University of Bradford
Bristol University
Brunel University
Cambridge University

City University
University College, Cardiff
Cranfield Institute of Technology
Dundee College of Technology
University of Dundee
University of Durham
University of East Anglia
University of Edinburgh
University of Essex
University of Exeter
University of Glasgow
Heriot-Watt University
University of Hull
University of Keele
University of Kent at Canterbury
University of Lancaster
University of Leeds
University of Leicester
University of Liverpool
London Business School
University College, London
Imperial College of Science and Technology, London
Royal Holloway College, London
Westfield College, London
Chelsea College London
Birbeck College London
King's College, London
Wye College, London
Queen Mary College, London
School of Pharmacy, University of London
Loughborough University of Technology
Manchester Business School
Manchester University
University of Manchester Institute of Science and Technology
Napier College
University of Newcastle-upon-Tyne
University College of North Wales, Bangor
University of Nottingham
Oxford University
Paisley College of Technology
Reading University
Robert Gordon's Institute of Technology
Royal Military College of Science
University of Salford
Scottish College of Textiles
University of Sheffield
University of Southampton
South West Universities Regional Computer Centre
University of St Andrews
University of Stirling
University of Strathclyde
University College, Swansea
University of Surrey
University of Sussex
New University of Ulster
University College of Wales, Aberystwyth
University of Warwick
University of York

POLYTECHNICS

Bristol Polytechnic
City of London Polytechnic
Coventry (Lanchester) Polytechnic
Hatfield Polytechnic
Huddersfield Polytechnic
Kingston Polytechnic
Leicester Polytechnic
Liverpool Polytechnic
Manchester Polytechnic
Middlesex Polytechnic
Newcastle-upon-Tyne Polytechnic
North East London Polytechnic
North East Polytechnics Mathematical Modelling and Computer Simulation Group
North East Wales Institute for Higher Education
Polytechnic of North London
Oxford Polytechnic
Plymouth Polytechnic
Portsmouth Polytechnic
Preston Polytechnic
Polytechnic of the South Bank
Sunderland Polytechnic
Teeside Polytechnic
Ulster Polytechnic
Wolverhampton Polytechnic
Polytechnic of Wales - Welsh Regional Management Centre

OTHER ORGANISATIONS

Agricultural Research Council
British Consulate-General - Zurich
British Council - Bonn
British Council - Helsinki
British Council - Peking
British Council - Rome
British Council - Saudi Arabia
British Embassy - Paris
British Embassy - Tokyo
British Embassy - Washington
British Technology Group
Cambridgeshire County Council, Directorate of Planning and Research
Committee of Directors of Polytechnics
Committee of Vice-Chancellors and Principals of the Universities of the UK
Confederation of British Industry
Council for National Academic Awards
Department of Industry
Engineering Council
Engineering Professors' Conference
Fellowship of Engineering
Institute of Chartered Accountants of Scotland
Institution of Chemical Engineers
Institution of Civil Engineers
Institution of Mechanical Engineers
Institution of Metallurgists
Institute of Physics
Licensing Executives Society (Britain and Ireland)

Medical Research Council
Ministry of Defence
National Association of Teachers in Further and Higher Education
National Economic Development Office
Natural Environment Research Council
Royal Society of Chemistry
Science and Engineering Research Council
Social Science Research Council
Society of Chemical Industry
The Royal Society
University Directors of Industrial Liaison Group
University Grants Committee

INDIVIDUALS

Mr Matthew Bullock, Barclays Bank plc
Dr A J Cochran
Professor J Ffowes-Williams, University of Cambridge
Mr C O Forestier-Walker, Minola Industries Ltd
Professor K Foster, University of Aston
Professor M W Fowler, University of Warwick
Professor A Gambling, Southampton University
Mark Haggard Esq
Dr E C Hambly
Professor Sir William Hawthorne
Mr G Hayward, Anglian Regional Management Centre
Mr W Herriot, Barclays Bank plc
Dr A Hooper, University of Cambridge
Professor P Hutton, Southampton University
Professor Daphne Jackson, University of Surrey
Dr A T Kuhn, Institute of Dental Surgeon, University of London
Dr A Mawson
Professor R A B Mollan, Queen's University of Belfast
Mr C Milner, North East London Polytechnic
Dr W Nixon, University of Cambridge
Professor R J O'Callaghan, University of Newcastle-upon-Tyne
Sir Joseph Pope, formerly University of Aston
Professor K E Porter, University of Aston
Dr D R Rosseinstry and colleagues, University of Exeter
Dr Roy Rothwell, Science Policy Research Unit, University of Sussex
Mr D Rowe, Director, University of Warwick Science Park
The Earl of Shannon
Mr J Smith, Imperial College, London
Dr D Spikins, Loughborough Consultants Ltd
Mr D Thomas, Imperial College, London
Mr D B Welbourn, Wolfson Industrial Unit, Cambridge

APPOINTMENTS IN CONFIDENCE

Ref. A083/1040

PRIME MINISTER

Membership of ACARD

With the regular rotation in the membership of ACARD, the term of office of five members expires shortly. They are Dr B C Lindley, Sir Alan Muir Wood, Mr J L van der Post, Professor W B Heginbotham and Dr D L Georgala.

2. I have consulted colleagues over possible replacements, bearing in mind the need to retain a balance of views on the application of research and technology from the perspectives of business and the academic world. In addition, there is a case for bringing some techno-economic expertise to the Council to strengthen the frame-work for ACARD's studies. As a result, I propose that the following should be invited to serve:

Dr C H Reece, Director of Research and Technology, ICI plc
Mr R Malpas, Managing Director, British Petroleum
Professor S Metcalfe, Professor of Economics, Manchester University

3. In addition, I propose that Dr B C Lindley, Director of Technology, Dunlop Holdings plc, be reappointed for a further three years. As well as a wide experience, Dr Lindley has knowledge of the standards field which is likely to remain of interest to ACARD. Since Sir Alan Muir Wood is leading the study of university-industry links which you commissioned from ACARD last year, I would propose he be reappointed for a further one year. In addition, I recommend that Sir David Phillips, the new Chairman of the Advisory Board for the Research Councils, be appointed to ACARD in place of his predecessor, Sir Alec Merrison.

4. If you are content with these proposals, I shall write accordingly.

5. I think it would be appropriate if, as in previous years, the retiring members were to receive a personal note from you. I attach drafts which take into account the desirability of both new and retiring members attending the meeting of ACARD in May.

ROBERT ARMSTRONG

11 April 1983

DRAFT LETTER FOR THE PRIME MINISTER TO SEND TO MR J L van der POST

I understand that you will be retiring from the Advisory Council for Applied Research and Development after its meeting in May at the end of your term of appointment. I should like to thank you for the time that you have given to the Council during the past three years. The Council's reports have, I know, been read with great interest in Government and industry.

Mr J L van der Post
Chief Executive
Water Research Centre
Medmenham Laboratory
Henley Road
Medmenham
Marlow
Bucks
SL7 2HO

DRAFT LETTER FOR THE PRIME MINISTER TO SEND TO PROFESSOR W B HEGINBOTHAM

I understand that you will be retiring from the Advisory Council for Applied Research and Development after its meeting in May at the end of your term of appointment. I should like to thank you for the time that you have given to the Council and in particular for your contributions to its Working Groups. I do hope that you will continue to participate ~~to~~ in the Council's study of advanced manufacturing technologies. The Council's reports have, I know, been read with great interest in Government and industry.

Prof W B Heginbotham
Director General
Production Engineering Research Association
Melton Mowbray
Leicestershire
LE13 0PB

DRAFT LETTER FOR THE PRIME MINISTER TO SEND TO DR D L GEORGALA

I understand that you will be retiring from the Advisory Council for Applied Research and Development after its meeting in May at the end of your term of appointment. I should like to thank you for the time that you have given to the Council and in particular for your leadership of its study on the food industry and technology. This report has, I know, been read with great interest in Government and industry.

Dr D L Georgala
Head of Laboratory
Unilever Research Colworth Laboratory
Colworth House
Sharnbrook
Bedford
MK24 1LQ

DRAFT LETTER FROM SIR ROBERT ARMSTRONG TO PROFESSOR SIR DAVID PHILLIPS

I understand that you have already learnt something of the work of the Advisory Council for Applied Research and Development since your appointment to the chair of the Advisory Board for the Research Councils, and that you have already attended a meeting of ACARD on an informal basis.

The link between the Board and the Council will continue to be important, and I am therefore writing to you formally (with the Prime Minister's approval) to invite you to join ACARD for the term of your chairmanship of the Board. I am afraid the appointment is purely honorary, but naturally any expense incurred would be refunded.

The Council will next meet at 10.00 am on Tuesday 3 May, here at the Cabinet Office, and I very much hope that you will be free to attend. I look forward to hearing from you.

Professor Sir David Phillips
Laboratory of Molecular Biophysics
Department of Zoology
University of Oxford
South Parks Road
Oxford OX1 3PS

Ref: A083/0026

Prime Minister

2

c. Mr. Ingham

MR. BUTLER

c Dr. Nicholson

The Prime Minister agreed some weeks ago that we should seek to broaden the Press profile of the Advisory Council on Applied Research and Development (ACARD) and that in this connection Sir Henry Chilver might give a Press conference.

2. Sir Henry Chilver gave a Press briefing on 14th December. The Prime Minister may like to glance at Dr. Nicholson's report of that conference, a copy of which I attach.

RCA

Robert Armstrong

6th January 1983

W.0801

31 December 1982

TO: SIR ROBERT ARMSTRONG

cc: Mr Sparrow
Mr Gregson
Dr Davies
Mr Courtney
Dr Miles/Mr King

FROM: DR NICHOLSON

ACARD'S PRESS PROFILE

On 14 December Sir Henry Chilver, Chairman of ACARD, was invited to lecture to the Parliamentary and Scientific Committee. He marked the occasion with a press briefing earlier the same day. This event was the first attempt to broaden ACARD's press profile in line with the approach endorsed by the Prime Minister.

PRESS BRIEFING

The press briefing was attended by about 15-20 journalists covering the major national dailies and weeklies. The BBC sent two correspondents. In addition to the briefing Sir Henry lunched with David Fishlock of the Financial Times and was interviewed by Channel 4.

Sir Henry's performance was very skilful, showing a commanding yet quiet authority. He defined a clear role for ACARD following 'Science and Government' and his main themes included the need for the exploitation of existing and new technology within industry emphasising that industry must recognise this in order to survive.

Sir Henry was very supportive of the Government line set out in 'Science and Government' and considered that the new arrangements for co-ordination of science and technology were a sensible compromise between fragmentation and centralisation. They were robust and should be workable under different administrations.

PRESS COVERAGE

One of the main objectives of the briefing was to 'teach-in' the journalists on the role of ACARD by pointing to the way forward.

The subject was not headline-catching; even so David Fishlock's article in the FT ran to 10 column inches and focussed on the need for selectivity in spending on R & D. In a shorter report, the Guardian's Peter Large concentrated on the inability of researchers to get their ideas used.

It is too early to assess the weeklies' response to the briefing.

LECTURE TO THE PARLIAMENTARY AND SCIENTIFIC COMMITTEE

In his lecture Sir Henry described the new arrangements for ACARD, setting them in context and explaining how they might help in encouraging the UK to improve its exploitation of science and technology. In discussion after the lecture Sir Henry was assisted by Oscar Roith, Chief Scientist in DoI (I had an unavoidable engagement). Sir Henry dealt very capably with the discussion, taking a line sympathetic to Government approach. On several occasions he steered the discussion on to the importance of public purchasing which can assist manufacturers to produce products competitive in the world market.

CONCLUSION

The first major press briefing for ACARD since the publication of 'Science and Government' achieved its main objective of enabling the Chairman of ACARD to meet an influential group of journalists to create a better awareness of the Council's activities. Success will be measured by the press response to forthcoming ACARD reports.

RBN.

Thank you.
I am glad this went well.

RCA
6.1.83

10 DOWNING STREET

From the Private Secretary

MR. HATFIELD
Cabinet Office

The Prime Minister has now seen Sir Robert Armstrong's minute of 22 September (Ref: A09538) about Sir Henry Chilver's proposals for increasing Press and public awareness of the activities of ACARD. The Prime Minister agrees in principle with Sir Henry's proposals; she considers, however, that a press conference taken by Sir Henry himself would have far more impact than an announcement of the kind envisaged in Sir Robert's minute.

TIMOTHY FLESHER

30 September, 1982

Ref: A09538

Prime Minister:
Agree to Sir Henry Chilvers proposal?
23/9

PRIME MINISTER

Sir Henry Chilver, the Chairman of the Advisory Council for Applied Research and Development, thinks that it would be desirable to increase Press and public awareness of the activities of ACARD, particularly with the quality national and technical Press. This would help to improve contacts between ACARD and industry (and other non-governmental bodies); and that would improve ACARD's effectiveness and the quality of its advice to Ministers.

2. He would therefore propose to announce the existence of ACARD's current studies on advanced manufacturing technologies and university-industry links (the latter of which you commissioned from the Council in June 1982). This would be done through the Management and Personnel Office Press Office.

3. Sir Henry would also propose in due course to brief a selected group of correspondents about ACARD's role more generally, particularly in the wake of the Government's White Paper on Science and Government (Cmnd. 8591). Such an event might constitute a re-launch of ACARD from a Press point of view. A suitable occasion for this might be the publication of the first joint report by the Chairmen of ACARD and ABRC foreshadowed in Cmnd. 8591. On current thinking this would be early in the New Year.

4. I think that it would be useful for Sir Henry to proceed as he proposes; may I tell him that he may proceed accordingly?

It would be better if he took - press conference - with the relevant men. It would have far more impact than an announcement

RA

Robert Armstrong

22nd September 1982

VB

good
read

MR. WRIGHT
CABINET OFFICE

Advisory Council for Applied Research and Development (ACARD): Information Technology

The Prime Minister has seen Sir Robert Armstrong's minute of 27 April, reference A08228. She is content for him to write to Sir Henry Chilver on the lines of the draft attached to his minute.

WFSR

4 May 1982

6c.

Prime Minister 4
Content that Sir Robert Armstrong should reply to ACARD as attached?

Yes MT

WM 27/4

Ref. A08228

PRIME MINISTER

Advisory Council for Applied Research and Development (ACARD): Information Technology

I submitted to you with my minute of 22nd January some comments from Sir Henry Chilver, ACARD's acting Chairman, on the Government's reply to the ACARD Report on Information Technology of August 1980. The Council commented on certain areas - notably regulation and education and training - in which they felt that further Government action was needed.

2. I propose to send to the Council the attached reply, which the Information Technology Secretariat in the Cabinet Office have prepared in consultation with the Department of Industry, the Home Office and other Departments concerned. It takes account of recent discussions between the Home Secretary and the Secretary of State for Industry on the question of responsibility for radio frequency allocation, and of other relevant recent developments such as the publication of the White Paper on Data Protection. The Chairman of the UGC has also been consulted and has endorsed the comments on education and training.

3. I should be grateful to have your approval to send this reply to the Council. Like the ACARD submission it would not be for publication.

RCA

ROBERT ARMSTRONG

27th April, 1982

DRAFT LETTER FROM SIR ROBERT ARMSTRONG TO SIR HENRY CHILVER

Advisory Council for Applied Research and Development (ACARD): Information Technology

I wrote to you on 22nd January indicating that the Prime Minister had instructed that ACARD's views on certain aspects of information technology (conveyed under cover of your letter to me of 18th January) should be brought to the attention of the senior Ministers concerned and that a full reply would be sent to the Council in due course.

I now attach a reply covering the points raised. Like the submission with your letter to me this is not, of course, intended for publication.

RESPONSE TO ACARD'S COMMENTS ON INFORMATION TECHNOLOGY (IT) SUBMITTED WITH SIR HENRY CHILVER'S LETTER OF 18 JANUARY TO SIR ROBERT ARMSTRONG

Regulation of telecommunications

ACARD have reiterated the proposal in their report on IT that the principal responsibilities for telecommunications regulation and radio frequency allocation should be more closely integrated. Like ACARD, the Government recognise that previously disparate activities are converging and that developments such as cable systems, which are now under active consideration, combine elements of different telecommunications services. Accordingly, they are keeping the present structure of regulatory responsibilities closely under review.

2. The Council's specific comments related to radio frequency allocations. As the Council know, the Home Office are the Department responsible for this and manage the spectrum as a whole, taking the lead in inter-Departmental machinery established for this purpose. Detailed engineering planning of services in particular bands is, however, delegated to users who have the resources to do this. British Telecom (BT), for example, operate their radio services under the general authority of a licence issued by the Home Office. But BT have no prescriptive right to radio frequencies allotted to them and the Government have the power to maintain or remove the monopoly in specific areas of service (as has happened in respect of the Mercury consortium's application for frequencies).

3. As for the more general question of constraints on new users of the frequency spectrum, the basic problem remains one of shortage of frequencies in the bands with growing demands. The Home Office have established machinery for consulting industrial and commercial interests and seek to improve such contacts. However, there is little scope for any short-term change in the present pattern of frequency

allocation, both because of binding international agreements on frequency bands and because of the existing investment by large users. These are fundamental difficulties, whatever the organisational arrangements for frequency allocations.

Data protection

4. ACARD have welcomed the Government's intention to legislate on data protection. The Government have recently published a White Paper setting out their proposals for legislation on data protection which will be introduced as soon as practicable.

Education and training

5. The Government share ACARD's concern that there should be an adequate supply of trained manpower for IT. The Government's response to the original ACARD report gave an account of activity in IT education and training. The initiatives described there are being kept under review and consideration is being given to what further action may be required to provide up-to-date and relevant courses in IT related subjects.

6. At the graduate level it is the Government's intention and that of the University Grants Committee (UGC) that provision for IT-related subjects should have an increased share of the available resources. That would follow from the guidance issued by the UGC in announcing its grant allocation to universities last year when recommending student numbers for engineering and technology and for mathematical sciences.

7. At other levels, various Government initiatives are now in train. The TOPS programme of the Manpower Services Commission (MSC) doubled its provision of places in computer-related skills between 1979 and 1981 and last year 4356 places were available. The total expenditure by the MSC in 1981-82 in support of computer-related training through TOPS, by grant assistance to employers in respect of exist-

ing staff, and through the 'threshold' scheme for unemployed school leavers, was £21 million. The Youth Opportunities / Scheme (YOP) also contributed further computer awareness and training schemes, and the Government have announced that about 100 IT centres will be established under joint MSC and DOI funding which will add significantly to the IT-related training facilities available for young people. Other initiatives include the Department of Industry's support (through the Micro-electronics Applications Programme) for short courses in microelectronics (some 34,000 extra places).

8. Although training must remain primarily the responsibility of employers, the Council will recognise that the Government's programmes represent a significant degree of support for IT-related training from public funds.

9. The placing rate for TOPS trainees has fallen in the last twelve months and the take up of MSC grants to employers has continued to fall short of the number on offer. MSC estimates of future demand at present suggest that there is unlikely to be a significant expansion in demand for computer occupations in 1982, although this could pick up fairly quickly as the economy revives. There is therefore no clear-cut case for an immediate increase in the level of public funding of initial training of the TOPS variety, although more support will be given to young people's needs, and further developments in technician training (including robotics) are in hand.

10. In the longer term, the Micros in Schools Scheme and Microelectronics in Education Programme will increase awareness in computers and experience in their use amongst school leavers; some 4,000 applications from secondary schools under the Micros in School Scheme have already been received and, as 2 teachers from each school have to agree to be trained as a condition of ordering a microcomputer, some

8,000 teachers will receive an initial 4 day course. Later this year the scheme is to be extended to primary schools, thus encouraging interest and 'hands on' experience among the youngest ago groups in education.

MFJ

Gork Mack

25 March 1982

ACARD Report on Exploiting Invention

Thank you for your letter of 24 March. I have consulted the Prime Minister and she is content for your Department to reply to ACARD on the lines described in your letter. She has commented that the Government's reply would have been much more useful, and would have made much more impact, if it had been completed by the middle of last year.

WR

Miss J. Donaldson
Department of Industry

E.R.

PRIME MINISTER

As part of the preparation for the Reception for Inventors and Innovators which you held in January 1981, we asked ACARD to report on the problems faced by private inventors in trying to exploit their ideas commercially.

The Department of Industry have taken a very long time to come up with a reply. They regret this, and lay part of the blame on changes in their Ministers and officials, although that is not really an excuse.

Given the delay, I do not think we would get much credit by publishing the reply widely. Although it tries to make a positive response to ACARD's recommendations, we would inevitably be criticised for the slowness with which the Government has responded. In these circumstances, Mr. Jenkin thinks it would be best for the Department of Industry to reply to ACARD, without any great publicity. The attached letter summarises the response that the Department of Industry have prepared.

Agree that the Department of Industry should proceed in this way?

Yes

CM

We must have a better system of chasing up outstanding matters. It is partly our fault that we let this go on so long

24 March 1982

DEPARTMENT OF INDUSTRY
ASHDOWN HOUSE
123 VICTORIA STREET
LONDON SW1E 6RB
TELEPHONE DIRECT LINE 01-212
SWITCHBOARD 01-212 7676

From the Parliamentary Under Secretary of State 's office
John Wakeham

Willie Rickett Esq
Private Secretary to the
Prime Minister
10 Downing Street
London SW1

24 March 1982

Dear Willie

ACARD REPORT ON EXPLOITING INVENTION

This report was prepared by ACARD at the invitation of the Prime Minister, who was concerned about the problems faced by private inventors seeking the commercial exploitation of their ideas.

2 The Secretary of State for Industry was asked, in consultation with colleagues, to provide a response. This is now ready to send to ACARD, having been cleared by Ministers in other Departments having a direct interest in the ACARD recommendations (DES, Inland Revenue, Treasury, Lord Chancellor's Department and Trade).

3 The Prime Minister may wish to be aware of the main features of the response. There were sixteen recommendations aimed at Government or public-sector institutions; wherever possible, we have provided a positive response to the recommendations.

4 ACARD decided to comment on the problems of innovative small firms as well as those of the independent inventor, but acknowledged that they had little original to say. Although ACARD concentrated on the role played by institutions in assisting innovation, they also referred, in general terms, to the creation of an environment that favours entrepreneurial activity, and acknowledged that the Government's economic policies aim to encourage profitable investment and the taking of risks.

5 The response recognises that the Government has a role to play in creating the educational, economic and social climate in which innovation can take place and as they have already taken steps in their educational, financial and fiscal policies to favour the invention and exploitation processes.

6 The response to the most important of the specific recommendations is summarised below.

Education

7 It is accepted that the UGC should examine possible barriers to the exploitation of ideas by university staff. The Committee of Vice Chancellor's and Principals has published a pamphlet "Universities and Industry", which gives some examples of successful academic contributions to industrial innovation and development.

8 DES has undertaken to act as the focal point in publicising good practice and identifying and overcoming any obstacles to closer and more effective relations between higher education and business.

9 It is agreed that the introduction of appropriate elements of business administration in engineering courses should be considered by the Engineering Council. There are already about 50 courses at universities which combine a business or management subject with an engineering subject.

NRDC

10 Four recommendations about NRDC are being considered within the wider review of the future of the British Technology Group. Its monopoly rights to certain public sector inventions have already been modified when suitable alternative arrangements were available (and future policy is currently being considered by a working party of DOI, DES, and the Research Councils). NRDC has agreed to give financial support to inventors, in appropriate cases, to meet patent and licensing costs, and has agreed to draw special attention to commercial factors to help inventors to appraise their ideas realistically.

Finance

11 The Business Start-Up Scheme and the Loan Guarantee Scheme, announced in the 1981 Budget, and the Venture Capital Scheme, introduced in 1980 for individual inventors and extended in 1981 to investment companies, go a long way towards meeting two of the ACARD recommendations on improving the availability of risk funds. Nonetheless, the provisions of loans to small businesses must be primarily for the private sector.

12 A recommendation that "the capital taxation rules applying to founders of companies should be as generous as those applying to agriculture" is rejected, as transfers of a controlling interest in a business have, since 1977, qualified for the same 50 per cent reduction in value as transfers of owner-occupied agricultural land.

Premises and Equipment

13 A recommendation that finance companies might receive development finance for providing equipment for lease is partially accepted; regional development grants are already available to finance companies providing equipment under lease when other criteria of the grant scheme are met.

Encouragement of Innovators

14 The EPIC Award (Education in Partnership with Industry or Commerce), organised by DOI in consultation with other Departments, and the Academic Enterprise Competition, organised by the British Technology Group, meet ACARD's proposal that there should be a national award scheme to recognise entrepreneurial initiative.

15 To assist in improving links between inventors and entrepreneurs, the Small Firms Service will provide a focal point for steering innovators towards the most appropriate support mechanisms in the public or private sector. Government sponsorship of a comprehensive guide to sources of advice and finance is not accepted because there are already sufficient guides published by the Small Firms Centres, the banks, the Institute of Directors and other organisations.

16 We believe that our response will be regarded by ACARD as constructive. We regret that it has taken much longer than expected to prepare. This is partly because an earlier inter-departmental draft agreed at official level was unacceptable to Ministers. There were considerable delays in redrafting because organisational changes here altered the duties of the officials involved.

17 You will recall that the ACARD report was not published in the normal way but was made available, on request, from the ACARD secretariat. It does not seem necessary that the Government response should be published.

Yours ever

Joanna Donaldson

JOANNA DONALDSON
Private Secretary

W F S Rickett Esq

CABINET OFFICE

With the compliments of
The Private Secretary to the
Secretary of the Cabinet

70 Whitehall, London SW1A 2AS
Telephone 01-233 8319

RESTRICTED

Govt. Machinery

CABINET OFFICE

70 Whitehall, London SW1A 2AS Telephone 01-233 8319

From the Secretary of the Cabinet: Sir Robert Armstrong KCB, CVO

Ref. A07723

8th March 1982

ACARD Submission on Information Technology

Thank you for your letter of ~~1~~ March with a suggested draft response to Sir Henry Chilver's letter of 18 January to Sir Robert Armstrong on information technology.

Sir Robert Armstrong is grateful for these suggestions and has asked the Information Technology Secretariat to take them into account in preparing a coordinated reply to Sir Henry Chilver's submission. I understand that the IT Secretariat have been in touch with your officials and will shortly be circulating for discussion a full draft reply which incorporates the contributions received from other Departments in response to Brian Unwin's letter of 9 February to Ralph Shuffrey at the Home Office (a copy of which was sent to your predecessor).

I am copying this letter to the recipients of yours.

D. J. WRIGHT

(D J Wright)
Private Secretary

Neil McMillan Esq

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10 DOWNING STREET

Note

I have asked Richard Riley

(a) why this response is a year late?

(b) what DoI think will be achieved by publishing it now?

(c) why is it written in such terrible language?

He will let us have a response, and possibly a redraft, next week.

LM
5/3

JH 331

DEPARTMENT OF INDUSTRY
ASHDOWN HOUSE
123 VICTORIA STREET
LONDON SW1E 6RB
TELEPHONE DIRECT LINE 01-212 3301
SWITCHBOARD 01-212 7676

Secretary of State for Industry

4 March 1982

Michael Scholar Esq
Private Secretary to the
Prime Minister
10 Downing Street
London SW1

Dear Michael

ACARD REPORT ON EXPLOITING INVENTION

You will recall that the Prime Minister asked that my Secretary of State should prepare, in consultation with other Departments, a reply to the Report which she had commissioned from ACARD.

2 I now enclose a draft which has been approved by my Secretary of State and his colleagues in other interested Departments. Most of ACARD's recommendations were directed at the Government and we have, wherever possible, provided a positive reaction.

3 You will recollect that the Prime Minister decided that the ACARD Report itself should be published. It was made available in typescript form from the ACARD Secretariat, its availability being announced through an arranged PQ and a press release from No 10. It seems appropriate to us that publication of the response should be arranged in a similar way.

Yours ever
Richard

RICHARD RILEY
Private Secretary

GOVERNMENT RESPONSE TO ACARD REPORT ON EXPLOITING INVENTION

1. The Government welcome this Report and ACARD's broadening of their remit to take account of the problems of existing and new small firms as well as those of the independent inventor.

2. This country has a long tradition of generating ideas in academic and research institutions, and has always had many individual inventors. Equally important however, as ACARD recognise in their report, is the exploitation of ideas and the availability of entrepreneurs, whether operating on their own or within larger businesses, who have the knowledge of the market place needed to select the promising ideas and the managerial ability to transform them into products which can be sold profitably. Whilst our success as a country in this endeavour will depend ultimately on private initiatives of this kind, the Government has a part to play at a number of points in the invention and exploitation process.

3. The Government has a role to help create the educational, economic and social climate in which this process can take place. The recommendations which relate to the educational systems are all being pursued. The Government recognise the need for a financial and fiscal climate favourable to innovation and a number of steps have already been taken.

4. The Government accept that it has a responsibility for encouraging the application of technology in industry as well as providing some support for research and development. The Government also assist the exploitation of this research and development effort through the National Research Development Corporation (NRDC). The Government's decision that the National Enterprise Board (NEB) and the NRDC should work together as the British Technology Group (BTG) whilst retaining for the time being their separate statutory identities, is intended

to strengthen this exploitation process and to facilitate, in partnership with private money, the introduction of new products and processes into British industry, whether the ideas originate in publicly financed research in universities or research coucils or privately financed work undertaken by firms or individuals. A number of the recommendations which relate to the NRDC are being considered in the light of the BTG's emerging policy.

5. The Government agree that changes in society's attitude to business are necessary in creating an environment that favours entrepreneurial activity. It is encouraged therefore by the evidence of higher education's increasingly positive contribution to the emergence and exploitation of new ideas. Through its basic functions of teaching and research, higher education provides the economy with a supply of well-educated manpower, new knowledge and improved understanding. The universities and polytechnics, however, also have a direct short and medium-term contribution to make. This they do in a variety of ways providing, often through industrial liaison units, advice, consultancy and commissioned research and development of Science Parks (which bring industrial concerns onto the campus) and the Government welcome the fact that more universitieis and polytechnics are now investigating the possibility of setting them up.

6. In addition, the Research Councils have provided national coordinators to bring companies and academic departments together in priority fields such as robotics, energy, polymer engineering, marine technology, bio-medical materials, distributed computer systems and production engineering. In most cases the coordinator is an experienced industrialist and in certain cases a consortium of companies contribute to a coordinator's salary. The Science

and Engineering Research Council (SERC) is also experimenting with Regional Brokers whose function is to introduce local industry, and especially small firms, to the help available to them in educational institutions. SERC's Cooperative Grants Scheme encourages industrial involvement in research at an early stage by allowing any company that contributes half the resources of a research programme to receive the exploitation rights, with NRDC receiving a small levy on subsequent sales.

7. Other initiatives for bringing together academic and industrial teams in joint activities include CASE (Cooperative Awards in Science and Engineering) and the Teaching Company Scheme. In CASE there is joint supervision of research of direct interest to participating firms, with some 2000 current projects. In the Teaching Company scheme, organised and funded by SERC and the Department of Industry, firms' problems are tackled jointly. There are 46 industrial/academic partnerships in being with others in the pipeline.

8. Notwithstanding these achievements, the Government are not complacent. More importantly, neither are the universities and polytechnics which will continue to extend and improve their contacts and their cooperative efforts with firms. The Department of Education and Science has already initiated discussions with representatives of the universities, polytechnics and research councils and has undertaken to act as the focal point in publicising good practice and identifying and overcoming any obstacles to closer and more effective relations between higher education and business.

Recommendation The UGC should examine the conditions that affect the exploitation of ideas, and the establishment of businesses, by university staff and seek appropriate changes (para 6).

9. The ACARD report does not adduce any concrete evidence for the contention that certain conditions inhibit the staff of higher education institutions from exploiting ideas and establishing businesses. While there may be instances where the "practices, if not the statutes, of some universities are unnecessarily restrictive in specifying the duties of university staff" (Report paragraph 6), it is worth noting that the university industrial liaison units report no case where insuperable difficulties have arisen.

10. The conditions of service of academic staff are determined by individual universities and, for polytechnics, by the employing local authority. The arrangements for the exploitation of ideas and the establishment of businesses varies from institution to institution, although legislation such as the Patents Act 1977 (which entitles employees to a fair share of the benefit their employers derive from inventions patented under the Act) applies to all.

Detailed guidance to universities was last provided in 1976 when the Committee of Vice Chancellors and Principals (CVCP) published the Report of a Working Party on Patents and the Commercial Exploitation of Research Results, and no difficulties have come to light in the operation of this guidance. The CVCP are, however, taking a continuing interest in university-industry collaboration and have compiled details of projects which illustrate universities contribution to industrial innovation and development. This information has been published in a pamphlet entitled "Universities and Industry".

Recommendation The Department of Education and Science should examine the links between business schools and university science and engineering departments (para 7).

11. This recommendation will be pursued in the context of the joint effort the Department of Education and Science has agreed to undertake in collaboration with the higher education institutions (paragraph 8 above).

12. Nonetheless, the terms of the recommendation merit comment. First management and business education is not confined to the two business schools at London and Manchester. Indeed about two thirds of such provision is made outside the universities, centering upon the 12 Regional Management Centres (RMCs) which are based on polytechnics. The RMCs are variously organised but frequently comprise a network of colleges involved in management education, centred on one or more polytechnics and in some cases also having links with a local university business school. Management and business education at all levels is thus pursued alongside science, engineering and other technical education. Nor is there evidence of "inadequate contact between the technical and financial/management sides" of universities. Indeed the industrial liaison units (see paragraph 5 above) were designed to facilitate just this sort of technical and managerial cross-fertilisation.

Recommendation In the current review of engineering education following the Finniston report, attention [should] be given to the introduction of appropriate elements of business administration in engineering courses (para 5).

13. There are already about 50 courses at universities which combine a business or management subject with an engineering subject. In 1978 the UGC encouraged developments of the kind now proposed by ACARD by providing funds to eight universities for experimental four-year courses aimed at giving undergraduates a better understanding of the business environment. Similar courses have been

developed at two polytechnics while the post-graduate Total Technology courses, supported by the SERC, have been in operation for some years.

14. Finniston recommended that under-graduate courses for engineers should aim primarily at producing first-class engineers with a good knowledge of engineering practice and that subjects such as business administration should be taught at a later stage. The education and training recommendations in the Finniston Report and related issues were debated at a two-day national conference sponsored by DES in October 1980. A report on the conference by an independent committee appointed by the Secretary of State for Education and Science was published in March 1981.

15. The future pattern and content of engineering degree courses will be greatly influenced by recent discussions and by the new Engineering Council. The Council will have the power to accredit engineering degree courses for the purpose of admission of individuals to a register. It will no doubt take into account the themes of recent debates, but it will be independent of Government and free to develop its own views.

Recommendation Government should consider the contrast between the State's role in protecting physical property and its role in protecting intellectual property (para 8).

16. The Government accept that intellectual property is of increasing importance in business life but it is not convinced that there would be overall national advantage in moving, in matters relating to patent infringement, from civil to criminal procedure. Protection by patenting is of long standing and has evolved with time, increasingly being based on internationally agreed principles.

17. It is a longstanding rule that legal aid is not available to groups or corporations. Even the Royal Commission on Legal Services, which recommended some relaxation in the existing rule, specifically excluded from its recommendation groups carrying on a trade or business or operating for profit. Special arrangements for litigation concerning intellectual property do not seem appropriate.

NATIONAL RESEARCH DEVELOPMENT CORPORATION

18. The Corporation's remit is to secure, in the public interest, the development and exploitation of inventions. It can support inventions, whether or not they are patentable, from any source in the public or private sector, and it handles inventions relating to entirely new products or processes and also significant evolutionary improvements. The association of the Corporation with the National Enterprise Board under the title of the British Technology Group will strengthen the Corporation's entrepreneurial approach.

19. Since 1950 NRDC has had rights of first refusal to many inventions arising from Government R&D establishments and work funded by the Research Councils. This recognises that, to secure commercial exploitation, it is often necessary to obtain patent protection and, in many cases, to make financial support available for development or for work aimed at extending or improving the patent protection. In practice NRDC has accepted only about one-quarter of the public-sector inventions offered to it and the remainder could be exploited by some other route.

20. NRDC is subject to the financial discipline of breaking even, taking one year with another. Largely because of one invention which was exploited with outstanding success, the Corporation has been able to conform with this requirement. Nevertheless, the

Corporation's experience, as with similar bodies overseas, is that inventions of major commercial value emerge from academic research only very occasionally and generate substantial income only as a result of many years of further research and development. NRDC is currently self-financing.

Recommendation (i) The NRDC should be assured access to Exchequer funds up to its present £50 million borrowing limit (ii) its monopoly right to inventions originating in certain Government research establishments or financed from the Science Vote should cease (para 15).

21. In recent years NRDC's rights to public sector inventions have been modified in favour of alternative arrangements. For example, with Science and Engineering Research Council Cooperative Grants, industrial property rights arising from the research go directly, in the first instance, to the industrial partner in the collaborative project who then pays a modest royalty NRDC should he make commercial use of the rights. The Government will be considering both these recommendations in the light of BTG's emerging policy.

Recommendation NRDC /should_7 consider giving financial support to the inventor to meet, at least in part, patenting and licensing costs, but without providing any staff support for these activities (para 19).

22. The Corporation has been reconsidering its policy on this issue and is willing to provide such support in appropriate cases.

Recommendation NRDC /should_7 reserve funds specifically for the support of inventors and place these under the

control of the official responsible for dealing with private inventors (para 22).

23. NRDC has not so far made such allocations either for private or academic inventors, but executive staff responsible for private inventors now have delegated financial authorities similar to those for staff responsible for public sector inventions.

Recommendation NRDC should do more to educate inventors in the realistic appraisal of their projects and should in particular consider amending their initial document for inventors.

24. The main educational need for many inventors is a better understanding of commerce and industry. Few such courses for innovators have yet been provided, but the Government is examining how the needs should best be met.

25. NRDC is revising its booklet "Help for the Inventor" which normally accompanies the application form (attached to the ACARD report) and the new version will draw special attention to commercial factors.

FINANCE

26. There has recently been some improvement in the availability of risks funds for the exploitation of inventions and innovations. This is partly the result of improvement in the quality of the presentations to the financial institutions by those seeking finance. The financial institutions have also taken steps to improve their technical appraisals of projects and their implications for the market. Steps taken by the Government include the Business Start-up Scheme and the Loan Guarantee Scheme for small businesses.

Recommendation The capital taxation rules applying to founders of companies should be as generous as those applying to agriculture (para 24).

27. The Government remain committed to reducing the impact of capital taxation and a useful start was made in the 1980 Finance Act. The 1981 Finance Act contains further measures aimed specifically at encouraging lifetime transfers. Further progress will, of course, depend on the economic climate. But so far as this particular recommendation is concerned it should be borne in mind that since 1977 transfers of a controlling interest in a business have qualified for the same 50 per cent reduction in value as transfers of owner-occupied agricultural land.

Recommendation The Government should consider the introduction of a personal tax relief in respect of investment in small firms (para 25).

28. The Chancellor announced such a relief in his 1981 Budget Statement (the Business Start-up Scheme). The details are contained in the Finance Act 1981, Part IV, Chapter III.

Recommendation Small companies should, like individuals, be able to offset capital losses against income. And we would restate two recommendations made in "Industrial Innovation" (page 8):

(i) that tax arrangements which made it attractive to large companies to assist or spawn small businesses might be developed; and in this connection note that a recent report by the Business Graduates Association concludes that United Kingdom Tax laws actively discourage this.

(ii) that the idea of a multiple public sector loan facility, based on the amount of private sector investment in small businesses, should be considered. (Para 26)

29. These suggestions will be borne in mind but the Government believe that the provision of loans to small businesses must be primarily a matter for the private sector. The Government are nevertheless anxious to see an improved flow of private sector funds to small business owners and entrepreneurs wishing to establish their own ventures. Some progress has already been made to encourage private individuals to invest in small businesses through the Business Start-up Scheme (see paragraph 28 above) and the Venture Capital Scheme. This latter scheme (introduced in 1980 for individual investors)was extended in 1981 to investment companies. The Chancellor also announced that the Government have reached agreement with the banks for the introduction of a Government-backed loan guarantee scheme for small businesses. This has been operative from June 1981.

30. These and the other measures already introduced by the Government to help small firms have been publicised under the Business Opportunities Programme. One aim of the programme, launched on 6 May 1981, is to ensure that individual entrepreneurs as well as the owners of small businesses are aware of how they can benefit from these measures to take full advantage of business opportunities.

PREMISES AND EQUIPMENT

31. It is the Government's policy to encourage the start-up and growth of small businesses and as part of this policy steps have already been taken to stimulate small factory building. The first-year industrial building allowance for new premises of up to 2500 sq.ft. was increased from 50 to 100 per cent in April 1980. Agencies

such as the English Industrial Estates Corporation (EIEC), the Welsh Development Agency (WDA) and the Scottish Development Agency (SDA) develop industrial estates in the assisted areas with Government and private money.

32. The small workshops allowance and other industrial building allowances apply throughout the United Kingdom and investment in small premises can be particularly profitable. Direct subsidy for small premises is normally undesirable as it would tend to distort the market and prevent investment by the private sector. So as not to discourage other developers in the area and to persuade the financial institutions to participate there must be an expectation of a reasonable return. A tenant is therefore usually required to agree to a long lease with a right to assign to another business if the venture is unsuccessful or there is a need to move to larger premises.

33. However, the English Industrial Estates Corporation realise that a long lease could cause problems for a business just starting up and have recently been offering very easy terms on their small factories as suggested in the ACARD report. So long as the tenant is prepared to pay an economic rent the terms of the rental agreement are negotiable and may be as short as three months. It is hoped that this practice will extend to estates in the private sector if the EIEC experiment is successful.

Recommendation Finance companies might also receive it [development finance] for providing equipment for lease (para 28).

34. Regional Development Grants are already available to finance companies providing equipment under lease for use in Special Development Areas and Development Areas when other criteria of the grant scheme are met.

Recommendation Government should actively encourage such links [between inventors and local authorities and educational establishments] (para 29).

35. The Government agree that closer links with small firms and individual inventors should be encouraged particularly for turning ideas into prototypes through use of the facilities in colleges of further education. Many colleges are receptive to such approaches and some already make their facilities available. It is the responsibility of each local authority to decide what arrangements are appropriate for its area, for example, Sunderland Local Education Authority have received funds under the Urban Programme to develop facilities in the local college for local enterprises to try out their ideas, and a growing number of local authorities are joining with universities to establish Science Parks.

36. However, colleges which wish to exploit their facilities and expertise for gain must operate within the legal framework of the Local Authorities (Goods and Services) Act 1970 and the Local Government Act 1972.

GENERAL COMMENT

37 The ACARD report has provided a useful stimulus to Government and to a range of other organisations whose long-term interests can be served by reconsideration of the role of the inventor in the creation of wealth, and by review of the adequacy of the existing mechanisms. Since the report was first drafted there have been contributions to the debate from entrepreneurs, bankers, academics and individual inventors.

38. It has been suggested that academic staff have little incentive to exploit the results of their ideas commercially or to make special efforts to avail commercial innovators of their expertise, since their promotion depends mostly on the traditional pattern of research

followed by open publication. Equally, it has been suggested that industrial and commercial staff are not sufficiently aware of and do not make sufficient efforts to exploit academic expertise. It was proposed that a national award scheme, which would recognise successful entrepreneurial initiative involving close and active partnerships of higher education institutions with industry and commerce, could help to remedy these deficiencies. The Government supports this view and has established through the Department of Industry a scheme, to be known as the EPIC Award (Education in Partnership with Industry or Commerce), with cash grants in some cases to assist the development of the partnership. The aim will be to reward and encourage successful examples of cooperation between universities, polytechnics or colleges of higher education and industrial or commercial companies which contribute towards improving the competitive performance of UK industry and commerce, and which can also serve to encourage others. It is intended that the Award should create recognition for such activities as comparable with that given in higher education to published academic work. The scheme will be organised and funded by the Department of Industry in consultation with other Departments. In addition, the British Technology Group has recently announced its Academic Enterprise Competition which offers cash awards to academics who have set up or intend to set up businesses to exploit the results of their research.

39. It has also been suggested that individual inventors and small businesses need further advice on how to make contact with the most appropriate sources of assistance. The Department of Industry will examine the suggestions made in para 13 of the ACARD report for improving links between inventors and entrepreneurs. There is already a multiplicity of channels, including the trade and technical

press, NRDC and private-sector financial institutions, and professional licence brokers. Informal personal contact is often of great importance, as are local and regional organisations.

40. There are many services in the private and public sectors for supporting innovation, the principal institutions being referred to by ACARD in para 16 of their report. Most provide help for inventors and small businesses as part of their broader function. It therefore seems appropriate that each should continue to promote its services individually rather than through a single point. The Government accepts, however, that individuals and small companies can be helped by access to a local source of advice. The Government's Small Firms Services already provides sign-posting services and can, in particular, steer enquiries towards the most appropriate support mechanisms in the public or private sector. In addition, an in-depth counselling service provides many of the features identified by ACARD as being necessary in getting an inventor with a viable proposition on the road to successful exploitation. The Government therefore consider that no additional service is necessary, but the Department of Industry will ensure that the Small Firms Service is fully attuned to giving the right advice to inventors and that this function is publicized.

41. The face-to-face guidance provided by the Small Firms Centres is usefully complemented by published guides, such as those in the Department of Industry's Small Firms series, Money for Business prepared by the Bank of England and the City Communications Centre (1) Official Sources of Finance and Aid for Industry in the UK, published by the National Westminster Bank Ltd., and Sources of Finance for the Smaller Company, published by the Institute of Directors. Further information is provided in the booklets and leaflets published under

(1) Available from the Bulletins Group, Economics Division, Bank of England.

the Business Opportunities Programme referred to in paragraph 30 above. It therefore seems unnecessary for the Government to take steps to sponsor the publication of a comprehensive guide which ACARD recommend in para 17 of their report.

42. This country has an enviable record of scientific achievement and invention but this had not been adequately matched by application to create wealth through competitiveness in world markets. Attitudes which lead some (but not all) UK business sectors to be less effective in long-term international business than as innovators must be changed. The twentieth century British innovator must be as accepted, honoured and rewarded as his forebears were in the first half of the nineteenth century. But of course the technologies, market needs and institutional mechanisms have moved on. The Government will welcome further ideas for additional changes which may now be needed in those areas which they can influence.

WM 3/3

Cont March

DEPARTMENT OF INDUSTRY
ASHDOWN HOUSE
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6401

FROM THE
MINISTER OF STATE
FOR INDUSTRY AND
INFORMATION TECHNOLOGY
KENNETH BAKER'S OFFICE

David Wright Esq
PS/Sir Robert Armstrong
Cabinet Office
WHITEHALL, SW1

1 March 1982

Dear David,

Willie Rickett wrote to Andrew Jackson on 25 January enclosing a letter from Sir Henry Chilver, acting Chairman of ACARD, about various aspects of regulating information technology and said that the Secretary of the Cabinet had been asked to prepare a reply which would not be for publication.

Sir Henry and ACARD have suggested that four aspects of the regulation of information technology should be brought together in a single Department, namely approval of equipment for attachment to the network, regulation of value added services, regulation of private communications systems, which are the responsibility of this Department, and allocation of radio frequencies which is the responsibility of the Radio Regulatory Department. As you know this Department has put forward very similar proposals which would mean, if implemented, the transfer of the Radio Regulatory Department to this Department. The matter is to be considered by Ministers shortly.

Mr Baker has considered Sir Henry's paper and has pointed out that it is his own intention and that of my Secretary of State to issue a consultative document in the very near future which would invite comment on the various alternative options which are open to the Government for regulating information technology. My Secretary of State intends to put forward a paper to E Committee in March which would deal with the introduction of private sector capital into BT and would seek agreement to the issue of a consultative paper. The consultative document would discuss a range of options but would reflect a preference for the creation of a regulatory authority. The future of frequency allocation would need to be mentioned but no particular course of action would be advocated.

In the circumstances Mr Baker thinks that the Prime Minister's reply to Sir Henry might be on the lines of the attached draft.

M30/M30ACP

I am copying this letter to Willie Rickett (No.10), Andrew Jackson (Home Office) and the Private Secretaries to the Secretaries of State for Employment and Education & Science.

NEIL MCMILLLAN
PRIVATE SECRETARY

M12/M12AES

DRAFT LETTER FOR THE PRIME MINISTER TO SEND TO SIR HENRY CHILVER, ACTING CHAIRMAN OF ACARD

Sir Robert Armstrong has shown me your letter of 18 January and its enclosed submission to me on information technology. I am grateful to you for explaining your concern.

The Government entirely accepts ACARD's view that previously disparate activities are converging and that information technology makes it necessary to consider carefully the existing allocation of functions within Government. You suggested that four principal responsibilities in the area of regulating information technology should be brought within the responsibility of a single Department, namely approval of apparatus for connection to the BT networks, licensing of value added services, regulation of private telecommunications systems and the allocation of radio frequencies. The first three of these activities were brought together under the responsibility of the Secretary of State for Industry when the British Telecommunications Act was passed last year; the fourth is the responsibility of the Home Secretary. You are therefore suggesting a transfer of responsibilities between the two Departments.

M30

You mentioned that BT's competitive interests might conflict with its role of assisting the Department of Employment to carry out its regulatory functions. There is a real problem here but its extent should not be exaggerated. BT has no long term role in the approval of apparatus for connection to BT's network: the standards to which equipment must conform, before being connected, are being written by the BSI and the testing for conformity with those standards will be carried out by BEAB. BT is currently helping by testing the so called "pre-liberalised" apparatus which has been selected by the Department for connection to the network but this is only a short term arrangement and there is no conflict with BT's commercial interests.

In the field of licensing value added services and private networks BT's role has, however, given rise to concern. The BT Act gives the power to grant such licences to both the Secretary of State and BT and BT is granting licences in both areas. This raises questions of fairness - should one competitor have the power to keep another off the pitch? - and commercial confidentiality - should BT be enabled to learn the commercial secrets of its competitors when they apply for licences? The problem of fairness is not a serious one, however, because the Department can overrule BT and grant licences when BT has refused them; the Department's recent decision to licence the Mercury network, which was opposed by BT, shows that BT has no

power of veto. The commercial confidentiality argument is valid and the fact that both the Department and BT have separate licensing powers is a cause of some confusion and a potential source of delay.

The separation of telecommunications licensing from the regulation of radio frequencies is also a source of some confusion and may in the past have resulted in inadequate attention being given to industrial and information technology considerations. On the other hand the present arrangements ensure that frequency allocation decisions take full account of broadcasting considerations and the needs of the emergency services. Defence interests have to be taken into account. Steps have nevertheless been taken to increase the industrial and information technology input into the consideration of frequency allocation; the Department of Industry has recently joined the Home Office's Mobile Radio Committee, while the Home Office is participating actively in the Department of Industry's Radiotelephone Working Party. Although progress has been made, the existing arrangements are not entirely satisfactory. The Government is considering the idea that all information technology regulative activities should be brought closer together and we plan to issue a consultative document shortly.

You also referred in your letter to data protection; and to education and training in information technology:

M3(

Data Protection

The DOE is working closely with the Home Office to produce a White Paper which will be followed by legislation.

Education and Training

The Government is well aware of the need actively to involve various Departments to ensure an adequate supply of trained manpower for information technology. At the schools level, the DOI's "Micros in Schools" Scheme complements the DES Microelectronics in Education Programme (MEP) which concentrates on teacher training and software development.

So far some 2,500 applications for microcomputers have been received under the scheme and as 2 teachers have to be trained before the micros can be ordered, 5,000 teachers will receive an initial 4 day course. DOI has also supported the setting up of 'O' and 'A' level electronics courses. DoI and DES continue to support similar developments to ensure industrial applications of technology are brought into the curriculum.

On the training side, the first 30 Information Technology centres have been announced and are being quickly set up: we hope to have established 100 such centres by the end of 1982. This is joint initiative with the Manpower Services

Commission. Beyond this, we have agreed to assist MSC to bring an IT module into Youth Opportunities schemes through an initial pilot in 15 centres - a successful module will then spread into all YOP provision. In the context of Mr Tebbit's New Training Initiative we are in close liaison with DES, Department of Employment, MSC and Industry over how best to ensure IT is given the strongest possible thrust.

To increase the supply of people retained in microelectronics skills, the Department's MAP meets some of the costs of setting up short courses for those already in industry as well as other training initiatives. Over 34,000 extra places have so far been created.

In the higher education sector, although Government believes that this cannot be shielded from the pressure to cut costs, and that it is best for independent bodies such as the UGC to take decisions on the allocation of the available resources we share the concern of the Council that training courses in subjects related to IT should be given a very high priority. There is already a shift in University spending towards science and technology courses and the Government recognises the obligation on the higher education sector to satisfy the needs of industry for highly trained staff in order to help it achieve a competitive position in the new technologies.

M3

Finally, Patrick Jenkin is shortly to have further discussions with Sir Keith Joseph about industry-education links. I shall be hosting a lunch on 2 April, at which I will be discussing with industrialists and academics the role the higher education sector should be playing in encouraging the development of the new technologies.

Gov Hall
file B.

PRIME MINISTER

I got a call this morning from the Chairman's office at ICI to say that Dr. Spinks had died. You will remember that he is the Chairman of ACARD and that you wrote to him when you heard of his illness. I attach that correspondence. He was also a Director of ICI.

C.S.

12 February 1982

Note: the originals of this correspondence were on a CF file - so this minute can be filed on that file.

Fill Govt Machs BK

CF

10 DOWNING STREET

From the Private Secretary

25 January 1982

The Prime Minister has received the attached submission from the Advisory Council for Applied Research and Development (ACARD) concerning information technology.

She has asked that the Council's views on regulating information technology be brought to the attention of the Home Secretary, the Secretary of State for Industry and the Minister for Information Technology, for their information.

The Prime Minister has also asked the Secretary of the Cabinet, in consultation with the Minister for Information Technology, to prepare a reply to ACARD which, like the Council's submission, would not be for publication. She has asked that the reply should specifically indicate the Home Secretary's intentions as to the timing of a White Paper and subsequent legislation on data protection; and comment on the question of education and training for information technology.

I am copying this letter to the Private Secretaries to the Secretaries of State for Employment, Industry, Education and Science, the Minister for Information Technology and to David Wright (Cabinet Office).

W. F. S. RICKETT

Andrew Jackson, Esq.,
Home Office.

file

BM

10 DOWNING STREET

From the Private Secretary

MR. WRIGHT
CABINET OFFICE

Advisory Council for Applied Research and Development (ACARD)

The Prime Minister has seen Sir Robert Armstrong's minute of 22 January, reference A07205.

The Prime Minister is content with Sir Robert's proposals for the handling of Sir Henry Chilver's letter and submission about Information Technology and I have written to the Private Secretaries of the Ministers concerned as in the draft attached to Sir Robert's minute.

I should add that the Prime Minister commented that it was most important to keep up the pressure on the Home Office to come back to colleagues with definite proposals and a draft white paper on data protection. She shares ACARD's fears that lack of legislation in this country could place the United Kingdom at a disadvantage with countries that have already legislated, and that UK industrial interest could suffer as a result.

The Prime Minister has also suggested that the Chairman of the UGC should be invited to comment on ACARD's conclusions on education on training, as well as the Secretaries of State for Education and Science and Employment.

W.P.S. DICKETT

25 January 1982

Prime Minister

Content for Sir Robert to act as he proposes below?
Content with draft letter at A?

MAP 22/1

Ref. A07205

PRIME MINISTER

Yes pm

Advisory Council for Applied Research and Development (ACARD)

I have received from Sir Henry Chilver, ACARD's acting Chairman, the attached letter and submission about Information Technology. It follows from the Council's report on the subject in 1980. The Government accepted many of the report's recommendations but the Council still feels that further action is needed in the areas of regulation, and education and training.

2. The question of regulating information technology and the regulatory activities which ACARD identifies are under review. In particular, we are looking at the arrangements for allocating radio frequencies which are at present the responsibility of the Home Secretary; and I shall in the first instance be discussing the subject with the Home Secretary and the Secretary of State for Industry, and if it is thought that the functions should be transferred in whole or in part to the Department of Industry (or indeed to some other department or agency) I shall make a full submission to you. In the meantime I shall pass ACARD's views on to the two Secretaries of State and to the Minister for Information Technology for their information.

3. On the subject of data protection, ACARD reiterate their fears that, with the increasing use of new methods of collecting and handling data, the lack of legislation in this country will increasingly place the United Kingdom at a disadvantage with other countries who have already legislated, and that British commercial and industrial interests of many kinds would suffer as a result. ACARD therefore urges speed in publishing the White Paper currently being prepared by the Home Office. I am already in touch with the Home Office on this matter, and I will continue to keep up the pressure on them to come back to colleagues with definite proposals and a draft White Paper.

Most important

pm

4. On education and training, ACARD estimated in its earlier report that this country was short of between 25,000 and 40,000 trained people for information technology. The Council is particularly concerned that the reductions in university spending will restrict the supply of graduate-level manpower at a time when there are already predictions of a shortfall in numbers of electronics engineers. The Secretaries of State for Education and Science and Employment might be invited to comment, in consultation with the Minister for Information Technology. and the Chairman of UGC.

5. With the help of the IT Unit in the Cabinet Office, and in consultation with the Minister for Information Technology, I will arrange for the preparation of a reply to ACARD. Like the present Council submission, it would not, of course, be for publication.

6. I attach a draft letter for your Private Secretary to send to the Private Secretaries of the Ministers concerned informing them of ACARD's views and outlining proposals for the coordination of a reply. In the meantime, I shall write to Sir Henry Chilver telling him that the Council's views are being brought to the attention of the Ministers concerned, and that there will be a full Government reply in due course.

RCA

ROBERT ARMSTRONG

22nd January 1982

DRAFT LETTER FROM PRIVATE SECRETARY TO THE PRIME MINISTER TO THE PRIVATE SECRETARY TO THE HOME SECRETARY

The Prime Minister has received the attached submission from the Advisory Council for Applied Research and Development (ACARD) concerning information technology.

She has asked that the Council's views on regulating information technology be brought to the attention of the Home Secretary, the Secretary of State for Industry and the Minister for Information Technology, for their information.

The Prime Minister has also asked the Secretary of the Cabinet in consultation with the Minister for Information Technology, to prepare a reply to ACARD which, like the Council's submission, would not be for publication. She has asked that the reply should specifically indicate the Home Secretary's intentions as to the timing of a White Paper and subsequent legislation on data protection; and comment on the question of education and training for information technology.

I am copying this letter to the Private Secretaries to the Secretaries of State for Employment, Industry, Education and Science, and Minister for Information Technology and David Wright (Cabinet Office).

IT

ADVISORY COUNCIL FOR APPLIED RESEARCH AND DEVELOPMENT
70 Whitehall, London SW1A 2AS Telephone: 01-233

cc- Mr Unwin
Mr Courtney
Mr Norman

RNK

Sir Robert Armstrong KCB CVO
Secretary to the Cabinet
Cabinet Office
70 Whitehall
London SW1A 2AS

18 January 1982

Dear Robert

Information Technology

As you may recall, ACARD presented a report on Information Technology to the Government in August 1980, and received the Government's written response last autumn.

The Council has now had an opportunity to discuss the responses and, while many of our recommendations have been accepted, we are still very concerned over the issue of regulation, and education and training. We discussed these problems with Mr Kenneth Baker last month but we feel that their solution goes beyond the Department of Industry and into other departments of Government.

I have set out the Council's views briefly in the attached note, and we would be grateful if you would draw these to the attention of the Prime Minister.

Yours ever

Henry

SUBMISSION TO THE PRIME MINISTER

from Sir Henry Chilver, Acting Chairman, ACARD

INFORMATION TECHNOLOGY

In August 1980 the Council presented to the Government a report on Information Technology (IT). The Government accepted many of ACARD's recommendations, and the Council has discussed the subject with Mr Kenneth Baker. We recognise that much is being done. But there are two areas in which the Council feels that Government action is still needed. These concern (1) regulation and (2) education and training.

ACARD drew attention to four principal responsibilities in the regulatory field which should, it is suggested, be brought within the responsibility of a single Department: approval of equipment for connection to the public communications network; regulation of "value added" services using the network (eg data processing services); regulation of private communications systems; and control of the use of radio frequencies. The Government has announced its new policies regarding the first two of these areas, but the Council's preference would still be for these four regulatory functions to be more closely integrated. In IT, many previously disparate activities are converging as such techniques as satellite and cable communications become more widely used and integrated with the more traditional telecommunications systems. The results will be a greater demand for telecommunications services which overlap traditional regulatory boundaries. We are concerned that, as far as we are aware, there is no way in which an overview can be taken of this area of regulation. Two examples may suffice.

First, we are concerned that British Telecom's new competitive interests will conflict with the regulatory functions which it still retains, to the detriment of its competitors. Some civil bands are regulated by the Home Office and others (the so-called "common carrier bands") by British Telecom (BT). In the wake of the British Telecommunications Act, the Government intends to allow and encourage a wider range of communications services. But as far as the Council is aware, there is no mechanism in Government for deciding whether the frequencies to be used by new services should be allocated from the "common carrier bands" or from the other civil bands available. BT's commercial interests might lead BT to resist encroachment on their own frequencies.

Second, ACARD is aware that present arrangements for allocating and regulating radio frequencies impose constraints on new users. We suspect the reason for this to be that established users in the public sector, such as defence and broadcasting services, are taking up so much of the radio spectrum that would-be private sector users are being constrained. We suggest that among the criteria to be weighed in the national interest

are the interests of customers, manufacturing industry, and new companies providing telecommunications services. The Council therefore still considers that there is a requirement to bring together the regulation of all frequencies used for telecommunications. It would also like to see the criteria used for allocation defined more clearly and publicised more widely than at present.

In the area of regulation for data protection, the Council welcomes the Government's intention to legislate. We look forward to early publication of the promised White Paper in order that legislation may be introduced in the next Parliamentary Session.

With regard to education and training, the Council recommended that the Government, its agencies concerned with training, and educational bodies at all levels should examine the provision of education and training courses in subjects related to IT and propose measures to stimulate an increase of training in firms. We welcome the Government's intention to establish thirty IT centres to provide training and work experience for disadvantaged young people in inner city areas. But the reduction in grants recently announced by the University Grants Committee has borne heavily on those institutions most closely associated with the provision of trained graduate-level manpower in IT. Although the Government in its response to our report "hopes that ... institutions will take into account the contribution which ... information technology can make to the long term health of the economy ...", the Council is deeply concerned that the depth of the cuts will negate this sentiment. Indeed, we understand that current predictions indicate a serious shortfall in the supply of electronics engineers in the future. We therefore urge that the Government consider further steps to ensure an adequate supply of trained manpower for IT.

Sir Henry Chilver

Acting Chairman, ACARD

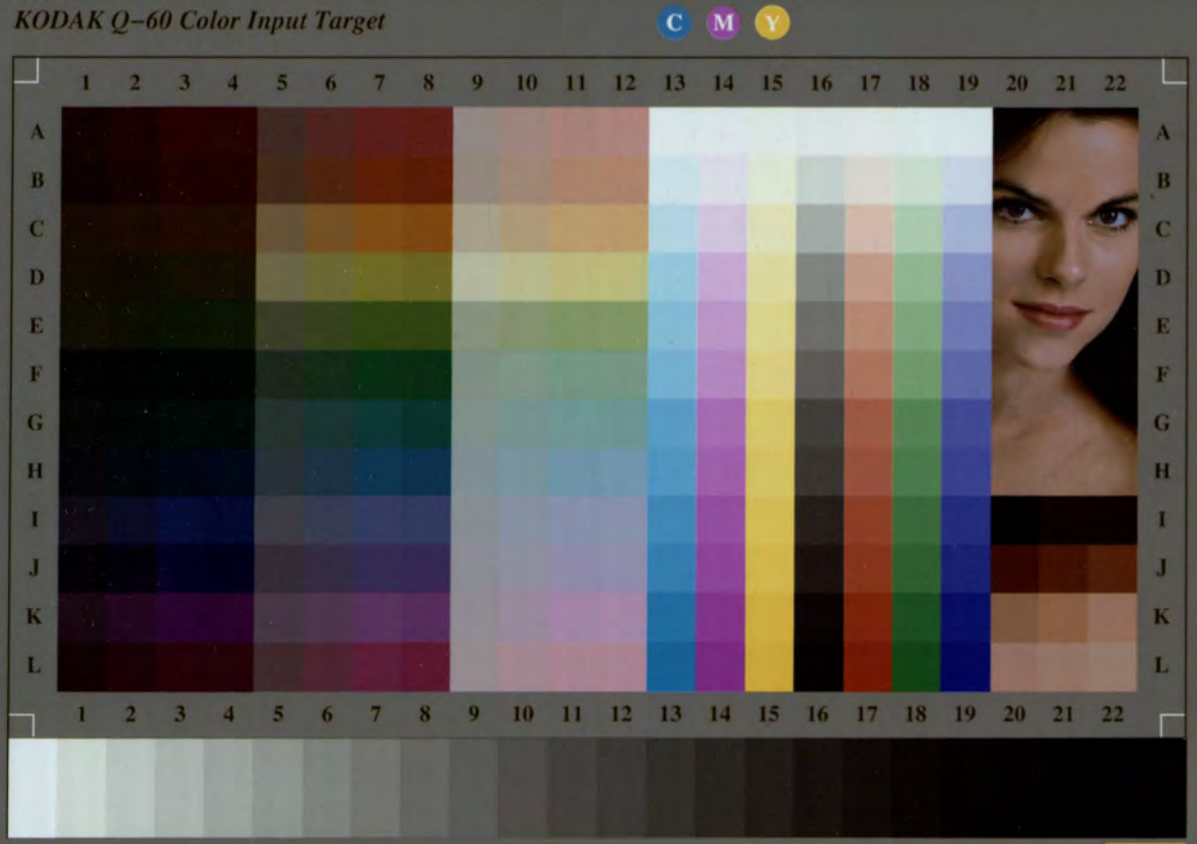
18 January 1982

PART 2 ends:-

WR to O. Wright 14/12/81

PART 3 begins:-

ACARD to RTA 18/1/82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